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Peculiarities of the Camel and Sheep Narial Musculature in Relation to the Clinical Value and the Mechanism of Narial Closure

Eman A. Eshra[1*] and Adel M. Badawy[2]
Department of Anatomy and Embryology[1], Department of Surgery and Radiology[2]
Faculty of Veterinary Medicine, Benha University, Egypt-13736

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ABSTRACT

The camel closes its nostril during adverse climatic condition, that may be indicative for unusual muscular anatomy. The camel seems to have a group of muscles similar to that of the proboscis-bearing animals. The proboscis is a muscular nose able to close by the aid of the maxillolabial group of muscles and the lateralis nasi, coupled with evacuation of air through certain vestibular recesses. This article, suggested similar mechanism in camel, as the structure and attachments of narial muscles were close to that found in the proboscideal nose. Clinical value was stepping on determination of the site for definite surgical interference.

Key words: Lateralis nasi, Levator labii maxillaries, Narial muscles, Nasolabialis

A little is known about the anatomy of the camel narial musculature (Ali *et al.*, 1979; Smuts and Bezuidenhaut, 1987). The nasal region has a special importance in racing camel, as they sometimes need a surgical operation for widening their nasal opening. So the anatomy of this region should be studied in details to avoid the destruction of nasal cartilages or the other related structures during such operations. Camel is the only domesticated animal known for its ability to close the nostrils. The nose of camel (*Camelus dromedarius*) and sheep (*Ovis aries*) are similar in terms of external shape, but camel nose closes during sand storms while sheep nose remains open. So, the paper compared the narial musculature of camel and sheep and discussed the mechanism of narial closure.

MATERIALS AND METHODS

This study was carried out on 20 heads of apparently healthy adult animals, 10 camels and 10 sheep. Camels and sheep heads were obtained immediately after slaughter from Toukh abattoir in Qaloibia. The heads were examined before and after slaughtering to record the narial shape and flexibility. The bled heads were injected through the common carotid artery with 10% formalin solution and kept in 10% formalin, 4% phenol and 1% glycerin solution for preservation.

1 Lecturer; 2 Asstt. Prof., Surgery & Radiology
*Corresponding author: eman.eshrah01@fvtm.bu.edu.eg

RESULTS AND DISCUSSION

In the camel, the rostral part of the nasal septum was muscular and extended along the nasal vestibule (Fig. 1) as reported earlier (Badawi and Fateh-El-Bab, 1974). The Nasal septum in proboscis-bearing animals ex. Saiga antelope has a large membranous anterior portion as recorded by Frey and Hofmann (1997). Narial muscles in camel and sheep were m. levator nasolabialis; m. levator labii maxillaris; m. caninus; m. depressor labii maxillaris; m. lateralis nasi and m. transversus nasi. These muscles arranged in four layers were the maxillolabial group of muscles (m. levator labii maxillaris; m. caninus; m. depressor labii maxillaris) (Figs. 2, 3). The deep part of the levator nasolabialis which formed the third layer in the camel was absent in sheep. The fourth layer was the most medial one and formed by the strong lateral nasal muscle.

M. levator nasolabialis was a flat rectangular muscle, intimately adherent to the skin and was divided into superficial and deep layers in camel. The maxillolabial group of muscles passed between these two layers as reported by Nickel *et al.* (1979) in ox, and differ from that found in sheep as this muscle was a single thin layer. The levator nasolabialis arose from the frontal and nasal fascia. It inserted in the lateral nasal angle and the adjacent parts of the upper lip in sheep. While, in the camel, the superficial layer of this muscle inserted along the lateral wing of the nostril and the upper lip (Fig. 4). In both animals, the muscle fibres attached to the skin at the insertion site and interdigitated with the fibres of m. orbicularis oris similar to that mentioned by Nickel *et al.* (1979) in ruminants. In camel, the levator nasolabialis and the lateralis nasi were attached along the dorsal lateral nasal cartilages. While these muscles in sheep mostly attached with the nasal bone, thus the dorsal and lateral sides of the nose might be more retractable in camel than in sheep. Clinically, removal of triangular skin area with partial myectomy of the superficial layer of this muscle was beneficial during the surgical widening of the nasal opening in camels. The base of this triangle was 2-3 cm from the margin of the external nasal orifice and extended in curvilinear manner parallel to the medial wing of the nostril (Fig. 4).

