*Vol 17 No 2, p 167-171*

# TOPOGRAPHIC ANATOMY, BLOOD SUPPLY AND NERVE SUPPLY OF THE EXTRINSIC MUSCLES OF THE EYE BALL IN CAMEL (*Camelus dromedarius*)

**R.K. Jain, Pawan Kumar and A.D. Singh**
Department of Veterinary Anatomy, College of Veterinary Sciences,
CCS Haryana Agricultural University, Hisar, India

## ABSTRACT

The anatomical studies on the extrinsic muscles of the eye ball revealed that the dorsal oblique muscle had the longest tendon while the ventral oblique muscle had the shortest tendon among all the extrinsic muscles of the eye ball. The line of insertion of dorsal rectus muscle was the widest while the ventral rectus muscle was the narrowest among all the recti muscles of the eye ball. The medial rectus muscle had most posterior line of insertion while the lateral rectus muscle had the nearest line of insertion to the corneo-scleral junction. The blood supply to the eye ball was carried by the ophthalmic artery which arose from the internal maxillary artery. It gave off the frontal artery, lacrimal artery and a branch to the dorsal oblique muscle and then formed the ophthalmic rete. The ophthalmic rete gave off branches to the rectus and retractor muscles of the eye ball. The sensory nerve supply to the muscles of eye ball was carried by the ophthalmic nerve which arose from the trigeminal ganglion. The ophthalmic nerve divided into nasociliary and zygomaticotemporalis branches. The nasociliary nerve gave off branches to the muscle obliquus dorsalis and then terminated by dividing into the ethmoidal and frontal nerves. The motor nerve supply to the muscles of the eye ball was carried by oculomotor, trochlear and abducent nerves. The oculomotor nerve supplied the muscles rectus dorsalis, rectus ventralis, obliquus ventralis and levator palpebrae superioris. The trochlear nerve supplied the muscles rectus dorsalis and obliquus dorsalis. The abducent nerve supplied the muscles rectus dorsalis, rectus lateralis and retractor oculi.

**Key words:** Blood supply, camel, extrinsic muscles, eye ball, nerve supply

The eye ball is held in position by a group of extrinsic muscles which hold the eye ball in the orbit against the pad of retro-ocular fat. The muscle dorsal rectus and ventral rectus rotate the eye ball around the horizontal axis. The dorsal oblique muscle rotates the top of the eye ball medially while the ventral rectus rotates the ventral part medially. The retractor oculi muscle draws the eye ball backward. These extrinsic muscles of the eye ball are not inserted at equal distances from the corneo-scleral junction and movements of the eye ball are produced by the co-ordinated actions of these muscles, involving the combinations which are quite complex. The study of insertions of ocular muscles, blood supply and nerve supply is very important for the treatment of surgical affections which necessitate the resection of one or more muscles and enucleation of the eye ball (Hifny and Misk, 1977).

## Materials and Methods

The study was conducted on nine apparently healthy adult camels of either sex embalmed with 10% formaldehyde solution as per Grossman (1959) technique. These were divided in to three groups of three animals each. In the first group each extrinsic muscle of the eye ball was examined for its length, width, tendinous part, line of insertion and distance from the corneo-scleral junction. The horizontal and vertical planes of the cornea were also measured to know the relative size of the eye ball. In the second group a radio-opaque suspension (20% red lead oxide in liquid soap suspension) was injected through the external carotid artery with steady digital pressure to highlight the blood vessels. After satisfactory filling, it was allowed to settle for 24 hours at room temperature and then the blood vessels supplying the eye ball and its extrinsic muscles were dissected. In the third group a gross and subgross dissection was conducted with the help of an ocular lens to study the sensory and motor nerves innervating the eye ball and its extrinsic muscles.

## Results and Discussion

The present study revealed that the two eye balls in camel were similar to each other and there

SEND REPRINT REQUEST TO R.K. JAIN email: rkvj2008@gmail.com

was no significant difference in the tendons of insertion of the extrinsic muscles of the left and the right eye balls. Similar finding had been reported in cow and buffalo (Hifny and Misk, 1977). Miller *et al* (1964) in dog, Sisson and Grossman (1967) in bovines, Akaevsky (1968) in domestic animals, Williams (1971) in canines and Bradley (1973) in bovines had described the insertion of extrinsic muscles of the eye ball into the sclera. Similarly, Gao *et al* (2008) described the anatomical and histological characteristics of the lacrimal glands in bactrian camels. However, they did not report the width, direction, and distance from the corneo-scleral junction and the characteristic features of these muscles in different domestic animals.

