

## The Anatomy and Histology of Vomeronasal Organ (VNO) of Male Iranian Helical Horn Goat (*Capra persica*)

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**Abstract:** Vomeronasal organ is tubular structure which lies in floor of nasal cavity. The animals not only have essential olfactory system but also have accessory olfactory system. The vomeronasal organ has principle role in accessory olfactory system. Witten studied vomeronasal organ carefully for first time. This organ have principle role in urinary pheromones (sexual odor) sensation. In this survey, location, anatomical and histological structure of Vomeronasal Organ (VNO) of male Iranian helical horn goat (*Capra Persica*) was studied. Seventeen normal head of male Iranian helical horn goat were provided from Urmia industrial slaughterhouse. The mandible of 12 samples were separated and then the heads were sectioned longitudinally and horizontally (6 sections). Longitudinal sections are used for detection of length and horizontal sections are used for detection of diameter of VNO by biometry method. For histological studies, 4 sections were provided by maxilla in following regions: 4th palatine ridge, 8th palatine ridge, rostral of 1st premolar tooth and midline of first premolar tooth. Sections are decalcified and then they were stained by H and E method. Vomeronasal organ of Iranian helical horn goat was observed on maxillary bone, dorsally and superiorly of incisive duct. Its average length was measured 7.8 cm. It extended from incisive papillae to second premolar tooth. Its maximum diameter was observed in middle region with 1.8 mm length. Histological studies were appeared which VNO is encapsulated by hyaline cartilage capsule. Olfactory epithelium is lined inner part and respiratory epithelium is lined peripheral part of VNO of male Iranian helical horn goat. Lamina propria and tunica submucosa is filled by vascular loose connective tissue with erectile tissue. Results of this research appeared that VNO of male Iranian helical goat is connected with oral cavity by incisive duct. This connection was reported in other animals. In this animal, VNO has extended from incisive papillae to 2nd premolar tooth, Results of this research is similar to reports of other researchers. Due to length of muzzle of male Iranian helical horn goat is shorter than other animals (horse, cattle and buffalo) its Jacobson organ was shorter than them. Since, mucus layer of VNO is lined by respiratory and olfactory epithelium particularly, therefore this organ plays an effective role for receiving sexual odor and has a physiological role in sexual behaviors.

**Key words:** Anatomy, goat, histology, Iran, VNO

### INTRODUCTION

Vomeronasal Organ (VNO) has an important function in sexual odor sensation. The animals have an accessory olfactory system. This system function performed by VNO (Jacobson organ). This organ has a tubular structure and placed floor of nasal cavity (Abbasi and Khosravinia, 2002; Doring *et al.*, 1993). Witten (1985) studied physiological function of this organ firstly and Jacobson explained this organ anatomical structure completely

(Kumar *et al.*, 1992). VNO cause formation Flehmn reaction in many animals, especially in the horse. Flehmn reaction was studied in many mammals, for example horse, ox, sheep, goat, dog and mink (Doring *et al.*, 1993). In this reaction, nostril was dilated abnormally (similar to hyperpnoea) and upper lip was elevated that upper incisive teeth can be observed. In this condition inlet of this organ is opened and feremons can be entered (Kar and Beaucamp, 1997). VNO is similar to two blinded tubule which they placed in lateral aspect of nasal septum.

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They are surrounded by hyaline cartilage incompletely (Barone, 1984; Mendoza, 1986). Jacobson organ almost was connected to mouth by incisive duct and it has variation in size in different animals (Mendoza, 1986). There is not information about this organ in Iranian helical horn goat (*Capra persica*). In this research, anatomical and histological structure of this organ was studied in Iranian helical horn goat.

## MATERIALS AND METHODS

Total 17 healthy head of Iranian helical horn goat about 2.5-3 age were collected from Urmia industrial slaughterhouse. Twelve samples were used for anatomical studies and 5 used for histological studies. For anatomical studies, mandible was removed firstly. Palatine folds were counted. Then the heads were sectioned longitudinal and transverse. Longitudinal section was provided for study of length of this organs and transverse section was provided for measuring diameter and shape of this organ in different region. Transverse sections performed from incisive papillae till end of VNO. Distance between 2 section was 1.5-2 cm. VNO was observed in rostral and caudal aspect of any segment, between nasal septum and vomer. The medioventral and medioletral diameter were measured by caliper. These measurements were performed by 2 persons. The lumen diameter of VNO was measured by canola with 1-4 mm diameter. Outer diameter of any canola was measured by caliper and this diameter was true diameter of lumen of this organ.

For finding connection between mouth and nasal cavity by VNO, this region was showed very well by physiologic serum. The latex was injected into incisive papillae. Then this organ duct was dissected and length and diameter of connection region were measured. Anova test was used for statistic studies.