Maxillolabialis group: This group consisted of three muscles, m. levator labii maxillaris; m. caninus and m. depressor labii maxillaris. In sheep, each of these muscles was cord-like, originated together from an area just rostral to the facial tuber (Fig. 2). In camel, this group has a common origin from a tubercle rostro-ventral to the infraorbital foramen. These findings similar to that found in proboscis-bearing mammals as described by Saber (1987) in dik-dik and Clifford (2003) in moose and saiga antelope. In addition, this group formed together a fan-shaped structure and each muscle was a strap-like (Fig. 3) as observed by Saber (1987) in dik-dik and Clifford (2003) in moose and saiga antelope. In sheep, the group did not form this characteristic fan shaped pattern however, it extended dorsally, rostrally and then ventrally to end in the nostrils and the upper lip (Fig. 2) as reported by Saber (1987) in goat and Nickel *et al.* (1979) in ruminants. In the camel the infraorbital nerve (Fig. 3) and its branches were distributed medial to the three muscles of the maxillolabial group. These nerves located ventral to an imaginary line extended about 2.5 above the infraorbital foramen and the dorsal angle of the nose. The deep dissection in this area should be avoided during surgical operations.

M. levator labii maxillaris was the rostral most and the largest of the maxillolabialis group (Figs. 2, 3). In sheep, it terminated by several tendons in the upper lip as mentioned by Nickel *et al.* (1979) in ruminants and Clifford

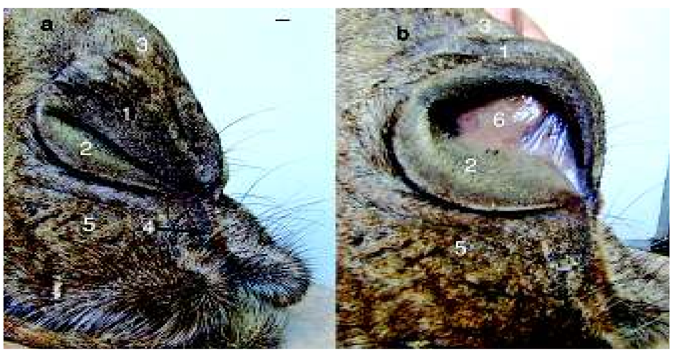

Fig. 1. A photograph showing the changes of the nostril shape and flexibility in camel, after slaughtering. Apex of the nose sagged over the upper lip (a), the narial opening easily dilated (b), (black bar = 1 cm). Note medial nasal wing (1), lateral nasal wing (2), apex of the nose (3), philtrum (4), upper or maxillary lip (5), muscular part of nasal septum (6).

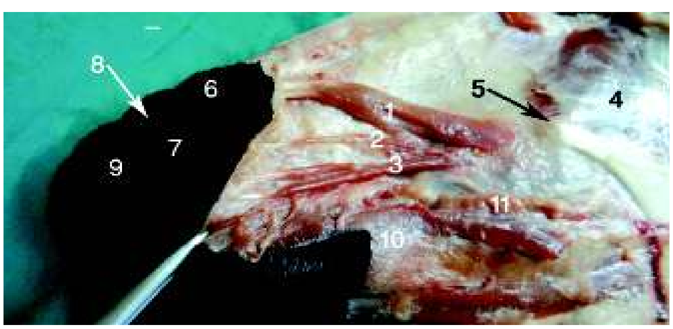

Fig. 2. A photograph of fresh specimen showing the three muscles of the maxillolabial group in sheep, after removal of m. levator nasolabialis). White bar = 0.5 cm. Note M. levator labii superioris (1), M. caninus (2), M. depressor labii superioris (3), M. masseter (4), fascial crest (5), medial nasal wing (6), lateral nasal wing (7), nasal opening (8), upper or maxillary lip (9), M. cutaneous fascii (10), dorsal buccal salivary gland (11).

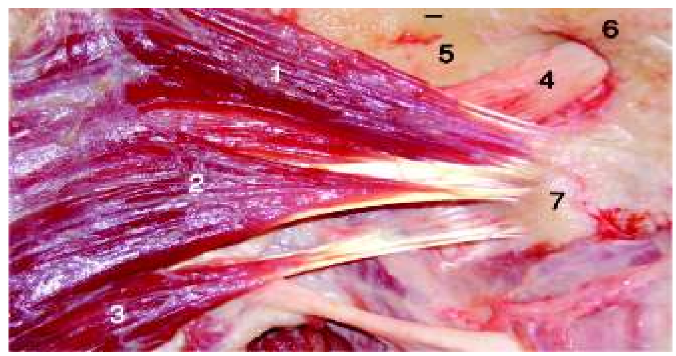

Fig. 3. A photograph of fresh specimen showing the characteristic fan-shaped maxillolabial group in camel, after removal of m. levator nasolabialis. Black bar = 0.5 cm. Note M. levator labii superioris (1), M. caninus (2), M. depressor labii superioris (3), infraorbital nerve (4), maxilla (5), infraorbital foramen (6), tubercle for attachment of the common origin of maxillolabial group (7).