The insertion of the extrinsic muscles of the eye ball in camel was not present at equal distances from the corneo-scleral junction. Generally, the line of insertion of the rectus muscles was nearer the cornea than that of the retractor oculi muscle. The insertion of the oblique muscles was in the intermediate zone between the line of insertion of the rectus and retractor muscles. The insertion of the lateral rectus muscle was the nearest to the corneo-scleral junction amongst all the extraocular muscles. The tendons of insertion of the extraocular muscles in camel were yellowish, thick and glistening and their fibres were arranged in bundles, while in cows and buffaloes they were white, thin and their fibres were equally distributed along the whole length of the tendons (Hifny and Misk, 1977).

The dorsal oblique muscle in camel had the longest tendon (3.02 cm) of any of the extrinsic muscles of the eye ball. It had the narrowest line of insertion which was 1.30 cm wide, it was situated between and behind the line of insertion of the dorsal and lateral rectus muscles and directed obliquely backward and laterally. The tendon of insertion was 3.02 cm long and it was located at a distance of 1.42 cm from the corneo-scleral junction. The line of insertion of the ventral oblique muscle was the shortest (1.60 cm wide) amongst all the extrinsic muscles except the dorsal oblique muscle. Its upper end was completely muscular and was covered under the lower end of tendon of insertion of the lateral rectus muscle for a distance of 1.53 cm from the margin of the cornea. Its lower end was tendinous and was 1.20 cm long and was situated 0.60 cm from the corneo-scleral junction. Hifny and Misk (1977) reported in cows and baffaloes that some fibres of the tendinous insertion of the dorsal oblique muscle were fused with that of the ventral oblique muscle. However, such fibres were not seen in camel.

The line of insertion of the dorsal rectus muscle was the widest (2.28 cm) amongst all the extrinsic muscles of the eye ball in camel while it was that of the ventral oblique muscle in cows and buffaloes

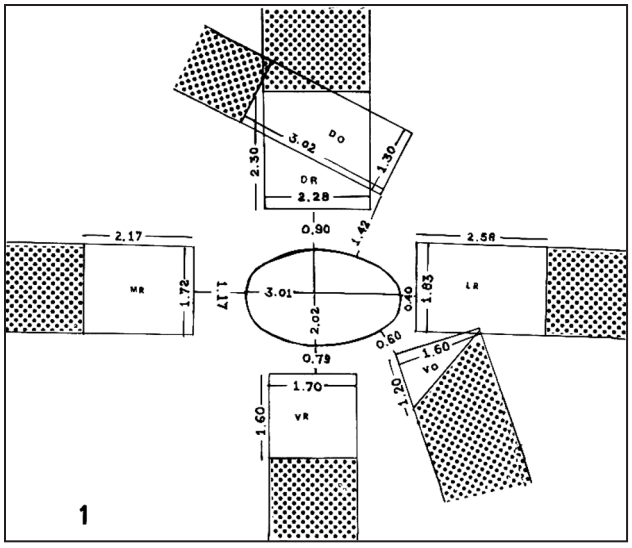


**Fig 1.** Line diagram showing the line of insertion, shape, length, width and direction of the extrinsic muscles of the eye ball in camel (left eye).