Histological studies performed on 5 samples. Mandibles were removed and 4 section were provided. These sections were provided in region fourth palatine fold, 8th palatine fold, rostral of 1st premolar teeth and rostral of 1st molar teeth. Provided segments were calcified and histological section provided by routine histological method and staining (H&E).

## RESULTS

Obtained results from this research are anatomical and histological results.

Anatomical results were showed which length of VNO (VNO) in Iranian helical horn goat is 6.5-8.3 cm. The mean of length of this organ in this animals  $7.8 \pm 1.3$  was

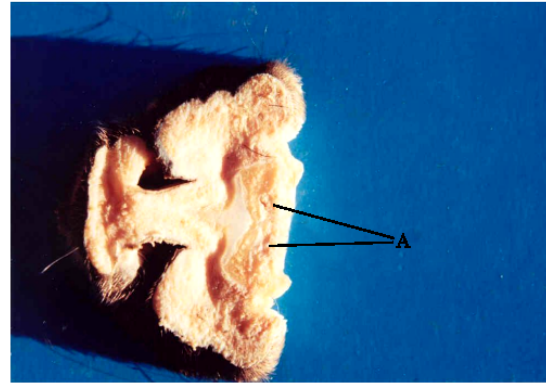


Fig. 1: Caudal aspect of 1st segment. (A) Incisive duct which it is caudally incisive papillae



Fig. 2: Caudal aspect of 2nd segment. Needle marked ovoid VNO duct around nasal septum

measured. VNO were extended from incisive papillae to second premolar teeth. Six segments were prepared in this region.

**First segment:** This segment was prepared by transverse section in dorsal region of incisive papillae (Fig. 1). Incisive papillae and nasal vestibule were observed in this segment. Two ducts of VNO were observed in oral surface of hard palate in this segment. Diameter of inlet VNO was narrow and about  $1 \pm 0.15$  mm.

**Second segment:** This segment extended from 1st palatine fold to 4th palatine fold. VNO have  $1/4 \pm 0/2$  mm diameter. Surrounding cartilage was not complete. The duct of VNO extended from incisive papillae initial part to end of this segment. its diameter was greater than its diameter in first segment. In other hand, the diameter of VNO was greater in caudal portion (Fig. 2).

**Third segment:** This segment extended from 4th palatine fold to 7th palatine fold. Surrounding cartilage was ovoid and complete. It extended from dorsal to ventral and medial to lateral. The large diameter of ovoid cartilage was  $3.23 \pm 0.1$  mm and small diameter of ovoid cartilage was  $1.83 \pm 0.3$  mm. The diameter of This organ was measured about  $1.5 \pm 0.1$  (Fig. 3).

**Fourth segment:** This segment extended from 7th palatine fold to 10th palatine fold. The lumen of VNO in caudal portion had been large suddenly. The large diameter of ovoid cartilage  $3.95 \pm 0.2$  mm and small diameter of ovoid cartilage  $2 \pm 0.15$  mm were measured. The diameter of connecting duct with mouth was measured  $1.6 \pm 0.2$  mm. The palate of this organ was observed in lateral region of nasal septum and vomer (Fig. 4).

**Fifth segment:** This segment extended from tenth palatine fold to 13th palatine fold. The mean of large diameter of ovoid cartilage was  $4.23 \pm 0.1$  and the mean of small diameter of ovoid cartilage was  $2.15 \pm 0.02$ . The mean diameter of connecting duct was  $1.8 \pm 0.3$ .

**Sixth segment:** This segment was prepared by a section in 1 cm caudal of end palatine fold and region second premolar teeth. In rostral portion of this segment, the mean of large diameter of ovoid cartilage was  $3.3 \pm 0.11$  mm and the mean of small diameter of ovoid cartilage was  $1.3 \pm 0.02$  mm.

Diameters of ovoid cartilage were compared in different segments. Obtained results showed which ovoid cartilage diameters (large and small) in fifth segment were larger than other segments. Ovoid cartilage diameters become large from 1st segment to 5th segment and then become short from 5th segment to 6th segment. VNO was observed similar to a small cartilaginous point. The length and wide of incisive papillae were 5 mm and placed in median part of dental pad. Two foramen was observed in its sides. The mean length and wide them were  $2.47 \pm 0.3$  and  $1.24 \pm 0.1$  mm. Diameters of these foramens were measured by using latex cast. They were  $1 \pm 0.1$  in size. This duct extended 1.3cm and terminated by 2 duct. One superior and another one was parallel to mouth roof which entered to VNO.