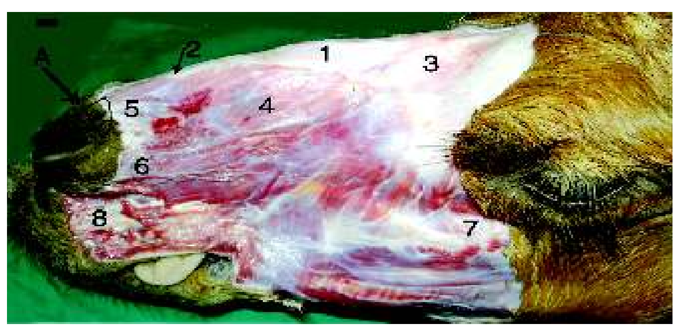

Fig. 4. A photograph showing the triangular area (A) for surgical interference during widening of the nasal opening in camel ,after removal of the skin. Black bar = 2.5 cm. Note nasal bone (1), dorsal lateral nasal cartilage (2), frontal fascia (3), superficial layer of M.nasolabialis (4), nasal part of the superficial layer of M. nasolabialis (5), labial part of superficial layer of M. nasolibialis (6), M. masseter (7), maxilary lip (8).

(2003) in saiga and moose. While in camel, the muscle fibres blended with that of the levator nasolabialis and orbicularis oris muscles. Thus, the insertion site at the upper lip formed a network of muscle fibres shared by the other maxillolabial muscles.

M. caninus (dilator naris lateralis) was the middle muscle of the maxillolabial group. It was the tiniest member of this group of sheep (Fig. 2) similar to that observed by Saber (1987) in goat. Moreover, this muscle sending out thin single tendon for insertion on the lateral accessory nasal cartilage, while it ended abruptly on this cartilage in camel. M. depressor labii maxillaris was the ventral-most muscle of the group. In its middle it was divided into dorsal and ventral branches in sheep (Fig. 2), as it was in ruminants (Nickel *et al.*, 1979), while it was not divided in camel. The muscle ended on the upper lip and the ventral portion of the nostril in both animals.

M. lateralis nasi was not present in sheep to the extent that it was in camel. It arose from the dorsal lateral nasal cartilage in camel, while it arose from the nasal bone, the dorsal and ventral lateral nasal cartilages in sheep. In both animals, the muscle terminated in the lateral wing of the nostrils in common with muscle fibres of the deep layer of the levator nasolabialis and the maxillolabial group, similar to that found in ruminants (Nickel *et al.*, 1979). The lateral nasal diverticulum was a small vestibular outpouching located between the maxillolabial group laterally and the lateralis nasi medially. The lateral nasal diverticulum present in camel was somewhat similar to the lateral nasal sac of saiga antelope (Clifford, 2003; Clifford and Witmer, 2004). M. transversus nasi was an unpaired, small quadrilateral muscle, which was located between the medial wings of the nostrils as reported in domestic animals (Nickel *et al.*, 1979).

The nostrils in the camel and sheep were slit like with rostro-medially directed longitudinal axis (Figs. 1, 2) that also observed by Badawi and Fathel-bab (1974). At first glance, it may seem that the nose of camel and sheep are similar, but after apparently examined before and after slaughter, it turns out they're totally different. The examination showed that the camel nose was relaxed and sagged over the upper lip (Fig. 1), while the sheep nose remained tight and the shape of the nostrils was not changed. The sag nose of camel revealed the internal structure that allowed this to happen. The lateral wall of the camel nose and the rostral portion of the nasal septum were composed entirely of muscles. These muscles were more extensive than in sheep and the attachment and relations were different. Muscles in camel were mostly related and attached to deficient and liable osseo-cartilagenous skeleton. In camel the bones surrounding the nasal opening were reduced and very short, especially when compared to that of the rest of ruminants (Smuts and Bezuidenhout, 1987). The shortness of nasal bone in camel gave the opportunity to extend the dorsal nasal cartilage for a distance of up to two-thirds the length of the nasal cavity, the medial and the lateral accessory nasal cartilages were very small and the ventral nasal cartilage was absent, therefore the lateral wall of the nose is devoid of cartilage.

