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Histological study of nasal cavity in pigs

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Abstract
The present study was carried as a part of PhD programme in Department of Veterinary Anatomy, Veterinary College, Bengaluru, Karnataka. The histological studies conducted on nasal cavity of 10 adult healthy pigs. Revealed vestibular, respiratory and olfactory regions. The smallest vestibular region was lined by stratified squamous epithelium and its propria submucosa contained hair follicles, sebaceous glands, sweat glands, venous caverns, mucous and serous glands. The respiratory region was lined by pseudostratified columnar ciliated epithelium and its propria submucosa had mucous glands increased rostro-caudally the olfactory region was lined with the olfactory epithelium and contained mucous type of Bowman's glands and increased number of nerve bundles.

Keywords: Nasal cavity, nasal turbinates, vestibular, respiratory, olfactory, pig

Introduction
Pigs have been proposed as an ideal animal model for human organ transplats because the anatomy and physiology of the porcine respiratory tract are more similar to humans than that of rodent models (Cunningham *et al.*, 2002) [3]. In particular, the sinonasal anatomy and airway cell biology of pigs are similar to that of humans.
The nasal cavity not only serves as the principal organ for the sense of smell, but it also functions to efficiently filter, warm, and humidify the inhaled air before it enters the more delicate distal tracheobronchial airways and alveolar parenchyma of the lung. The nasal passages have been described as an efficient "scrubbing tower" for the respiratory tract because it effectively absorbs water-soluble and reactive gases and vapors, traps inhaled particles, and metabolizes airborne xenobiotics. With its role as an "air conditioner" and a "defender" of the lower respiratory tract. Upper airway apparatus is one of the first lines of defense against inhaled pathogens, dusts, and irritant gases, toxicant-induced compromises in its defense capabilities could lead to increased nasal infections and increased susceptibility to lower respiratory tract diseases (Lunney, J.K 2007) [10].
The histology of nasal cavity has been studied in cattle (Pass *et al.*, 1971, Adams, 1986) [11, 1], buffalo (Gupta *et al.*, 1994) [5], goat (Kumar *et al.*, 1992, 1993) [6, 7], dog (Kumar *et al.*, 1994) [8], camel (Badawi and Bab, 1974, Suman *et al.*, 1998) [2, 10, 12] horse (Kumar *et al.*, 2000) and sheep (Ganganaik *et al*., 2004) [4].
The paucity of literature and recent interest in use of intranasal vaccines and pharmaceuticals has evoked a need for detailed exploration of the histomorphological studies of nasal cavity. Hence, a complete study and understanding of histology of nasal cavity of adult pigs was under taken.

Materials and Method
The present study was carried out in Department of Anatomy Veterinary College, Bengaluru, Karnataka. The present study was conducted on 10 adult local cross bred pigs of either sex. The heads were procured from local slaughter house immediately after slaughter and fixed in 10% neutral buffered formalin solution for one week. Once the heads were fixed they were split into two equal halves and tissues of interest from nostrils, nasal turbinates and ethmoturbinate were collected. Both nasal and ethmoturbinates were decalcified using formic acid and sodium citrate solution for a period of 24 hrs and processed as per the routine paraffin technique for histological study (Luna, 1968) [9].
The paraffin sections of 5-6 µ were cut and stained by routine Harris' hematoxylin and eosin method and vangeison for collagen (Luna, 1968) [9].

Results and Discussion

The nasal cavity in pigs was divided into vestibular, respiratory and olfactory region.

Vestibular Region

This region was lined by stratified keratinized epithelium which later transformed into into pseudo stratified ciliated epithelium. In between stratified cuboidal epithelium was also seen (fig 1).

Propria submucosa interdigitated via papillae with epithelium. Bundles of collagen, blood vessels, lymphocytes, nerves and seromucous glands were also noted (fig 2). The reticular fibres were seen underlining the base of the lining epithelium including the vessels, nerves and seromucous glands in propria submucosa. Similar observations were made by Ganganaik *et al*. (2004) [4] in sheep, Kumar *et al*. (1993) [7] and Sinha *et al.* (2012) in goats and Suman *et al*. (1998) [12] in camel.

Respiratory Region

The nasal cavity in pigs was divided into two equal portions by a median nasal septum and the major portion of the nasal cavity was occupied by dorsal and ventral turbinates which were lined by nasal mucosa with the following histological details.

The rostral portion of nasal turbinates was initially lined with stratified cuboidal epithelia and later transformed to pseudostratified columnar ciliated epithelium with goblet cells (fig 2). At places, the respiratory epithelium was modified, where the epithelial height was reduced, the cilia and goblet cells were less in number.

