Ultrastructural Study of Tracheo-Bronchial Epithelium of Indian Goats (Capra hircus)

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ABSTRACT

The ultrastructure of trachea and bronchi was studied in Indian goats. The epithelium of trachea was comprised of ciliated, non-ciliated, brush and basal cells. Ciliated cells were columnar and contained numerous cilia, round and elongated mitochondria and many vacuoles. Non-ciliated cells or mucous cells were columnar with basal nucleus and had mitochondria and mucous granules of varying density. Brush cells were columnar with short microvilli, mucous granules, mitochondria, Golgi complex, granular and smooth endoplasmic reticulum. Basal cells were arranged in two rows with few mitochondria, secretory vesicles and endoplasmic reticulum. Bronchial epithelium was lined with ciliated cells, mucous cells and basal cells similar to that of trachea however, ciliation was comparatively less.

Key words: Bronchi, Goat, Trachea, Ultrastructure

Respiratory tract has an extensive interphase with both external and internal environment. Researchers have been interested in the patho-physiological responses of ciliated mucous surface of the respiratory tract which may operate with traditional clearance mechanisms for protection of the lungs against inhaled dust and microorganisms. The ultrastructural studies on the epithelium of respiratory tract have been carried out in cattle (Iovannnitti et al., 1985). So the present study was initiated to examine the ultrastructure of the epithelium of lower respiratory tract focusing on trachea and bronchi of normal adult non-descriptive Indian goat (Capra hircus).

MATERIALS AND METHODS

The trachea and bronchi of adult non-descriptive Indian goats were collected immediately after slaughter from the local abattoirs of Hyderabad, Andhra Pradesh. The tissues were washed with normal saline and fixed in 2.5% gluteraldehyde in 0.05 M phosphate buffer (pH 7.2) for 24 hr at 4°C and post fixed in 2% aqueous osmium tetroxide in the same buffer for 2 hr. After post-fixation, the samples for scanning electron microscopy (SEM) were dehydrated in series of graded alcohol with a thin layer of gold using an automated sputter coater (JEOL JFC-1600) for about 3 min (Bozzola and Russell, 1999). After this the samples were scanned under scanning electron microscope (Model: JOEL-JSM 5600, JAPAN).

The samples for transmission electron microscopy (TEM) were dehydrated in a series of graded alcohol from 50% to 100% for 40 minutes each, infiltrated in 1:1 alcohol and spurr resin and later embedded in pure resin (Spur, 1969). Both semi thin and ultra thin sections were cut with a glass knife on a Leica Ultra cut UCT-GA-D/E-1/00 ultra microtome. Semi thin sections of 200-300 nm thick were stained with toluidine blue whereas, the ultra thin sections (50-70 nm) were mounted on copper grids. The sections were stained with saturated aqueous uranyl acetate for 30 minutes and counter stained with 4% lead citrate for 20 minutes (Bozzola and Russell, 1999) and were observed under transmission electron microscope (Model: Hitachi, H-7500, JAPAN) at RUSKA Labs, College of Veterinary Science, S.V. Veterinary University, Rajendranagar, Hyderabad, India.

RESULTS AND DISCUSSION

Scanning electron microscopy:

Trachea: Airway surface of trachea of goat was consisted of ciliated cells with numerous cilia, mucous cells and brush cells which were identified with their regularly arranged microvilli. However, Iovannnitti et al. (1985) in cattle, and Kahwa et al. (2000) in neonatal kid observed only two
types of cells i.e ciliated cells and non-ciliated cells or mucous cells. Surface of trachea did not present lenticular clefts in goats. The orifices of the submucosal glands were not revealed in this study (Fig. 1). These openings were considered to be a prominent feature in trachea of cattle (Iovannnitti et al., 1985).

**Bronchi:** Luminal surface of the bronchi was lined by ciliated and non-ciliated cells similar to the findings of Pirie et al. (1990) in horses. The ciliated cells were predominant but their number was less as compared to the trachea. Non-ciliated cells were of two types and more evident than in trachea. Some of these cells were dome shaped with smooth surface devoid of microvilli and having apical pores on the surface of the cell. This may indicate the secretory activity of cell as reported by Mariassy et al. (1975) in cattle. In the present study, another type of non-ciliated cells were found with microvillous like projections on their apical surface. But apical pores were absent as reported in neonatal kid (Kahwa et al., 2000). Ciliary carpet was relatively less denser from primary to secondary bronchi (Fig. 2).

