



## Gross and morphometrical study on the external and internal nares of *Gaddi* sheep

Virender Pathak and Rajesh Rajput

Department of Veterinary Anatomy, DGCN College of Veterinary and Animal Sciences  
CSK HPKV Palampur (H.P)-176062

Corresponding author: [pathakv26@yahoo.com](mailto:pathakv26@yahoo.com)

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### Abstract

An anatomical and morphometrical study was undertaken on the external and internal nares of 26 *Gaddi* sheep at Palampur during 2013-15. The results of the study revealed that the nostrils were slit like in *Gaddi* sheep and situated obliquely at rostral most part of head. The mean length of the nostrils was  $2.51 \pm 0.52$  cm. The mean distance between the dorsal commissures and ventral commissures was  $3.26 \pm 0.54$  cm and  $1.04 \pm 0.25$  cm, respectively. Nasal cavity of sheep extended from external nares to the chonae. The nasal cavity in *Gaddi* Sheep was provided with the three nasal turbinate bones (choanae) viz. dorsal, ventral and middle. Length of the dorsal turbinates ranged from 10.70 cm to 12.80 cm in adult animal. The width of the dorsal turbinate had range from 1.90 to 2.70 cm with mean length of  $2.36 \pm 0.40$  cm. The length of the ventral nasal turbinate ranged from 9.90 to 12.20 cm, whereas its width was from 2.40 to 3.50 cm.

**Key words:** External nares, internal nares, morphometry

Sheep (*Ovis aries*) are quadrupedal ruminant mammals typically kept as livestock. Sheep are members of the order Artiodactyla, the double toed ungulates. The sheep is a multipurpose animal, which provides meat, milk, hide and wool for human consumption and manure for the use in improving soil fertility for crop production. Himachal Pradesh contributes around 1.26% of the countries sheep population (19<sup>th</sup> Livestock Census, 2012). In Himachal Pradesh especially in Kangra, Kullu, Shimla, Sirmour and Chamba, we find more concentration of sheep of *Gaddi* breed. Here it plays a vital role in saving the rural uneducated youths from unemployment. The importance of respiratory system increases due to continuous migration of animals from low hills to the high Alpine pastures and back, depending upon the different seasons of the year. The animals not only have to adjust their respiration to the different climatic zones but also have to deal with varying oxygen levels in the atmosphere. Although many studies have been conducted in the animals of plains but we still lack scientifically documented studies on *Gaddi* sheep. What so ever studies were conducted that were in bits and parts. Therefore, efforts were made to study the external and internal nares of *Gaddi* sheep.

### Material and Methods

Present study was conducted on adult, healthy 26 *Gaddi* sheep from slaughter house. Heads were immediately collected after sacrifice. Sagittal and frontal sections of the head were made. The frontal sections were made at the level of 1<sup>st</sup>, 3<sup>rd</sup>, 4<sup>th</sup> palatel rugae, rostral margin of first cheek tooth; caudal to the third cheek tooth; caudal to the last cheek tooth; anterior to the rostral margin of orbits. With the help of hand lens and naked eye the external nares, nasal cavity and turbinate bones were examined to establish their anatomical relations. The morphometrical parameters were recorded with the help of digital Vernier's caliper. The data collected were subjected to statistical analysis.

### Results and Discussion

#### External Nares

Nostrils lead to the nasal cavity. The nostrils were slit like (Plate-1) and situated obliquely at rostral most part of head. The aperture was comparatively longer in length than that of goat as also observed by Sinha *et al.* (2015) in goats. The nostrils were comma shaped in ox (Hare, 1975b), buffalo (Dhingra and Kumar, 1978) and dog (Hare, 1975b), semi lunar in horse (Hare 1975a) and circular in pig (Hare 1975c). The planum nasai situated between the nostrils was devoid of

hair as also observed in Bangal Goat and Garole sheep by Sinha *et al.* (2015). Eshra and Badawy (2014) and Badawi and Fateh El-bab (1974) stated that camel and sheep had slit like nostrils with rostro-medially directed longitudinal axis. The nostrils were bounded by medial and lateral alae (wings). The wings met dorsally and ventrally to form commissure or angles (Plate-1). The mean length of the nostril was  $2.51 \pm 2.12$  cm (Table 1). The mean length of nostrils of yak was  $4.50 \pm 0.05$  cm, whereas mithun and zebu cattle nostrils measured  $7.27 \pm 0.18$  and  $7.00 \pm 0.17$  cm, respectively (Kalita and Kalita 2001). The mean width of the nostril of Gaddi sheep at center was  $0.41 \pm 0.42$  cm. The mean distance between the dorsal commissures and ventral commissures was  $3.26 \pm 2.19$  cm and  $1.04 \pm 1.01$  cm, respectively. Kalita and Kalita (2001) recorded the dorsal openings of zebu, Mithun and Yak as  $1.20 \pm 0.12$  cm,  $1.20 \pm 0.12$  cm and  $8.80 \pm 0.06$  cm and ventral openings as  $2.60 \pm 0.16$ ,  $2.60 \pm 0.12$  and  $2.80 \pm 0.06$  cm, respectively. There was no clear line of demarcation between external nares and internal mucosa.