The respiratory epithelium was comprised of basal, supporting cells, ciliated columnar cells and goblet cells. The oval nuclei of basal cells were placed close to the basement membrane. These nuclei had uniform distribution of fine chromatin material. The nuclei of supporting or sustentacular cells were narrow and elongated with their longitudinal axis parallel to the height of the epithelium. These nuclei were oriented at varying heights of epithelium but their more concentration was observed towards lower half of epithelium. Only a few nuclei reached upto the surface of epithelium.

The mid portion of turbinates showed its mucosa having outer and inner surfaces. Both the surfaces were lined with respiratory epithelium, however the thickness of epithelium was more on the outer surface compared to the inner surface. Number of goblet cells were more on the ventral surface (fig 3). However, Badawi and Bab (1974) [2] observed more number of goblet cells towards the outer surface in camel. The height of the epithelium continued to increase towards the caudal portion of the turbinates. However caudal region of turbinates was lined by olfactory epithelia in sheep (Ganganaik *et al*., 2004) [4], goat (Kumar *et al.*, 1993) [7], buffalo (Gupta *et al.*, 1994) [5], camel (Badawi and Bab, 1974 [2], Zguigal *et al.*, 1994 [13] Suman *et al.*, 1998) [12] and dog (Kumar *et al.*, 1994) [8] and horse (Kumar *et al.*, 2000).

The propria submucosa was divided into an outer and inner portion by an irregular osseous plate as reported in camel (Badawi and Bab, 1974) [2], buffalo (Gupta *et al.*, 1994) [5], bovine (Adams, 1986) [1] and horse (Kumar *et al.*, 2000).

The lamina propria consisted of loose connective tissue with numerous blood vessels of various sizes, nerve bundles and clusters of seromucous glands with their ducts. The similar type of the glandular acini had been reported in goat (Kumar *et aI.*, 1992) [6], buffalo (Gupta *et aI.*, 1994) [5], camel (Suman *et al.*, 1998) [12] and horse (Kumar *et al.*, 2000). However, Badawi and Bab, (1974) [2] observed a few seromucous glands in camel. The fine reticular and bundles of collagen fibers were present. Propria submucosa had lymphatic aggregates within forming a part of nasal associated lymphatic tissue (fig 4). In addition, large number of venous caverns or cavernosum stratum was also seen.

Olfactory Region

Both olfactory and respiratory epithelium were noted lining the ethmoturbinates of pigs. The initial portion of the ethmoturbinates were lined by respiratory epithelium and rest was lined with olfactory epithelium. However the olfactory epithelium was lining from the caudal apart of dorsocaudal part of nasal turbinates in goat (Kumar *et al.*, 1993) [7], buffalo (Gupta *et al.*, 1994) [5], camel (Badawi and Bab, 1974, Zguigal *et al.*, 1994, Suman *et al.*, 1998) [2, 12, 13] and dog (Kumar *et al.*, 1994) [8] and horse (Kumar *et al*., 2000).

Olfactory epithelium was lined by tall pseudostratified ciliated columnar cells which included olfactory cells, basal cells, and sustentacular cells or supportive cells (Fig 5). Olfactory cells were characterized by large oval shaped euchromatic nucleus with clear nucleoli and dendrites facing upward. Supporting cells were closer to the apex of the epithelium and comprised an intensely stained oval nucleus. (fig 6). Thickness of olfactory epithelia was very much increased towards the ethmoid crest region which is responsible for better olfaction capability of the animal.

Lamina propria comprised of loose connective tissue with nerve bundles and different sizes of blood vessels. Bowman's glands were seen consisting glandular acini with typical pyramidal cells and round nuclei located towards the periphery (Fig 7). These glands were compound acinar mucus type seen in intermittent patches between the epithelium and the bone. Predominantly mucus type glandular units consisted of compact pyramidal cells with an oval to round shaped intensely basophilic nucleus located at the periphery. Thicker bundles of nerve fibres were seen compared to other domestic animals. However, the concentration of nerve bundles was drastically increased in olfactory portion (Fig 8) as reported in buffalo (Gupta *et al.*, 1994) [5], camel (Zguigal *et al*., 1994: Suman *et al.* 1998) [12] and goat (Kumar *et aI.*, 1993) [7].