**Transmission electron microscopy:**

**Trachea:** The epithelium of trachea in goat consisted of ciliated, mucous, brush and basal cells. Ciliated cells were the predominant cell population in the epithelium and having numerous cilia on their apical surface that may be for the prevention of entry of dust particles. Cilia were arising from basal bodies present in the apical cytoplasm as reported in rhesus monkeys (Plopper et al., 1989). Nucleus was oval with light electron dense euchromatin and centrally placed prominent nucleoli. Cytoplasm consisted of numerous round and elongated mitochondria in apical portion and little amount of mitochondria were present in supra nuclear region. Many vacuoles were seen in the cytoplasm, which may be the autophagic vacuoles. Similar findings have been made by Plopper et al. (1989) in rhesus monkeys and Wilson et al. (1984) in bonnet monkeys with an exception of convoluted nucleus. Basal portion of ciliated cells were attached to basal lamina by a thin stalk like filamentous process in goat, whereas such attachments were rarely observed by Plopper et al. (1989) in rhesus monkeys (Figs. 3, 4).

Mucous cells were few in number with basal nucleus. Cilia projecting from ciliated cells may sweep the contaminated mucous towards the oropharynx for disposal. Numerous irregular sized mitochondria were evenly distributed in the apical end of nucleus but few basal to nucleus (Fig. 5). Mucous granules were present in mucous cells as roughly spherical, occasional coalescing membrane bound structures with varying granular density. Well-developed smooth endoplasmic reticulum (SER) and little granular endoplasmic reticulum (GER) were seen in accordance with Plopper et al. (1989) in rhesus monkeys.

Brush cells were columnar in nature with microvilli on their luminal surface. These cells may replace dead ciliated or goblet cells. Few membrane bound mucous granules and vesicles were observed in the cytoplasm of brush cells of goat. They may be the remnants of the mucous cells. Nucleus was basal and round with more electron lucent euchromatin (Fig. 5). Cytoplasm was consisted of mitochondria, predominant Golgi apparatus, SER, GER and vacuoles. Basal cells were arranged in rows on basement membrane and they did not reach the luminal airways. Some of these cells were attached to ciliated cells with pointed projection anteriorly in goat, which might be the stem cells that may replace other cell types.

**Bronchi:** Bronchial epithelium showed ciliated cells, mucous (goblet) cells and basal cells. Brush cells observed in trachea were not seen in bronchi of goat, which was similar to the findings of Castleman et al. (1975) in 3 species of monkeys. Ciliated cells were columnar with numerous cilia and euchromatic nucleus in goat. Cytoplasm was consisted of numerous mitochondria and many autophagocytic vacuoles and apical aggregates of mucous granules as reported earlier (Plopper et al., 1989 and Wilson et al., 1984).

The mucous cells contained membrane bound mucous granules of varying density, basal nucleus and cytoplasm filled with numerous mitochondria and well-distributed SER. Basal cells were of different types. Among them some of the cells showed oval to elongated nucleus with euchromatin whereas, some cells had convoluted nuclear membrane with little heterochromatin (Fig. 6). Cytoplasm was thin around the nucleus. Numerous mitochondria at the base of the nucleus, well developed SER, little rough ER and plenty of poly ribosomes were
Fig. 1. SEM of tracheal epithelium showing mucous cells (Mc) and ciliated cells (Cc). ×2000

Fig. 2. SEM of surface of bronchi showing numerous ciliated cells (Cc) with mucous (M) over cilia. ×5000

Fig. 3. TEM showing ciliated cell of trachea. Note cilia (Ci), mitochondria (M), cell membrane (CM), filamentous process (F) and nucleus (N). Basal cells (B) with mitochondria (M) and nucleus (N). ×3580

Fig. 4. TEM of mucous cell of trachea showing mitochondria (M), membrane bound mucous granule (Mg), smooth endoplasmic reticulum (SER), granular endoplasmic reticulum (GER) and Golgi complex (G). ×9650

Fig. 5. TEM of brush cells of trachea showing microvilli (Mv) towards the lumen, mitochondria (M), smooth endoplasmic reticulum (SER), granular endoplasmic reticulum (GER), Golgi complex (G), secretory vesicle (SV) and nucleus (N). ×12530

Fig. 6. TEM of bronchial epithelium showing ciliated cells (Cc) with pointed basal projection, mucous cells (Mc) and basal cells (B) with their nucleus (N). ×1720

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REFERENCES


Castleman, W.L., Dungworth, D.L. and Tyler, W.S. 1975. Intrapulmonary airway morphology in three species of...


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