

Gross anatomy of the nasal cavity of buffalo calves

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ABSTRACT

In the present study the local crossbred buffalo calves of approximately 6 to 12 months old were examined to document the gross anatomy of the nasal cavity. The study revealed that the nasal cavity of calves was completely divided into two compartments by a median nasal septum. The dorsal nasal turbinate was the longest and extended from the cribriform plate of ethmoid bone to the level of third transverse rugae of the hard palate. It continued rostrally as straight fold and contained a sinus. The ventral nasal turbinate was cylindrical in shape and extended from the first molar to the fourth transverse rugae of the hard palate. The middle nasal turbinate/ethmoturbinate was triangular in outline and extended up to the Third premolar tooth. The ethmoidal labyrinth composed of 6 endoturbinates and 8 ectoturbinates.

Key words: Buffalo calves, Gross anatomy, Nasal cavity

The anatomy of the nasal cavity will be helpful to understand the mechanism of thermoregulation of air which is inspired and expired during the process of respiration. The literature on the anatomy of the nasal cavity in buffalo calves is sparse and scattered; although a few fragmentary reports are available (Sisson and Grossman 1953, Dhingra and Kumar 1978, Nickel *et al.* 1979). Hence present study was carried out.

MATERIALS AND METHODS

Heads of local crossbred buffalo calves (6) aged between 6 and 12 months were collected from the local slaughter house, to study the gross anatomy of the nasal cavity. The heads were fixed in 10% neutral buffered formalin for 48 hr. Two heads were sectioned in mid sagittal plane and observed for the partition of the nasal cavity. Four heads were sectioned in transverse planes at different levels, i.e. at the level of papilla incisive, third palatine ruga, sixth palatine ruga, ninth palatine ruga and first molar tooth. The nasal cavity was studied in detail, and the topographic aspects of the nasal cavity were noted to establish their anatomical relations.

RESULTS AND DISCUSSION

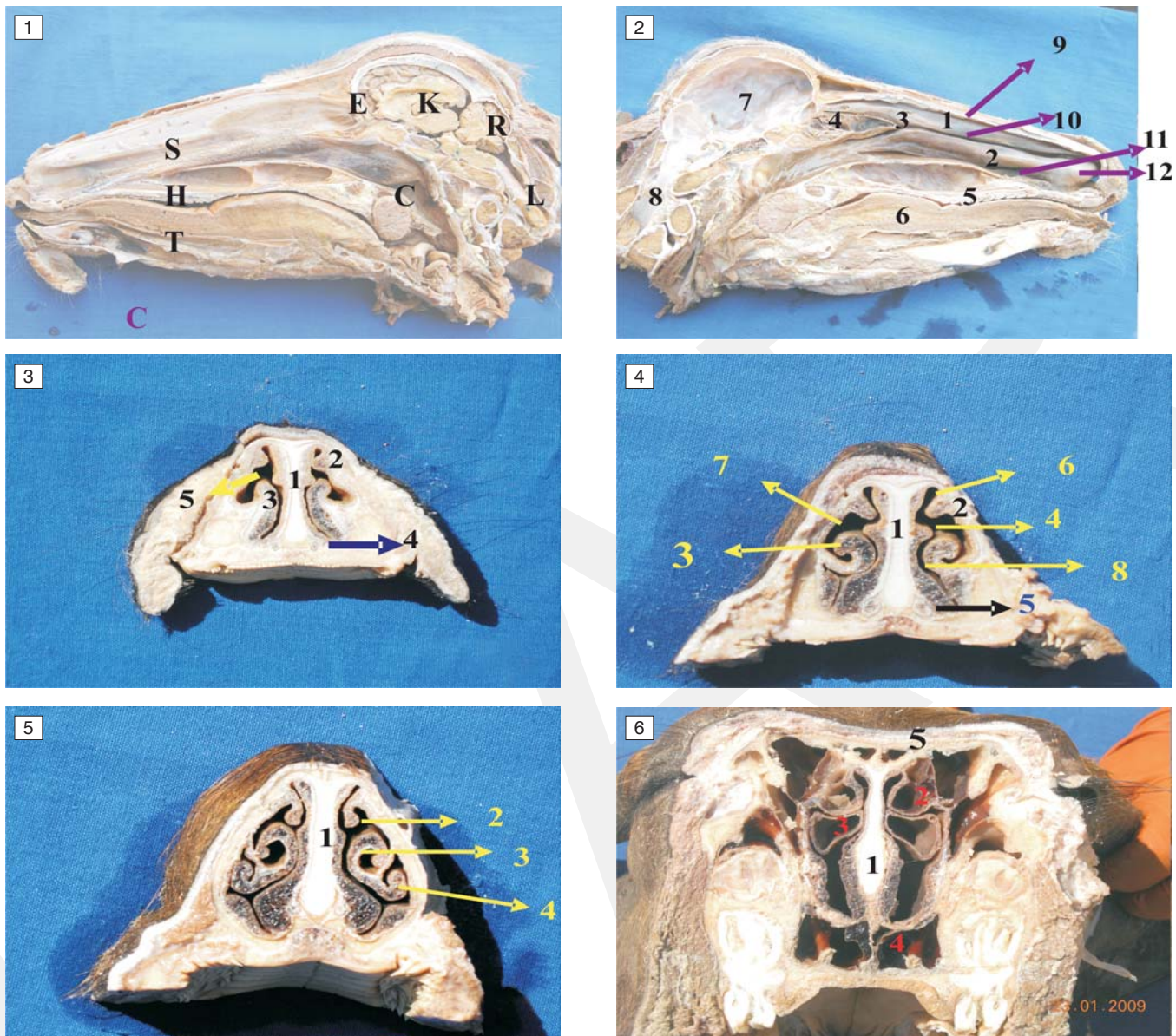
The nasal cavity of buffalo calves was cylindrical passage

