P-ISSN: 2304-3075; E-ISSN: 2305-4360

International Journal of Veterinary Science

www.ijvets.com; editor@ijvets.com

Research Article

An Anatomical Study on the Eye of the One-Humped Camel *(Camelus dromedarius)*

Ibrahim A Abuagla[1], Hassan A Ali[2] and Zarroug H Ibrahim[2,3*]

[1]Faculty of Veterinary Medicine, University of Al-Butana, Tamboul, PO. Box: 200 – Ruffa, Sudan
[2]College of Veterinary Medicine, Sudan University of Science and Technology, PO. Box. 204, Khartoum-North, Sudan.
[3]Current address: College of Agriculture and Veterinary Medicine, Qassim University, KSA
***Corresponding author:** zarrougibrahim@hotmail.com

Article History: Received: February 19, 2016 Revised: March 24, 2016 Accepted: April 11, 2016

ABSTRACT

The one-humped camel has a socioeconomic importance in hot and dry environments of Central Asia and East and North Africa. Research on the camel eye morphology is scanty in the available literature. The present study is an attempt to provide basic gross anatomical information on the eye of dromedary camel to elucidate the presence of structural modifications suiting the harsh desert conditions. Fresh and 10% formalin fixed specimens from thirteen heads of adult camels of both sexes collected from Tambul slaughterhouse were used to study the eyeball and its associated structures. The orbit of the one-humped camel was circular, equidistant, completely osseous and markedly projecting laterally. The upper eyelid had long cilia and tuft of long cilia was situated dorsal to the medial canthus. The cilia of the lower eyelid were short and they gradually disappeared towards the lateral cantus. The lacrimal gland located craniodorsal to the eyeball just medial to zygomatic process of frontal bone. It was lobulated and its duct system lacks puncta lacrimalia. There was no choroidal tapetum. The sclera formed the largest part of the fibrous layer and the cornea-scleral junction was heavily black pigmented. The different measurements of the right and left eye showed no significant differences (P>0.05). As a result, some variations in the gross anatomy of the camel eye were revealed in the present study that there could be structural modifications to suit the harsh desert conditions.

Key words: Eye, One-Humped Camel, Anatomy

INTRODUCTION

The camel occupies the north and south area of latitude 15ºC which is characterized by being an arid or semiarid zone (Wilson, 1984). The camel is a domestic multipurpose animal used by its owners for milk, meat, transportation, draft activities and riding. In order to survive in the harsh environmental conditions, the camel managed to adapt itself physiologically and anatomically (Yagil, 1984). This is well expressed by temperature regulation, concentration of urine, soft feet, long limbs and small well – protected eyes.

The anatomy of the eye of domestic animals is thoroughly investigated (Sisson and Grossman, 1975), yet most of the available literature on the eye of the camel is scanty (Bareedy *et al*., 1986; Ibrahim, 2003; Sadeg *et al*., 2007; Alsafy, 2010).

The gross anatomy of the eye has been extensively described in equines (Sisson and Grossman, 1975), bovines (Dyce and Wensing, 1971), sheep (May, 1954), goat (Constantinescu, 2001) and dog (Bradley, 1959). The basic architecture of the eye is similar in all farm animals except to minor difference.

Regardless of the socioeconomic importance of the one-humped camel, the gross anatomy of the eye has been received a little attention. The present study is therefore an attempt to provide basic anatomical information on the eye of camel to elucidate the presence of structural modifications to suit the harsh desert conditions.

MATERIALS AND METHODS

Thirteen heads of apparently healthy adult camels of both sexes and different ages and both sexes were collected from Tamboul slaughterhouse, Sudan. Five fresh whole heads were used for measuring the angle of binocular vision, estimation of weight (g) of the eye with and without periorbital tissue using a sensitive balance and estimation of volume (cm^3) of eye with and without periorbital tissue using the water displacement method. Linear measurements (cm) such as optic axis, visual axis, meridian corneal circumference and pupil diameter were

Cite This Article as: Abuagla IA, HA Ali and ZH Ibrahim, 2016. An anatomical study on the eye of the one-humped camel *(Camelus dromedarius)***.** Inter J Vet Sci, 5(3): 137-141. www.ijvets.com

done on the same eyes using a ruler. Data were statistically analyzed using Student's t-test and difference was considered statistically significant at P≤0.05.