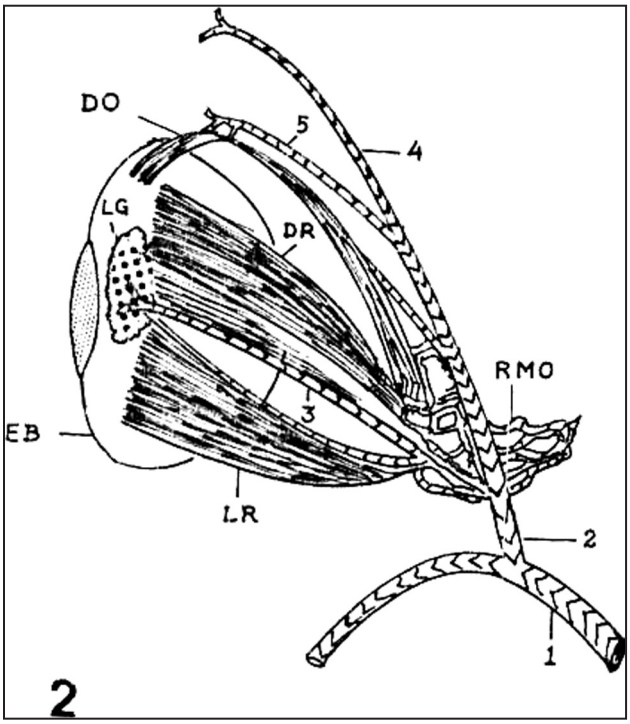


**Fig 2.** Line diagram showing the arteries supplying blood to the extrinsic muscles of the eye ball in camel (left eye). 1, internal maxillary artery; 2, ophthalmic artery; 3, lacrimal artery; 4, frontal artery; 5, artery to dorsal oblique muscle; DO, dorsal oblique muscle; DR, dorsal rectus muscle; EB, eye ball; LR, lateral rectus muscle; LG, lacrimal gland; RMO, Rete mirabile ophthalmicum.

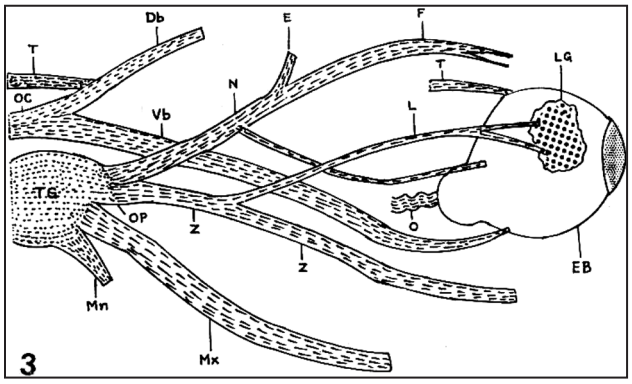


**Fig 3.** Line diagram showing the nerve supply to the extrinsic muscles of the eye ball in camel (left eye). OC, oculomotor nerve; T, trochlear nerve; TG, trigeminal ganglion; Db, dorsal branch of OC; Vb, ventral branch of OC; OP, ophthalmic nerve; N, nasociliary nerve; E, ethmoidal nerve; F, frontal nerve; Z, zygomaticotemporalis nerve; Mx, maxillary nerve; Mn, mandibular nerve; O, optic nerve; LG, lacrimal gland, EB, eye ball.

(Hifny and Misk, 1977). Its tendon was 2.30 cm long and it was situated at a distance of 0.90 cm from the corneal margin. The ventral rectus muscle in camel had the shortest tendon (1.60 cm) amongst all the extrinsic muscles except ventral oblique muscle. Its line of insertion was straight and measured 1.70 cm wide and located at a distance of 0.79 cm from the corneo-scleral junction.The line of insertion of the medial rectus muscle was the most posterior to the cornea (1.17 cm) amongst all the rectus muscles. It was 1.72 cm wide and its tendon of insertion was 2.17 cm long. The line of insertion of the lateral rectus muscle was nearest to the cornea amongst all the extrinsic muscles (0.40 cm). Its line of insertion measured to be 1.83 cm wide and the tendon was the longest amongst all the recti muscles (2.58 cm). The line of insertion of the retractor oculi muscle was the farthest from the corneal margin among all the extrinsic muscles (2.20 cm). The muscle bundles were not well developed and terminated smoothly on the sclera in camel but they terminated abruptly in cows and buffaloes (Hifny and Misk, 1977). The length of the horizontal plane of cornea measured to be 3.01 cm while that of vertical plane was 2.02 cm. The eye ball of camel could easily be differentiated from cows and buffaloes by its larger cornea and eye ball of cow could be differentiated from that of buffalo by smaller cornea (Hifny and Misk, 1977).