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completely divided into 2 compartments by a median nasal septum (Fig.1). The nasal compartments of cavity extended from the external nares to the internal nares (choanae) and continued caudally as the nasopharynx. These observations were similar to those observed in Gaddi sheep (Sharma *et al.* 1989), Gaddi goat (Gupta *et al.* 1992), goat (Singh *et al.* 1992), buffalo (Dhingra and Kumar 1978), yak (Sharma and Gupta 1991), camel (Grossman 1960), horse (Hare 1975a) and sheep (Ganga Naik *et al.* 2004). However, they differ from cattle (Sisson and Grossman 1953, McLeod 1958, Hare 1975b) and dog (Miller *et al.* 1964), wherein the division was incomplete. The external nares are sigmoid shaped with a broad opening at the lower end whereas, these were slit-like in sheep (Hare 1975b, Ganga Naik *et al.* 2004), comma shaped in ox (Hare 1975b), buffalo (Dhingra and Kumar 1978) and dog (Hare 1975d), semilunar in horse (Hare 1975a) and circular in pig (Hare 1975 c).

The nasal cavity in buffalo calves has 3 nasal turbinate bones (choanae), viz. dorsal, ventral and middle/ethmoturbinate (Figs 2, 3, 4). These turbinate bones might provide a larger surface area for the passage of air. The dorsal nasal turbinate was the longest and largest one and extended from dorsal part of ethmoid crest to the level of third transverse ruga of hard palate, whereas it extended from dorsal part of ethmoid crest to the level of angularis oris in Gaddi sheep (Sharma *et al.* 1989), and in Gaddi goat (Gupta *et al.* 1992). In yak it extended up to the level of frontal and nasal bones (Sharma and Gupta 1991). It extended from the cribriform plate of ethmoid bone up to the rostral end of