#### Nasal Cavity

Nasal cavity of sheep extended from external nares to the chonae. These were conical shaped passages which were slightly bloated in the centre. Sharma *et al.* (1989) made similar observation on Gaddi sheep. The roof of the nasal cavity was formed by nasal bone and the inner table of the frontal bones. The nasal cavities were completely separated by the median nasal septum as observed in Gaddi sheep (Sharma *et al.* 1989), Gaddi goat (Gupta *et al.* 1992), buffalo (Dhingra and Kumar, 1978), yak (Sharma and Gupta, 1991), camel (Grossman 1960) and horse (Hare 1975a). However Hare (1975b) had reported that the nasal septum of ox remains separated from the nasal floor in its caudal thirds. In the dog, the division was also incomplete (Howard *et al.* 2013). The nasal septum of Gaddi sheep was mainly cartilaginous, vomer, ethmoid and palatine bones too contributed to its formation. Gupta *et al.* (1992) had observed that median nasal septum was mainly cartilaginous and small osseous part was formed by ethmoid and vomer bones in Gaddi Goat.

The nasal cavity in Gaddi Sheep had three nasal turbinate bones (choanae) *viz.* dorsal, ventral and middle. These turbinates increased the surface area many folds over which the air passed in the nasal cavity. The dorsal turbinate was the longest one. It extended from dorsal part of the ethmoid caudally to the level of first or second rugae palatine. Ganganaik *et al.* (2004) agree with the present study in sheep. Sharma *et al.* (1989) described that cranially dorsal turbinate extended up to the level of angularis oris in

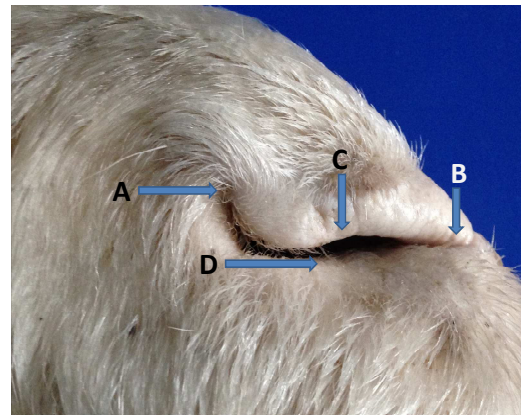


Plate 1. Nostril of Gaddi Sheep. Dorsal commissure (A), Ventral commissure (B), Dorsal lamina (C), Ventral Lamina (D)

**Table 1.** Measurements of nostrils of Gaddi Sheep (N=16)

Parameter	Mean $\pm$ SE (mm)
Length (distance between dorsal commissure and ventral commissure)	25.15 $\pm$ 0.52
Width	4.13 $\pm$ 0.10
Distance A (distance between dorsal commissures)	32.60 $\pm$ 0.54
Distance B (distance between ventral commissures)	10.47 $\pm$ 0.25
Height (distance between line joining the dorsal commissures and ventral commissures)	15.60 $\pm$ 0.13

gaddi sheep. Gupta *et al.* (1992) observed their cranial extension up to the rostral end of nasal bone in Gaddi goat. Hare (1975) limited its rostral extent up to the first cheek tooth in all the ruminants. Sharma and Gupta (1991) observed that the rostral limit of dorsal turbinate extended up to the nasal bones in Yak. It extended from the cribriform plate of ethmoid bone up to the 4<sup>th</sup> transverse ruga of hard palate in case of goat (Singh *et al.* 1992). Length of the dorsal turbinates ranged from 10.70 cm to 12.80 cm in adult animal. The mean length of the dorsal turbinate in Gaddi sheep was recorded as  $12.13 \pm 0.61$  cm. The width of the dorsal turbinate ranged from 1.90 to 2.70 cm. The mean length was recorded as  $2.36 \pm 0.20$  cm (Table 2). Dorsal concha in Gaddi sheep was almost non-sinuous at first and last cheek tooth levels, but had wide sinus at the level of 3<sup>rd</sup> cheek tooth as reported by Sharma *et al.* (1989). However, Ganganaik *et al.* (2004) observed that the narrow cavity of dorsal sinus extended up to the level of medial canthus of eye in sheep.

**Table 2.** Gross parameters of the nasal turbinates of Gaddi sheep

Turbinate	Mean $\pm$ SE (cm)
Dorsal turbinate (L)	12.11 $\pm$ 0.12
Dorsal turbinate (W)	2.36 $\pm$ 0.04
Ventral turbinate (L)	11.33 $\pm$ 0.09
Ventral turbinate (W)	3.18 $\pm$ 0.04
Middle turbinate (L)	5.23 $\pm$ 0.04
Middle turbinate (W)	2.62 $\pm$ 0.02

N=23, P value >0.10, Length (L), width (W)