Three fresh whole heads and five whole heads fixed in 10 % formalin were carefully dissected using a dissecting microscope to study the eyelids, periorbita, lacrimal glands, eyelids, eyeball tunics (fibrous, vascular and nervous tunics), ocular muscle, and nerve supply.

RESULTS

Orbit

The camel orbit was completely osseous and was situated almost equidistantly between the premaxilla and nuchal crest (Fig-1).The frontal bone formed the roof of the orbit and a portion of the medial wall. The zygomatic process of the frontal bone extended laterally and formed a large portion of the roof and lateral wall of the bony orbit. The presphenoid bone formed the caudomedial part of the orbit. The palatine formed a portion of the ventromedial wall of the orbit. The maxilla contributed a small area to the rostral ventral part of the orbital wall. The lacrimal bone forms a portion of the medial and rostral wall of the camel orbit. The zygomatic bone forms the greater portion of the rostral and ventral margin of the orbital rim and the rostroventral part of the orbital wall. The orbital cornea, which was a light – blue area formed by a modified thin skin with little hair, encircled the lids (Fig-2).

Eyelids and conjunctiva

Two upper and lower eyelids that guarded the eye were quite thick and appeared rolled or thrown into transverse hillocks when viewed in the living animal (Fig-2).A third eyelid (nictitating membrane) was also observed in the medial canthus. Long cilia were present in both lids and the upper lid cilia were coarse and longer compared to those attached to the lower lid. The longest cilia of the upper lid were in its middle portions whereas the longest cilia of the lower lid were on its medial third.

A well-developed tuft of long cilia was situated just dorsal to medial canthus in both lids. There were slips of muscle bundles, which projected, from the orbicularis muscle into the upper and lower lids. The conjunctiva was attached to the lids and there was a pigmented junction of the conjunctiva and the lids at the lateral angle, butthe medial angle was devoid of pigment. The palpebral fissure was elliptical in shape but wider toward the medial angle. The conjunctiva that covered the third eyelid formed a fold covering an underlying T-shaped cartilage.

Periorbita and orbital fasciae

The preriorbita formed a two-layered fascial pocket around the lacrimal gland (Fig-3). One layer of fascia was dorsal to the lacrimal gland. The obliquus dorsalis muscle and a layer of fat were also found in this pocket. After passing under the rectus dorsalis muscle and the lacrimal gland, it joined the superficial layer of fascia at the lateral margin of the lacrimal gland. Anteriorly the periorbita joined the fascia of the upper lid and the periosteum of the orbit.

The position of lacrimal gland was craniodorsal to the eyeball just medial to zygomatic process of frontal bone. It was lobulated in appearance but has two distinct parts, dorsal thick portion and ventral thin one (Fig-3).

Ocular muscles

There were seven ocular muscles in the camel that comprised the dorsal, ventral, medial and lateral recti, the dorsal and ventral oblique and the retractor bulbi (Fig-4). The recti muscles originated from the apex of orbit around the optic foramen and a flattened tendon into the cranial part of the sclera inserted them. The ventral oblique muscle originated from the fovea trochlearis and was inserted to the sclera between the ventral and lateral recti muscles. The dorsal oblique muscle originated from fovea trochlearis and inserted to the sclera. The origin of retractor bulbi muscle was near the optic foramen and its insertion was on the posterior aspect of the globe.

Nerve supply

The retractor muscle surrounded the thick, rounded, cord-like optic nerve, which emerged from the ventrolateral aspect of globe and passed into the optic foramen (Fig-5). Optic disc (papilla) was a circular whitish spot at the caudo-ventral part of the globe from which the optic nerve originated. The trochlear nerve laid lateral to the dorsal oblique muscle, which entered after a very short intra orbital course (Fig- 6).

The oculomotor nerve entered the orbit at its apex and supplied all the muscles of the eyeball except the dorsal oblique, the lateral rectus and the retractor (Fig .6). Two main divisions of the nerve were observed: the upper division supplied branches to the dorsal straight muscle of the eyeball and the levator of the upper lid; the lower division was larger and passed between the ventral and lateral straight muscles to end in the ventral oblique.

A part of the abducent was found running along the border of the lateral straight muscle into which it disappeared at a point about the middle of the length of the muscle. In addition, the nerve supplied the retractor muscle.