**Blood supply :** The blood supply to the eye ball in camel was carried by the ophthalmic artery which arose from the dorsal aspect of the internal maxillary artery (Kanan, 1972). Smuts and Bezuidenhout (1987) in camel and Ghoshal (1975) in ruminants

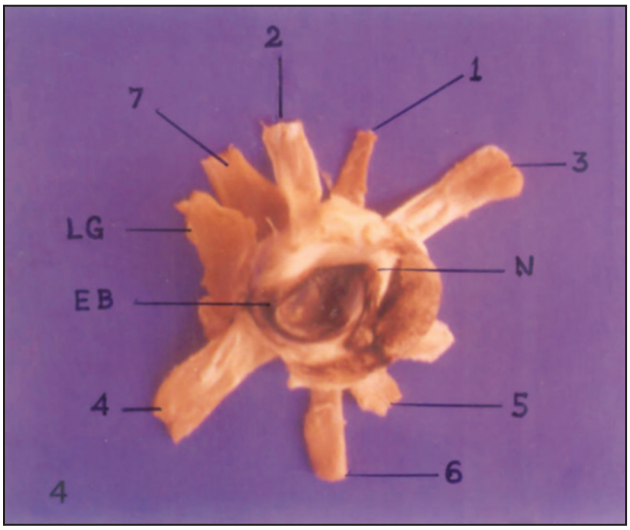


**Fig 4.** Photograph of eye ball of camel showing the muscles of the eye ball (cranial view). 1, dorsal oblique; 2, dorsal rectus; 3, medial rectus; 4, lateral rectus; 5, ventral oblique; 6, ventral rectus; 7, levator palpebrae superioris; EB, eye ball; LG, lacrimal gland; N, nictitating membrana.

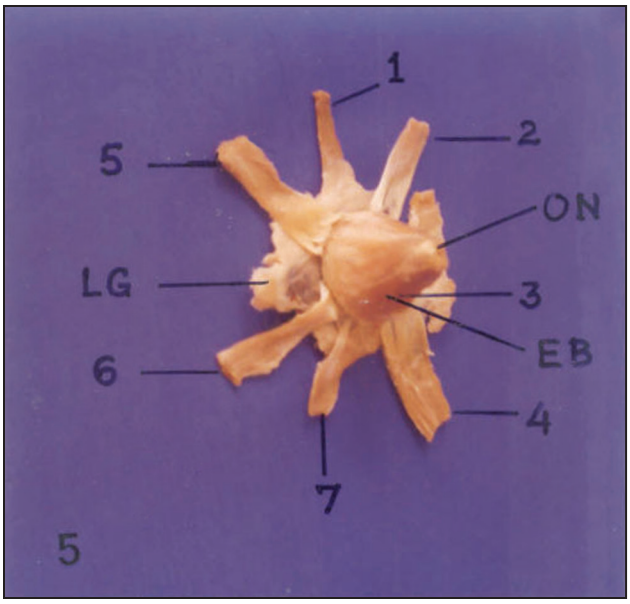


**Fig 5**. Photograph of eye ball of camel showing muscles of the eye ball (caudal view). 1, dorsal oblique; 2, dorsal rectus; 3, retractor bulbi; 4, medial rectus; 5, lateral rectus; 6, ventral oblique; 7, ventral rectus; LG, lacrimal gland; EB, eye ball.

named this artery as the external ophthalmic artery. Ghoshal (1975) stated that the external ophthalmic artery arose from the maxillary artery. Raghavan (1964) reported in ox that the ophthalmic artery arose from the convexity of the bend of internal maxillary artery from a common trunk with the anterior meningeal artery. He further reported that the ophthalmic artery gave off the lacrimal branches, muscular branches, periorbital branches,