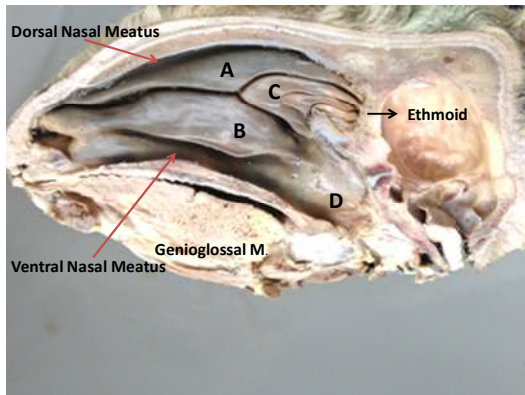


Plate 2. Sagittal section of the skull of Gaddi Sheep. Dorsal turbinate (A), Ventral turbinate (B), Middle turbinate (C), Nasopharynx (D)

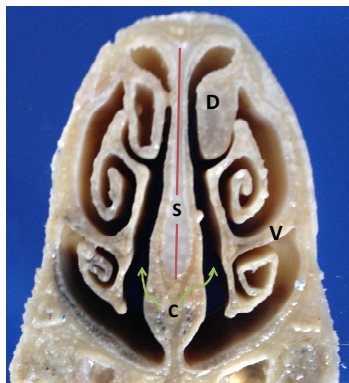


Plate 3. Transverse section of nasal cavity of Gaddi Sheep. Nasal septum (S), Dorsal nasal turbinate (D), Ventral nasal Turbinate (V), Common nasal meatus (C).

The ventral nasal turbinate was the largest one. It was fusiform in shape. It extended from the level of 4<sup>th</sup> cheek tooth to the tip of the nasal bone and ended into the alar fold. Ganganaik *et al.* (2004) observed their limit from third transverse ruga of hard palate to the level of caudal face of second molar tooth in sheep. May (1970) found it between the sphenopalatine foramen to the rostral end of nasal bone. Hare (1975) reported it between the last cheek tooth to the nasoincisive bone. While in buffaloes it was present at the level of third molar tooth (Dhingra and Kumar, 1978). The length of the ventral nasal turbinate ranged from 9.90 to 12.20 cm (mean 11.33 $\pm$ 0.43 cm) (Table 2), whereas its width ranged from 2.40 to 3.50 cm (mean 3.18 $\pm$ 0.21 cm). Its width started decreasing with the appearance of middle concha, at the level of 3<sup>rd</sup> cheek tooth and diminished abruptly along the lateral and ventral wall of the ethmoturbinates ventral to the frontal sinus. The lamina divided into two, the dorsal and ventral scrolls (Plate 3). At the 1<sup>st</sup> cheek tooth level, the dorsal scroll had one complete turn, while the ventral had only half turn. At the third cheek tooth level, the dorsal scroll had 2 complete turns enclosing its double sinus whereas, the later had one complete turn enclosing one sinus. Ganganaik *et al.* (2004) reported that dorsal scroll had 1 $\frac{1}{4}$  turn and was devoid of conchal sinus whereas, the ventral scroll had 1 $\frac{1}{2}$  turn and it enclosed a conchal sinus. Similar finding had been reported in goat (Singh *et al.* 1992). Gupta *et al.* (1992) found that the dorsal scroll had 2 turns and ventral scroll had 1 $\frac{1}{2}$  turn in Gaddi goat.

The middle or the ethmoidal turbinate was pyramidal shaped structure having a shelf like arrangements (Plate 2). Its apex projected between the dorsal and ventral conchae at the level of 4<sup>th</sup> cheek tooth. The base lay along the cribriform plate of ethmoid bone, which corresponded to the last cheek tooth ventrally and supraorbital foramen dorsally. May (1970) observed that the rostral limit of the ethmoturbinate was at the 3<sup>rd</sup> cheek tooth level in sheep. Similar observations were made in Gaddi goat by Gupta *et al.* (1992). The length and width of the ethmoidal turbinate ranged from 4.90 to 5.60 cm (mean, 5.23 $\pm$ 0.19 cm) and 2.30 to 2.80 cm (mean, 2.62 $\pm$ 0.02 cm), respectively (Table-2). There were six ectoturbinates and five endoturbinates in Gaddi Sheep as also reported by Sharma *et al.* (1989). Gupta *et al.* (1992) reported 12 ectoturbinates and 4 endoturbinates in Gaddi goat. Singh *et al.* (1992) reported 5-6 ectoturbinates and 9-10 endoturbinates in goat. In a dog 6 ectoturbinates and 4 endoturbinates were present (Howard *et al.* 2013).

The choanae (posterior nares) were oval shaped, obliquely placed caudal openings of the nasopharyngeal meatus into the pharynx. They laid in the centre of the hard palate caudal to the last ruga at the level of 2<sup>nd</sup> cheek tooth. These openings were bounded ventrally by hard palate and dorsally by the fold of mucosa which extended from the ventral surface of vomer bone. They were separated from

the oral cavity by means of the palatine bone and the soft plate. A median nasopharyngeal septum hung down from the roof of the nasopharynx from the 2<sup>nd</sup> cheek tooth to the level of pterigoid bone ventral to the sphenoid bone. Similar description had been given in pig (Hare, 1975c) and dog (Howard *et al.* 2013).

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