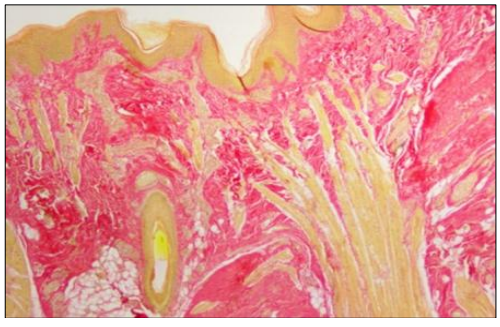

Fig 1: Stratified keratinised epithelium with collagen bundle and hair follicle. (Vangeisons stain)

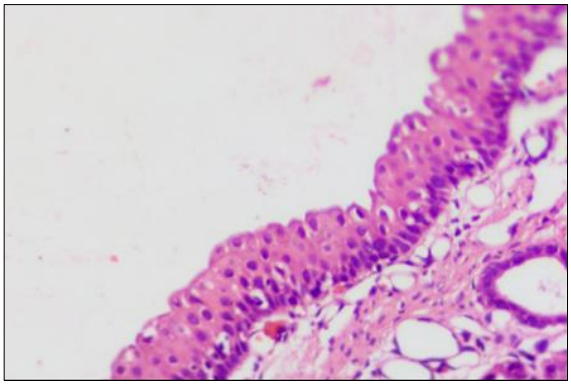

Fig 2: Transitional zone with stratified cuboidal epithelium (arrow) (H &E)

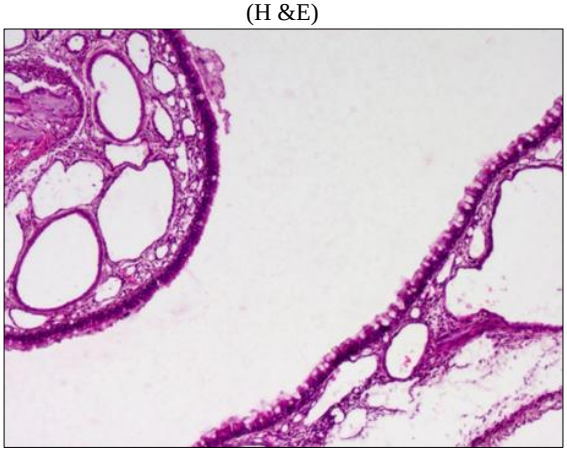

Fig 3: Goblet cells (small arrow) and venous cavernous tissue in the turbinates. (Large arrow)

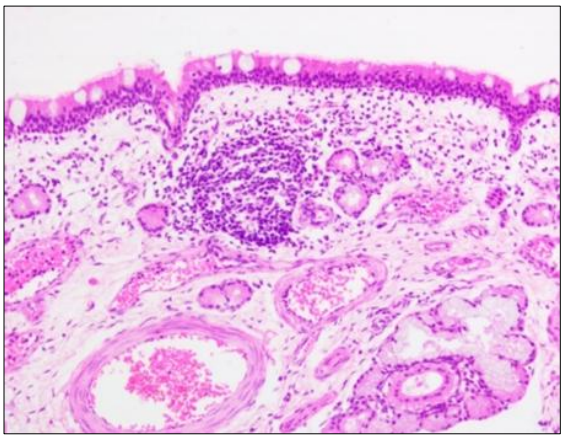

Fig 4: Psuedostratified ciliated columnar epithelium and NALT (Arrow)

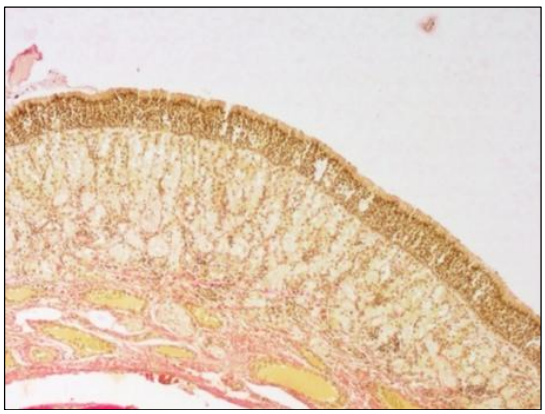

Fig 5: Olfactory epithelium (O) and Bowman's glands. (B) (Vangeisons stain)

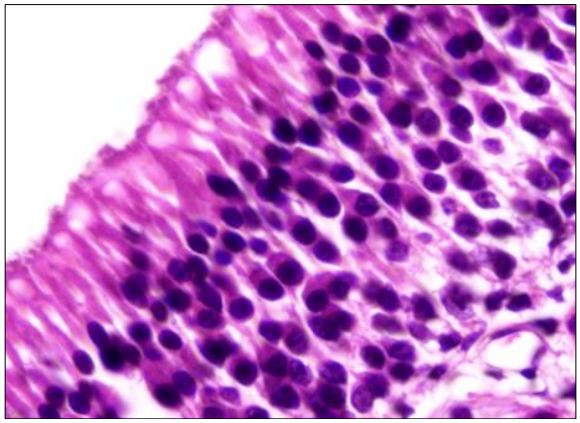

Fig 6: Olfactory epithelium under high magnification

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