Figs 1–6. Photograph showing: **1.** mid-sagittal section of the nasal cavity of buffalo. S, median nasal septum; C, choana; H, hard palate; T, tongue; E, ethmoidal crest; K, cerebrum; R, cerebellum and L, spinal cord; **2.** mid-sagittal section of the nasal cavity of buffalo after removing the median nasal septum. 1, dorsal nasal turbinate; 2, Ventral nasal turbinate; 3 middle nasal turbinate; 4, ethmoturbinate; 5, hard palate; 6, tongue; 7, Cranial cavity; 8, spinal canal; 9, dorsal nasal meatus; 10, middle nasal meatus; 11, ventral nasal meatus; 12, alar fold; **3.** cross section of the nasal cavity of buffalo calves at the level of sixth transverse rugae of hard palate. 1, median nasal septum; 2, dorsal nasal turbinate; 3, Ventral nasal turbinate; 4, vomeronasal organ and 5, common nasal meatus; **4.** cross section of the nasal cavity of buffalo calves at the level of sixth transverse rugae of hard palate. 1, median nasal septum; 2, dorsal nasal turbinate; 3, Ventral nasal turbinate; 4, common nasal meatus; 5, vomeronasal organ; 6, dorsal nasal meatus; 7, middle nasal meatus; 8, ventral nasal meatus; **5.** cross section of the nasal cavity of buffalo calves at the level of ninth transverse rugae of hard palate. 1, median nasal septum; 2, dorsal nasal turbinate; 3, dorsal scroll of ventral nasal turbinate; 4 m, ventral scroll of ventral nasal turbinate; **6.** cross section of the nasal cavity of buffalo calves at the level of first molar. 1, median nasal septum; 2, dorsal nasal turbinate containing the sinus; 3, ventral nasal turbinate containing the sinus; 4, palatine sinus; 5, frontal sinus.

nasal bone in pig (Hare 1975c) and up to the level of second transverse rugae of hard palate in sheep (Ganga Naik *et al.* 2004). The dorsal nasal turbinate contained a sinus at the level of the caudal face of the first premolar extending up to

the level of first molar or medial canthus of the eye, and contained a narrow cavity.

The ventral nasal turbinate was cylindrical, which extended from the fourth transverse ruga of hard palate to

the level of caudal face of the first molar tooth (Figs 2, 3, 4, 5). It was attached to the conchal crest of the maxilla in ruminants (Mc Leod 1958, Hare 1975b), in buffalo (Dhingra and Kumar 1978), horse and pig (Hare 1975a c), dog (Sisson 1975b) and in buffalo from the third molar tooth to the incisive papilla (Dhingra and Kumar 1978). In sheep and ox it extended from the last cheek tooth to the naso-incisive notch (Hare 1975b), and in goat from the level of the last cheek tooth to alar fold and basal fold (Gupta *et al.* 1992).

The ventral nasal turbinate in buffalo calves was divided into dorsal and ventral scrolls. The dorsal scroll had 2 turns and was devoid of conchal sinus, whereas the ventral scroll had $1\frac{1}{2}$ turns and enclosed a conchal sinus. However, in sheep, dorsal scroll had $1\frac{1}{4}$ turns and ventral scroll had $1\frac{1}{2}$ turns (Ganga Naik *et al.* 2004). In Gaddi sheep the dorsal scroll had 2 complete turns enclosing its doubled sinus and ventral scroll had one complete turn enclosing its own sinus (Sharma *et al.* 1989). Similar findings were reported in goat (Singh *et al.* 1992) and buffalo (Dhingra and Kumar 1978). The dorsal scroll had 2 turns and ventral scroll had $1\frac{1}{4}$ turns in goat (Gupta *et al.* 1992), while in bovines ventral scroll had $2\frac{1}{2}$ turns and in yak (Sharma and Gupta 1991), the dorsal scroll had $2\frac{1}{2}$ turn (Mc Leod 1958) and ventral scroll had its own sinus.

The middle nasal turbinate (ethmoturbinate) in buffalo calves considered as second turnbinate of ethmoid labyrinth had a sinus. Its rostral limit was present at the level of caudal face of third premolar tooth. While in adult buffaloes it was present at the level of third molar tooth (Dhingra and Kumar 1978). However, in sheep it was present at the caudal face of first molar tooth (Ganga Naik *et al.* 2004). In Gaddi sheep it was present at the level of the second or third cheek tooth in between dorsal and ventral nasal turbinates (Gupta *et al.* 1992).