Tunics of the eyeball

There were three tunics (layers) in the camel eyeball were studied in longitudinal sections; they were:

Table 1: The weight and volume of the right and left camel eyeballs

Eyeball	Weight with periorbital/g	Weight without periorbital/g	Volume with periorbital/cm^3	Volume with periorbital/ cm^3
Right	41.30±1.09	21.30±3.11	4.70±0.51	2.3±0.17
Left	42.50±2.26	21.10±2.75	4.40±0.73	2.1±0.25

Table 2: The linear measurements of the right (R) and left (L) camel eyes

Angle of binocular vision/°	Meridian corneal circumference/ cm		Optic axis/cm		Visual axis/cm		Pupil diameter/cm	
	R	L	R	L	R	L	R	L
62.00±4.15	3.10±0.04	3.30±0.25	3.24±0.20	3.28±0.22	2.86±0.24	2.82±0.21	2.04±0.21	2.08±0.23

Fig. 1: The circular orbit in a fresh specimen. It notes that it is entirely osseous.

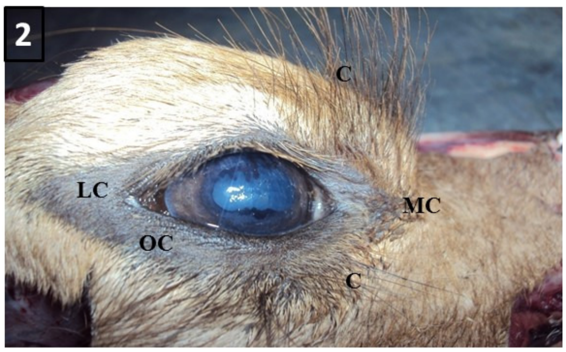

Fig. 2: The orbital corona (OC) surrounding the eyelids. It notes the long cilia associated with the upper lid and the tuft of long cilia (C) on medial canthus (MC) and lateral canthus (LC).

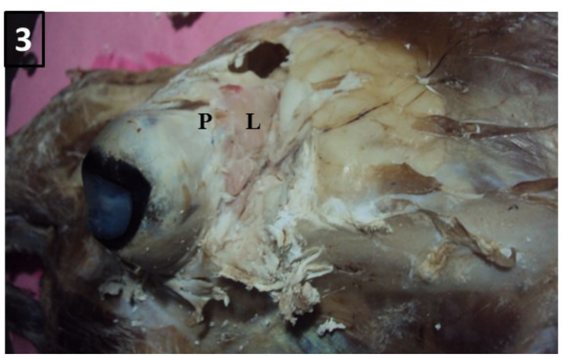

Fig. 3: The periorbita (P) and lacrimal gland (L).

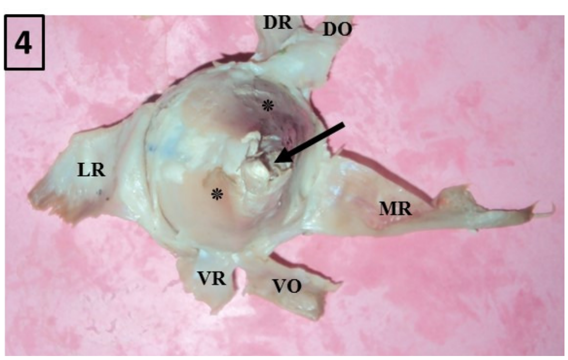

Fig. 4: Ocular muscles: dorsal rectus (D R), ventral rectus (VR), lateral rectus (LR), medial rectus (MR), dorsal oblique (DO) and ventral oblique muscles (VO). It notes the retractor muscles (asterisks) surrounding the optic nerve (Arrow).

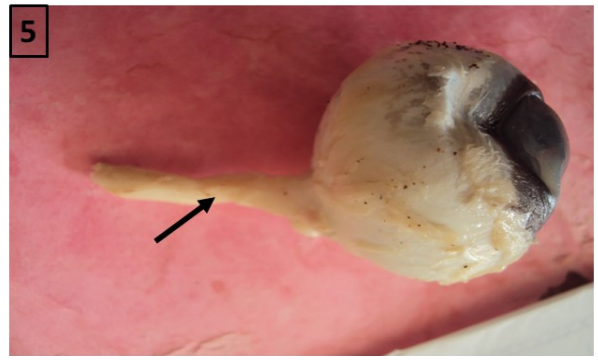

Fig. 5: Nervus opticus (Arrow).