Histological studies showed which ovoid cartilage or surrounding cartilage was hyaline cartilage. It was not complete except in some regions (Fig. 5). Lining epithelium in medial region of VNO was pseudostratified columnar with goblet cell (Fig. 6). Muscularis mucosa was not observed and lamina propria and tunica submucosa were loose connective tissue with seromucose gland which serous glands were abundant (Fig. 7). The lateral region of

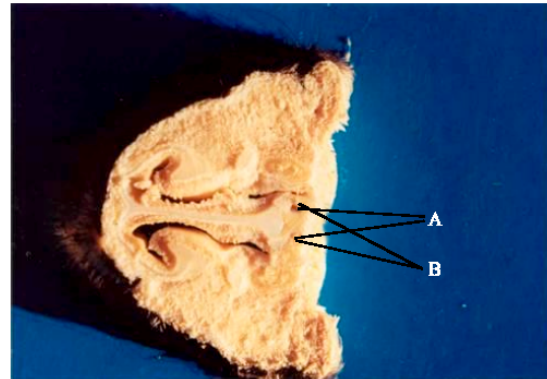


Fig. 3: Caudal aspect of 3rd segment. In this segment the VNO duct (A) become bigger than before segments and surrounding cartilage (B) is observed very clearly

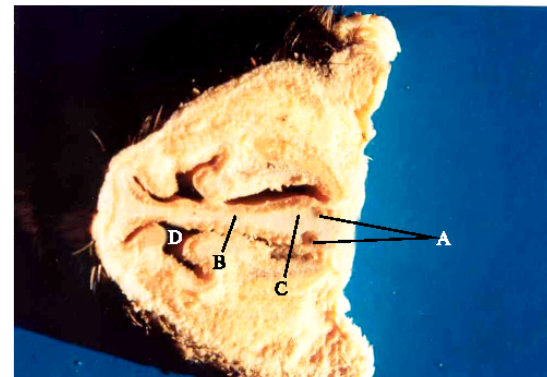


Fig. 4: Caudal aspect of 4th segment. (A) Ovoid VNO duct become bigger than VNO in cauda aspect of third segment. (B) nasal septum, (C) Vomer bone, (D) Nasal cavity

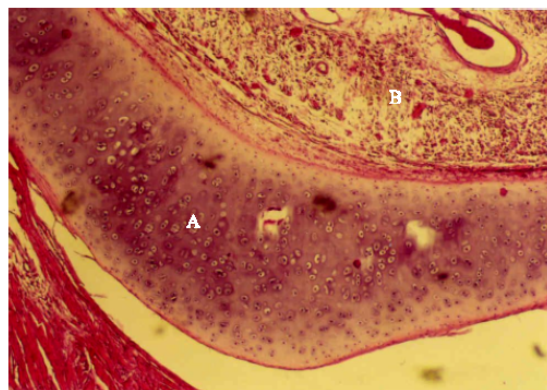


Fig. 5: Microscopic structure of VNO. (A) Surrounding cartilage is hyaline type cartilage. (B) Lamina propria and tunica submucosa is vascular loose connective tissue (H and E, X100)

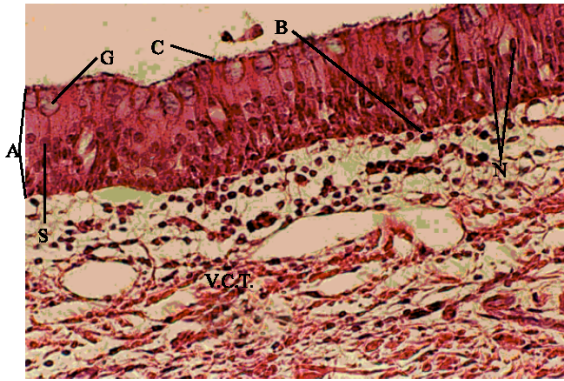


Fig. 6: Epithelial tissue and connective tissue of lamina propria and tunica submucosa of medial region of VNO. (A) Ciliated pseudostratified columnar with goblet cell. (G) Goblet cell, (C) Cilia, (B) basal cell, (N) Neuroepithelial cell, (V.C.T) Vascular loose connective tissue (H and E, X1000)

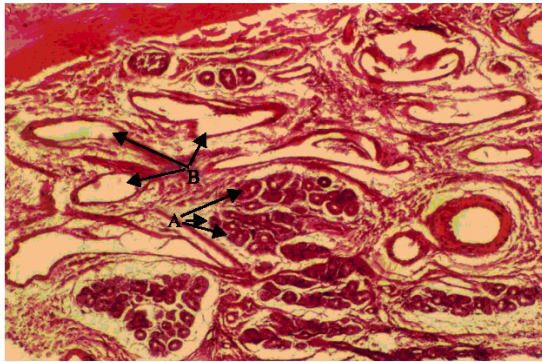


Fig. 7: Lamina propria and tunica submucosa of VNO. (A) The ducts of seromucosa gland. (B) Vascular tissue of erectile tissue (H and E, X400)

VNO in this animal was pseudostratified columnar without goblet cell and cilia. Three type cell was observed in this tissue. These cells were neuroepithelial cell, supporting cell and basal cell.