The ethmoidal labyrinth in buffalo calves consisted of 6 endoturbinates which were shelf like in arrangement and 6–8 ectoturbinates, which were like the paper scroll (Fig 4). However, in sheep, 5 endoturbinates and 5–6 ectoturbinates were recorded (Ganga Naik *et al.* 2004). There were 5 endoturbinates and 6 ectoturbinates in Gaddi goat (Sharma *et al.* 1989), 4 endoturbinates and 12 ectoturbinates in Gaddi goat (Gupta *et al.* 1992), 5–6 endoturbinates and 9–11 ectoturbinates in goat (Singh *et al.* 1992), 5 endoturbinates and 16–20 ectoturbinates in buffaloes (Sisson 1910), 4 endoturbinates and 15 ectoturbinates in yak (Sharma and Gupta 1991), whereas in dog, 4 endoturbinates and 6 ectoturbinates were present (Miller *et al.* 1964).

There were 3 nasal meati in buffalo calves, namely dorsal, middle and ventral. The dorsal nasal meatus was a narrow passage between the roof of the nasal cavity and dorsal turbinate (Figs 2, 4). It extended caudally from the level of the cribriform plate of ethmoid bone and rostrally merged with the middle nasal meatus to open externally. Similar observations regarding the course of this meatus were

reported in sheep (Ganga Naik *et al.* 2004), in Gaddi sheep (Sharma *et al.* 1992), goat (Singh *et al.* 1992) and ruminants (Mc Leod 1958, Raghavan 1964, Hare 1975b, Khatra 1980). However, Dhingra and Kumar (1978) reported that the dorsal nasal meatus opened rostrally into the vestibule in buffaloes.

The middle nasal meatus in buffalo calves passed between the dorsal and ventral nasal turbinates (Figs 2, 4) and divided into dorsal and ventral limbs at the level of the third premolar tooth. However, the middle nasal meatus was divided into dorsal and ventral limbs at the level of the first molar in sheep (Ganga Naik *et al.* 2004), and goat (Singh *et al.* 1992). In Gaddi sheep and goats, the middle nasal meatus was divided at the level of second or third cheek tooth (Sharma *et al.* 1989, Gupta *et al.* 1992). While in yak it was divided at the level of last cheek tooth (Sharma and Gupta 1991). In dog, the division of meatus into dorsal and ventral limbs was not appreciable (Hare 1975d).

The ventral nasal meatus extended rostrally into the vestibule, while caudally it received the ventral limb of the middle nasal meatus (Figs 2, 4). Similar findings were reported in sheep (Ganga Naik *et al.* 2004), Gaddi sheep (Sharma *et al.* 1989), Gaddi goat (Sharma and Gupta 1991) and yak (Gupta *et al.* 1992).

The ethmoid meatus in buffalo calves were slit like passages between endoturbinates. Similar observations were made in sheep (Ganga Naik *et al.* 2004), in ruminants (Hare 1975b), and buffaloes (Dhingra and Kumar 1978).

The common nasal meatus in buffalo calves extended from the vestibule to the choanae (Fig. 2). It was bound dorsally by the roof of the nasal cavity, ventrally by the floor of the nasal cavity. The lateral boundary was formed by the nasal turbinates and nasal meatuses, while the medial boundary was formed by the median nasal septum. The common nasal meatus was completely wider at the floor of nasal cavity than the rest of the area. Similar observation was reported in sheep (Ganga Naik *et al.* 2004), Gaddi sheep (Sharma *et al.* 1989), Gaddi goat (Gupta *et al.* 1992) and goat (Singh *et al.* 1992).

The choanae (posterior nares) were rhomboid, obliquely placed, openings located at the level of caudal face of last molar tooth and continued caudally into a short passage as nasopharynx (Fig. 1). These openings were bound ventrally by hard palate and dorsally by the fold of mucosa which extended from the ventral surface of the vomer bone. Similar observation was given in pigs (Hare 1975c), buffaloes (Dhingra and Kumar 1978), other ruminants (Hare 1975b) and dog (Miller *et al.* 1964). However anatomical land mark had not been mentioned by these authors. Hare (1975a) reported in horse that the choanae were placed almost horizontally but they were comparatively shorter and undivided (Nickel *et al.* 1979).

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