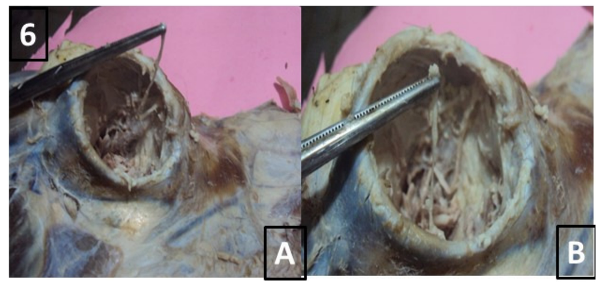

Fig. 6: The forceps handled pointes out; A: Trochlear (T) and B: Oculomotor nerves.

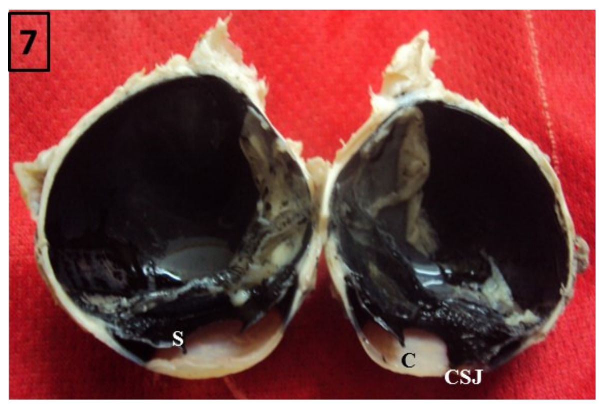

Fig. 7: Pigmentation at corneosclaral junction (CSJ), sclera (S) and cornea (C).

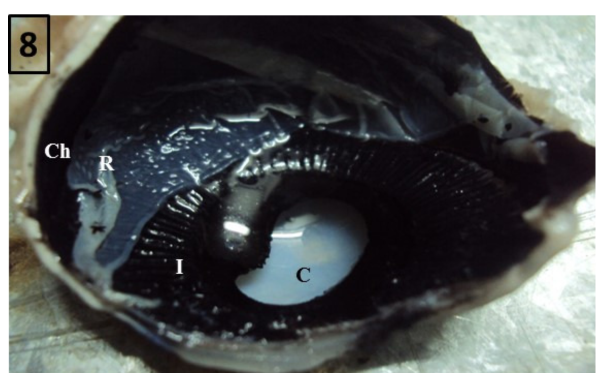

Fig. 8: Tunics of the eyeball. It notes the cornea (C), iris (I), choroid (Ch) and folded retina (R).

Fig. 9: Transverse section of the eyeball shows the ciliary processes (Cp) and Lens (L).

Fig. 10: Eyeball longitudinal section shows the lens (L) attached to ciliary body (Arrow).

Tunics of the eyeball

There were three tunics (layers) in the camel eyeball were studied in longitudinal sections; they were:

Fibrous layer

It was made up of a large whitish sclera and a small central transparent cornea. The sclera, which was penetrated caudo-ventrally by the optic nerve, was thin at the points of attachment of recti muscles. It showed black pigmentation along the corneo-scleral junction (Fig-7). The cornea was more strongly curved than the sclera and it was transparent although some pigmentation, especially towards the cornea-scleral junction was common and tended to increase with age (Fig .7).

Vascular Layer

It consisted of the choroid, ciliary body and iris. The choroid had an outer heavily and darkly pigmented layer and an inner vascular layer. (Fig- 8 and- 9). No tapetum was observed. The ciliary body was situated caudal to the lens and was made up of radially arranged ciliary processes, which encompassed the pupil, and grooves to which the zonula or suspensory ligament of the lens were secured (Fig .9). The iris was interposed between the cornea cranially and the lens caudally where it was attached to the anterior margin of the ciliary body (Fig- 9). It was dark in color and corrugated on both sides. It completely surrounded the pupil. Granular projections from its free margins were not observed.

Nervous Tunic (Retina)

The retina was gray in color and formed the entire inner coating of the eyeball. It was limited cranially by the iris and caudally by the origin of optic nerve (Fig-8).