conjunctival branches and a ciliary artery as the collateral branches and then divided into the frontal and nasal branches. Steven (1964) investigated in detail the distribution of external ophthalmic artery in ox and observed an internal ophthalmic artery in adult. Kanan (1972) reported that the internal ophthalmic artery was present only in the foetal life of the camel and regressed in the adult specimens. However, the internal ophthalmic artery was not observed during the present investigation in camel. Kanan (1972) and Ruskell (1962) reported an accessory ophthalmic artery arising from the internal maxillary artery. However, no such vessel was observed during the present investigation in camel. The ophthalmic artery gave off the frontal artery, lacrimal artery and a branch to the dorsal oblique muscle of eye ball and then terminated in to a number of primary and secondary branches and formed the Rete mirabile ophthalmicum. The rete mirabile ophthalmicum gave off several branches to the rectus and retractor muscles of the eye ball. Unlike ox the ciliary artery arose directly from the internal maxillary artery in camel. The ciliary artery, after a short course, divided into the anterior and posterior branches. The former pierced the sclera and ramified into the tunics of the eye ball while the latter divided further into the primary and secondary branches to supply blood to the tunics of the eye ball. Similar finding had been reported earlier in camel (Kanan, 1972).

**Nerve supply :** The sensory nerve supply to the muscles of the eye ball in camel was carried by the ophthalmic nerve which arose from the convex surface of the trigeminal ganglion. The ophthalmic nerve with in the cranial cavity divided into the nasociliary and zygomaticotemporalis branches. The origin of zygomaticotemporal branch from the ophthalmic nerve in camel was similar to that in horse, ruminants and pig (Godinho and Getty, 1971; Godinho and Getty, 1975) but in dog from zygomatic nerve (Prince *et al,* 1960) and in horse from the lacrimal nerve (Bradley, 1973). The nasociliary branch was the larger branch and emerged out of the cranial cavity through the foramen orbitorotundum and terminated by dividing into the ethmoidal and frontal nerves. Before its termination it gave off branches to supply the M. obliquus dorsalis. Similar finding had been reported earlier in this species (Fath-Elbab *et al,* 1983). Smuts and Bezuidenhout (1987) reported that the ophthalmic nerve supplied the dorsal and medial straight muscles, dorsal oblique muscle and retractor bulbi muscle of the eye ball. The motor nerve supply to the muscles of the eye ball in camel was carried by oculomotor, trochlear and abducent nerves. The oculomotor nerve arose from the medial border of interpeduncular fossa and divided into a dorsal smaller and ventral larger branches. The dorsal branch ramified into the M. rectus dorsalis and levator palpebrae superioris. Similar finding had been reported in ruminants (Ghoshal, 1975). The ventral branch gave off branches to the muscle rectus ventralis, communicating branch to the maxillary nerve and finally ramified into the obliquus ventralis. Smuts and Bezuidenhout (1987) reported that the dorsal and ventral branches of the oculomotor nerve supplied the dorsal, medial and ventral straight muscles of the eye as well as the ventral oblique and superior palpebrae levator muscles. Similar description had been given earlier in this species (Godinho and Getty, 1975). Raghvan (1964) reported in ox that the oculomotor nerve supplied all the muscles of the eye ball except external rectus and superior oblique. Ghoshal (1975) reported that in ruminants the ventral branch of oculomotor nerve traversed the structure of retractor bulbi muscle and innervated the rectus ventralis and rectus medialis muscles. The trochlear nerve originated from the lateral side of the sulcus post quadrigeminus. Godinho and Getty (1975) reported that the trochlear nerve arose from the rostral cerebral peduncle in horse and pig, while in bovine, ovines and dogs the nerve arose at the rostral medullary velum (Seiferle, 1975). It emerged out of the cranial cavity through the foramen orbitorotundum where it detached twigs to the M. rectus dorsalis and obliuus dorsalis. Smuts and Bezuidenhout (1987) reported that the trochlear nerve innervated the dorsal oblique muscle of the eye ball. The abducent nerve originated from the craniolateral aspect of the medullary pyramid. Similar finding had been reported in ox (Raghavan, 1964). Seiferle (1975) stated that the abducent nerve arose from the corpus trapezoideum in camel, bovine and ovines (Godinho and Getty, 1975). It emerged out of the cranial cavity through the foramen orbitorotundum and on reaching the apex of the ocular muscle cone it terminated by dividing into 3 branches which supplied the muscle rectus dorsalis, rectus lateralis and retractor oculi. Similar description had been given earlier in this species (Fath-Elbab *et al*, 1984). Smuts and Bezuidenhout (1987) in camel and Raghavan (1964) in ox reported that the abducent nerve innervated the lateral rectus and retractor bulbi muscles.