### CONCLUSION

The function of this organ in sexual behavior of mammals was founded in many years ago. For example, the bulls by using this organ not only can be to olfaction urine odor and vagina of female cow but also can be olfaction his urine odor and another bulls urine odor. Female VNO have important function in olfaction new born calve and another female cow (Albright and Arave, 1997). Flehmn reaction was observed in horse, cattle, sheep, goat, dog, cat, elephant, swine, rat, monkey and

some primates (Kar and Beaucamp, 1997). Also this organs is presenting snake, frog and lizard (Miller and Guzke, 1999). VNO was studied in many animals by many different scientist. Lindsay *et al.* (1978) studied it in horse and donkey and reported that the length of VNO is 2-15 cm in the horse (Lindsay *et al.*, 1978). Adams *et al.* (1984) was reported that the length of VNO 5-6 cm from incisive foramen to end portion and the length of incisive duct is 1.3-1.6 cm in the dog (Ardalani *et al.*, 1999). The length of it was reported 4cm by Baron (1984). The different present in sizes reported by many scientist is in order to different present in sizes muzzles in different dog species. The length of Jacobson is 15-20 cm and Ardalani *et al.* (1999) was reported which the length of it is  $18.9 \pm 1.5$  in buffalo. Present research results was showed which the length of VNO is 6.5-8.4 with mean equal 7.8 cm in Iranian helical horn goat. To comparing of sizes obtained of VNO in different animals and Iranian helical horn goat was showed which the length of this organ have closely relation with length of muzzle and length of nasal cavity. The duct of VNO was related to mouth by incisive duct in many mammals (connecting region is near oral foramen of incisive duct). Therefore, the mouth and nasal cavity connected in this region (Barone, 1984; Mendoza, 1986). The mucosa membrane of mouth of horse is covering incisive duct, therefore VNO can not be terminated to mouth and it connected only to mouth (Ardalani *et al.*, 1999; Barone, 1984; Mendoza, 1986). Obtained results of study on VNO of Iranian helical horn goat indicated which it was connected to mouth by incisive duct, similar to other animals. Also, results were appeared which the end part of this organ was the a region between second and third premolar teeth and largest diameter was measured in median region. The diameter of VNO was becoming smaller in rostral or caudal portion. Many scientist studied epithelial tissue of VNO in rodentae, amphibian, laboratory animals and the most domestic animals. These studies appeared which it has respiratory and olfactory epithelium (Abbasi and Khosravinia, 2002; Adams and Wiekamp, 1984; Ardalani *et al.*, 1999; Hunter *et al.*, 1984; Johnson *et al.*, 1993; Kumar *et al.*, 1992; Lindsay *et al.*, 1978; Mendoza, 1986). Epithelial tissue of this organ around incisive duct is nonkeratinized stratified squamous in studied domestic mammals. Epithelial tissue is changing in deep region and is replaced with stratified columnar epithelium and stratified cuboidal. Finally, its epithelial tissue becomes olfactory epithelium in lateral region of lumen of this organ. Lamina propria and tunica submucosa were reported loose connective tissue with many vessels and seromucosa gland (Abbasi and Khosravinia, 2002; Adams and Wiekamp, 1984; Ardalani *et al.*, 1999;

Hunter *et al.*, 1984; Johnson *et al.*, 1993; Kumar *et al.*, 1992; Lindsay *et al.*, 1978; Mendoza, 1986). Abbasi *et al.* (2003) reported which mucus units are abundant in this region (in seromucosa glands) (Adams and Wiekamp, 1984). Histological studies of VNO of Iranian helical horn goat appeared which it have pseudostratified columnar epithelium with goblet cell in lateral region and pseudostratified columnar epithelium with cilia, neuroepithelial cell, supporting cell and basal cell (Olfactory epithelium). Olfactory epithelium present in this organ indicates the important role of it in sensation sexual odor and performs sexual reaction. In lamina propria and tunica sub mucosa were loose connective tissue with distributed vascular plexus and seromucosa gland. Mucosal secretory units were abundant in seromucosa glands. Distributed vascular plexus was organized cavernous plexus form. Cavernous plexus is cause to performing Flehmn reaction. Lamina propria and tunica submucosa of this region were loose connective tissue with seromucosa gland. Mucosal glands were abundant.

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