Lens

The lens (Fig- 10) was situated caudal to iris .In fixed specimens it was biconvex in shape and was attached to the ciliary body at its poles by thin fibrous strands (Zonula).In fresh specimens it was jelly-liked.

Measurements

The different measurements of the right and left eye (Tables 1 and 2) showed that there was no significant difference (P>0.05).

DISCUSSION

In the present study, the orbit is completely osseous, circular and equidistant. This confirms the findings of Smuts & Benzuidenhout (1987) which has mentioned that the orbit is situated at the border of skull between cranium and face. The presence of a colored orbital corona surrounding the lids was reported for the first time.

Al-Ramadan and Ali (2012) described the third eyelid of camel as a large conjunctival semi-lunar fold extending up to 3 cm from the medial canthus over the anterior surface of the eyeball. In the current investigation, the third eyelid formed a fold covering an underlying T-shaped cartilage. In camels (Ibrahim, 1990) the third eyelid is situated on the rostromedial aspect of the eyeball and it is quadrilateral in outline in camel (Ibrahim, 1990) in the same species. In domestic mammals, the superficial part of the third eyelid possesses a dark pigmentation at the free margin (Sisson and Grossman, 1975). Moreover, Ibrahim (1990) mentioned that another dark pigmentation appears at the line of reflection of the conjunctiva onto the superficial gland of the third eyelid especially in old camels.

The present results showed a pigmented junction of the conjunctiva and the lids at the lateral angle. According to Ibrahim (1990) there were darkly pigmented areas in several horizontal lines on the caudal half of the conjunctival which represented sub-conjunctival lymph nodules.

Unlike other domestic animals (Sisson and Grossman, 1975) the present study showed that the cilia of both lids in camel were numerous and extremely long. Furthermore, a tuft of long cilia was observed dorsal to the medial canthus. It has also been found that the medial margin of the camel eyelids possesses a triangular hairy area Tayeb (1962). The palpebral cilia and the tuft were probably protective mechanisms against sun light, dust, foreign bodies and insects. Moreover, Tayeb (1962) suggests that the long, strong and densely arranged eyelashes at the margins of the eyelids of the camel are important in the dry and sandy environment.

According to the present study, the lacrimal gland was lobulated and it had dorsal and ventral parts. The periorbita formed a two-layered fascial pocket around the gland, which occupied the craniodorsal part of the eyeball just medial to zygomatic process of frontal bone. The position and shape of the lacrimal gland was similar to that described by Bareedy *et al* (1986), Ibrahim (2003), Sadeg *et al* (2007) and Alsafy (2010). In the present study no puncta lacrimalia are observed. This confirms the report of Sadeg *et al* (2007), Reece (2009) and Alsafy (2010) in the camel.

The number and distribution of the ocular muscles currently reported in the camel are similar to that described by May (1954) in sheep , Bradley (1959), in the dog, Sisson and Grossman (1975) in equines, Dyce & Wensing (1971) and Habel (1983) in bovines and Constantinescu (2001) in the goat .

The present study confirms the findings of Jain *et al* (2010) that the motor nerve supply to the muscles of the eyeball comes from oculomotor, trochlear and abducent nerves. Weight and volume of both eyeball with and without periorbita were described for the first time.

The internal architecture of eyeball in this studyis similar to that of other domestic animals (Sisson and Grossman, 1975). It contained three layers: fibrous layer, vascular, layer and nervous layer (retina). However, in the present investigation, the sclera formed the largest part of the fibrous layer. This is in agreement with the findings of Bareedy *et al* (1986) who stated that the sclera constituted 85%. Furthermore, in this study, the corneo-scleral junction is heavy pigmented in black. This and the heavy pigmentation of the choroid possibly absorb harmful rays (ultraviolet).

In the present study, the eyeball weight with periorbita was about 41.9 g and without periorbita was about 21.2 g; its volume with periorbita was about 4.55cm^3 and without periorbita was about 2.2cm^3. The different measurements of the right and left eye in this study showed that there was no significant differences. Camel eyeball was also reported to weigh about 36.2 g. and to measure about 3.7 cm in length and about 4.1 cm in width Symthe (1958) reported that the dimensions of the eyeball of the camel are 4.5 cm in length and 4.0 cm in width (Amira-Abuelhassan, 2007). According to Symthe (1958) the dimensions of the eyeball of the camel are 4.5 cm in length and 4.0 cm in width. Moreover, Rahi *et al* (1980) stated that the eyeball of the camel is about 3.5 cm in length and 3.1 cm in width, the cornea is about 2.5 cm in length, and 1.7 cm in width. The controversy in these reported measurements might be due to differences in the age and breed of the animals studied.