## References

Bradley R (1973). Some aspects of histological structure of bovine extrinsic eye muscles. Research in Veterinary Science 15(2):274-276.

Gao C, Shao B, Ma J, Yu S and Wang J (2008). Anatomical and histochemical characteristics of the lacrimal glands in bactrian camels (*Camelus bactrianus*). Journal of Camel Practice and Research 15(2):167-172.

Fath-Elbab MR, Hifny A, Ahmed AK and Abdel-Moneim El-M (1983). Some anatomical features of the ophthalmic nerve in the one humped camel (*Camelus dromadarius*). Assiut Veterinary Medical Journal 11(21):21-24.

Fath-Elbab MR, Hifny A, Ahmed AK and Abdel-Moneim El-M (1984). The motor nerves of the eye, origin and distribution in the one humped camel (*Camelus dromadarius*). Assiut Veterinary Medical Journal 11(22):3-6.

Ghoshal NG (1975) In Getty's Sisson and Grossman's "The Anatomy of the Domestic Animals". Ruminant Heart and Arteries pp 968-970 and Ruminant Nervous System pp 1081-1083. Vol I, 5th Ed., W.B. Saunders. Co. Philadelphia, USA.

Godinho HP and Getty R (1971). The branches of the ophthalmic and maxillary nerves to the orbit of the goat, sheep and ox. Arquius da Escoda de veterinaria (Belo Horizonte, Brasil). 23: 229-241 (cited from Fath-Elbab *et al,* 1983).

Godinho HP and Getty R (1975). In Getty's Sisson and Grossman's " The Anatomy of the Domestic Animals". The cranial nerves. 5th Ed. W.B. Saunders Co. Philadelphia, USA. pp 1081-1083.

Grossman JD (1959). Embalming by intravascular injection. Indian Council of Agricultural Research, New Delhi. India.

Hifny A and Misk NA (1977). The Anatomy of the tendons of insertion of the extrinsic muscles of the eye ball in the buffalo, cow and camel. Zbl. Vet. Med. C. Anatomia, Histologia, Embryologia 6:339-346.

Kanan CV (1972). Observations on the distribution of external and internal ophthalmic arteries in the camel (*Camelus dromadarius*). Acta Anatomica 81:74-82.

Miller M E, Christensen GC and Evans HE (1964). In "The Anatomy of the Dog". The Heart and Arteries. W. B. Saunders Co. Philadelphia, USA. pp 316-342.

Prince JH, Diesem LD, Eglitis I and Ruskell GL (1960). Anatomy and Histology of the Eye and Orbit in Domestic Animals, Charles C. Thomas. Publisher. Springfield Ilinois (cited from Fath-Elbab *et al,* 1984).

Raghavan D (1964). In "The Anatomy of the Ox". The Arteries pp 518-522, The cranial nerves, pp. 646-648. The Indian Council of Agricultural Research, New Delhi, India.

Ruskell GL (1962). The orbital arteries in the rabbit. American Journal of Ophthalmology 53:96-107 (cited from Kanan, 1972).

Sisson S and Grossman JD (1967). In "The Anatomy of the Domestic Animals". 4th edn. The Systemic Arteries. W.B. Saunders Co. Philadelphia, USA. pp 662-672.

Smuts MMS and Bezuidenhout AJ (1987). In "Anatomy of the Dromedary" The Heart and Arteries. PP 145-150 and The Nervous System. pp 185-190. Clarendon Press, Oxford.

Seiferle E (1975). In "The Anatomy of the Domestic Animals". Nickel R., Schummer A. and Seiferle E Vol. IV. Verlag paul Parey, Berlin, Hamburg (cited by Fath-Elbab *et al,* 1984). pp 150-154.

Steven DH (1964). The distribution of external and internal ophthalmic arteries in the ox. Journal of Anatomy London 98:429-435.

William GM (1971). "Canine Ophthalmology". 2nd Ed. Lea and Febiger, W.B. Sauders Co., Philadelphia, USA.