When combining the above-mentioned facts together, it is clear that the camel nose anatomy is unique among the domesticated animals. In ruminants, equines and carnivores the bones formed the caudal two-thirds of the nose, leaving the anterior-third for the cartilages and muscles, i.e the skeleton of the nose is mostly osseo-cartilagenous (Nickel *et al.*, 1979 in domestic animals. The reduction in the bones and cartilages of the camel nose and the remarkable expansion of narial muscles has resulted in an organ that is might be interpreted as a proboscis.

Proboscis can be defined generally as flexible snout, has the ability to closure by the aid of the maxillolabial muscles. There are two types of proboscis, the first type, known as the maxillolabial proboscis characterized by the presence of mobile elongation of the rostral end of the nose. This type was present in pigs Suidae, peccaries Tayassuidae, Coatis procyonidae and the elephant shrews Macroscelidia. The second type was known as the vestibular proboscis and can be defined as a nose has fleshy end and sags over the upper and lower lips when relaxed. The vestibular proboscis was present in moose (*Alces alces*), Saiga antelope (*Saiga tatarica*) and dik-dik (*Madqua guntheri smithi*) (Clifford, 2003). There are many matches between the anatomy of the camel nose and the vestibular proboscis, both of them have nasal bones retracted or reduced, and the maxilla usually formed a large portion of the margin of bony naris as observed by Clifford (2003) in moose and Saiga antelope. The presence of well developed three maxillolabial muscles in the camel, rostral muscular part of the nasal septum and the lateral nasal diverticulum. In addition to the previously mentioned matches, the presence of a proboscis also has resulted in a major transformation of the internal anatomy of nasal cavity as an expansion of the nasal vestibule, change in the position of the opening of nasolacrimal duct and retraction and modification of the bony turbinates (Witmer *et al.,* 1999; Clifford and Witmer, 2004). The first difference appeared when compared the size of the camel nose to the usual size of the proboscis, as the apex of the camel nose and the nasal vestibule was relatively small. The second difference was in the appearance of the nose in the living animal, the nose of the living camel appeared somewhat rigid and fixed, while it relaxed and sages over the upper lip only after the slaughtering and before rigor mortis.

Closuring natural orifices usually associated with the presence of sphincter muscles. In the camel, Smuts and Bezuidenhout (1987) stated that, the muscles of the nostrils are arranged in such a way that sphincter formed enables the nostrils to close. The aforementioned statement does not provide a full explanation for the closure mechanism as the narial closure not depends only on the action of muscles, but also might be attributed to the deficient osseocartrilaginous skeleton, musculo-membranous septum and retracted turbinates which arranged in such away enables the muscles to close the nostril.

Comparison between the camel and the proboscis-bearing mammals facilitates understanding of the closure mechanism of the nostrils. Camel and Siaga antelope forced to close their nostrils during sand storms. Moose tightly closes the nostrils when diving in cold water to feed on the underwater plants. The closure mechanism of the proboscideal nose depends on the apposition of the dorsal and ventral wings of the nostrils coupled with evacuation of air from the vestibular recesses as suggested by Clifford (2003) in Saiga and moose and Witmer *et al.* (1999) in tapirs. In the camel, the lateral nasal diverticulum was a cylindrical shaped pouch, pierces the lateral wall of the nasal vestibule and opened at the level of limen nasi (Arnautovic and Abdalla, 1969). This diverticulum located between the maxillolabial muscles laterally and the lateralis nasi medially, so it compressed during these muscles work to appose the wings of the nostrils. Results showed that the M. levator labii maxillaris, M. levator labii mandibularis and the labial part of M. levator nasolabialis of camel were all directly connected to the orbicularis oris muscle without forming tendons for insertion as occurred in other ruminants (Nickel *et al.,* 1979) and the proboscis-bearing animals Saber (1987) in dik-dik and Clifford (2003) in Saiga and moose. So the orbicularis oris muscle and the levator nasolabialis may have a role in the closure of the camel nostrils.

In the camel, the muscles of the nostrils arranged in such a way similar to that of the proboscideal nose. In addition, all the narial muscles are united at their insertions, this may enable them to act as one unit closing the nostrils. This action coupled with evacuation of air through the lateral nasal diverticulum may provide an explanation of the narial closure mechanism in camel. Although validation of this mechanism has not been tested experimentally, the narial anatomy would suggest that this hypothesis is feasible.

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