According to Reece (2009), herbivores have more laterally placed eyeball and have wider field of vision. In the present investigation, the angle of binocular vision was wide ranging between 55^o to 65^o. This coupled with a long flexible neck probably helps the camel to maintain greater protection against predators.

Conclusion

The present study revealed several variations in the gross anatomy of the eye when compared with other domestic animals; these variations could be structural modifications to suit the harsh desert conditions.

REFERENCES

Alsafy MAM, 2010. Comparative morphological studies on the lacrimal apparatus of the one-humped camel, goat and donkey. J Biol Sci, 10: 224-230.

Al-Ramadan SY and AM Ali, 2012. Morphological Studies on the Third Eyelid and its Related Structures in the One-Humped Camel (*Camelus dromedarius*). J Vet Anat, 5: 71-81.

Amira-Abuelhassan IA, 2007. Morphology and Morphometry of the eyeball and its appendages of the dromedary camel (Camelus dromedaries). MSc. Thesis. University of Khartoum. Sudan.

Bareedy MH, Z Soliman KH, AM Balah and AM Omer, 1986. Macro and microanatomical studies on the cornea, sclera and choroid of the eye of the dromedary camel. Proceedings of the ninth scientific conference of the Egyptian Anatomical Society.

Bradley OC, 1959. Topographical anatomy of the dog 6th Ed Oliver & Boyd, Edinburgh.

Constantinescu GM, 2001. Guide to regional ruminant anatomy based on the dissection of the goat. Iowa state University press. Ames.

Dyce KM, WO Sack and CTG Wensing, 1971. Essentials of bovine anatomy. A cademische paperback Utrecht.

Habel RE, 1983. Guide to the dissection of domestic ruminants. 3d. Ed .R .E. Habel, New York.

Jaint RK, P Kumar and AD Singh, 2010. Topographic anatomy, blood supply and nerve supply of the extrinsic muscles of the eyeball in camel (*Camelus dromedarius*). J Camel Pract Res, 17: 167-171

Ibrahim MT, 1990. Surgical Anatomical Studies on appendages of the eye in camel, buffalo and donkey. Thesis Submitted for Ph. D. of Anatomy. Department of Anatomy and Histology. Assiut University Egypt.

Ibrahim ZH, 2003. A morphological, histochemical and morphometric study of the lacrimal apparatus of the camel (*camelus dromedarius*) MSc Thesis, University of Khartoum, Sudan.

Majid AA, 2000. The one-humped camel (*camelus dromedarius*) in the Sudan. An annotated bibliography (1905-2000). 2nd Edition .Camel applied research and development network (CARDN); Animal Resources Research Corporation (ARRC).

May NDS, 1954. The anatomy of the sheep: a dissection manual. 3rdEdition. University of Queensland.

Rahi AHS, H Sheikh and G Morgan, 1980. Histology of the camel eye. *Acta Anatom*, 106: 345-350.

Reece W, 2009. Functional anatomy and physiology of domestic animals .r54th Edition. John Wily Inc, Publisher Ames, Iowa.

Sadeg AB, Shadkhast M, Sharifi S, Mohammadania A, 2007. Lacrimal apparatus system in the one-humped camel of Iran (*camelus dromedarius*): Anatomical and radiological study. Iran J Vet Sc, 2: 75-80.

Sisson S and JD Grossman, 1975. The anatomy of the domestic animals Vol. IWB. Saunders Philadelphia, London.

Symthe RH, 1958. Veterinary ophthalmology. Second Edition. Bailliere Tindall and Cox. London.

Wilson RT, 1984. The Camel. 1st Edn., Longman, London, New York, pp: 119-127.

Tayeb MAF, 1962. The eyes of the camel as an animal adapted to live in the desert. Vet Med J GIZA, 8: 151-155.

Yagil, R, 1984. The camel: Self-sufficiency in animal protein in droughts-stricken areas in the right to food. International Conference Hunger, Montreal, Proceeding, pp: 28.