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Histomorphological studies on lymphoid tissue in lung of Assam local goat (*Capra hircus*)

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Abstract

Lung and its associated lymphoid tissue have been widely studied in various mammalian species. But detailed literature in Assam local goat is not available. Histomorphological studies on lung of Assam local goat revealed that majority of the lymphatic tissue was located along the bronchial tree and associated arteries. The bronchus associated lymphoid tissue (BALT) presents nodular form located in the lamina muscularis mucosae of bronchi and bronchioles and nodules had distinct marginal and central areas. Diffuse lymphoid aggregates were found adjacent to the basement membrane of bronchi and also in the interalveolar septa. The results revealed that in Assam local goat BALT is well developed.

Keywords: Assam local goat, lung, BALT, lymphatic tissue

Introduction

Lungs being the prime organs of respiration are in constant contact with the external environment and are exposed to various environmental pathogens and toxins and pulmonary immunity is essential to respond to such challenges. Bronchus-associated lymphoid tissue (BALT) is an important immune component of lung mucosal immune system. It influences the mucosal immunity in lung by inducing immune responses against pathogens such as bacteria, viruses, and environmental air pollutants. The role of BALT in antigen uptake and immune response is well established by various worker in different laboratory animals. Based on primarily obtained data, BALT is linked together as part of the “common mucosal immune system” (Iijima *et al.*, 2001) [6] and the term integrated MALT has been suggested (Pabst, 2022) [10]. The agro-climatic condition of Assam is a very hot and humid and the goat farming is highly affected by mortality caused by pneumonia and other respiratory illness. In this regard the lung immunity in goat is a critical defense system and the pulmonary lymphoid tissue plays a major role in antigen uptake and immune response. However the literature pertaining to histomorphology and distribution of BALT and extended pulmonary lymphoid tissue in goat is not available. Hence in this investigation, an attempt has been made to differentiate the morphological characteristics and the extent of lymphatic tissue in Assam local goat by using traditional histological techniques.

Materials and Methods

The study was carried out on twelve (12) numbers of adult Assam goats. All the animals screened for the experiment were clinically healthy and free from internal and external parasites. Animals were first anesthetized using 0.1mg/kg xylazine and 5 mg/kg ketamine and were exsanguinated. Subsequent to sacrifice, the thoracic cavity of the animals was exposed and the lungs along with the trachea were dissected out. Tissue samples were randomly collected from each lung and were fixed in 10% neutral buffer formalin solution. The paraffin blocks were sectioned in Shandon Finesse microtome in 5 µm thickness and the sections were stained by Mayer's Haematoxyline & Eosin and PAS-Alcian blue staining. The slides were examined under microscope for the presence of lymphatic tissue in both lungs.

Results and Discussion

Present study revealed that the lymphoid tissues in the bronchi and bronchioles of adult Assam goat were found in 2 forms: diffuse aggregates in the basement membrane of bronchial and bronchiolar wall and as Nodular form at bronchial bifurcations and around terminal bronchioles. Numerous lymphocytes were also seen scattered throughout the lamina propria and in between the columnar epithelial cells. These intraepithelial lymphocytes (IEL) were also reported by Goto *et al.* (2000) ^[5] and Wisniewski *et al.* (2001) ^[12] in both rodent and human. Bienenstock & McDermott (2005) ^[3] stated that respiratory IEL were phenotypically similar to IEL of intestine. Nickel *et al.* (1996) ^[8] in ruminants termed these intra-epithelial lymphocytes as the first line of defense against microorganisms entering the intestinal lumen.

In the present study, the diffused aggregates were located primarily in the basement membrane and rarely in the tunica adventitia of bronchi, while the nodular form with a more organized aggregation of lymphocytes were observed beneath the muscular layer of bronchi and bronchioles (Fig.1). However, quantity of diffused lymphatic tissue decreased towards terminal and respiratory bronchioles. Similar observations were also reported by Bienenstock

(1980) ^[2], and Cavallotti *et al.* (2004) ^[4] in rabbit and rat respectively.

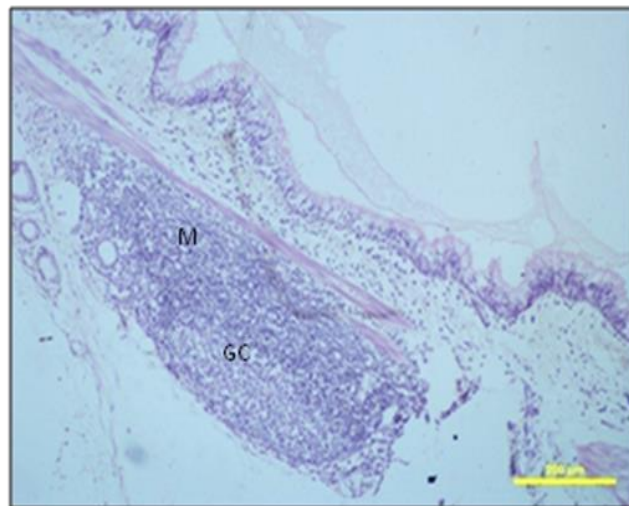


Fig 1: Photomicrograph showing solitary lymphoid nodule with germinal centre and mantle layer around primary bronchus, H&Ex100.

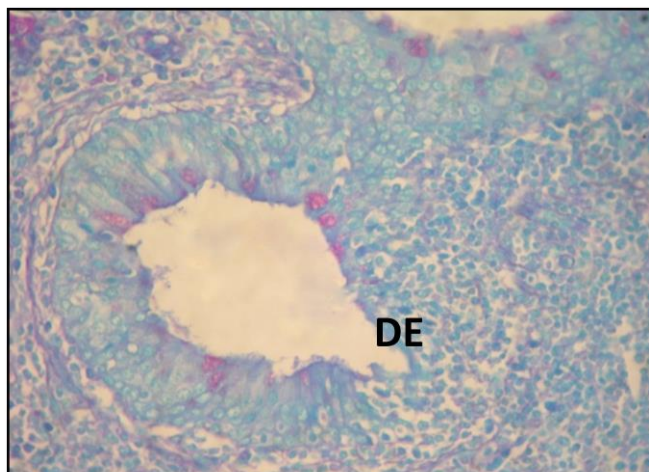


Fig 2: Photomicrograph showing distribution of mucopolysaccharide in the dome epithelium (de) of BALT around smaller bronchiole. lymphocytes were seen with acid mucopolysaccharide, PAS-AB, x400,

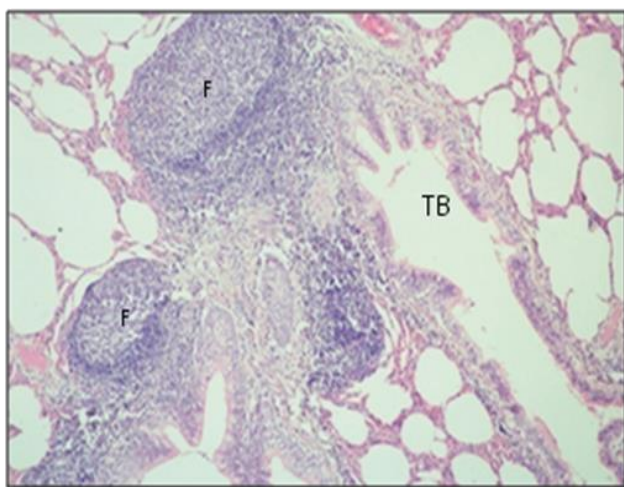


Fig 3: Photomicrograph showing lymphoid nodule with follicles around a terminal bronchiole H&E, x100.

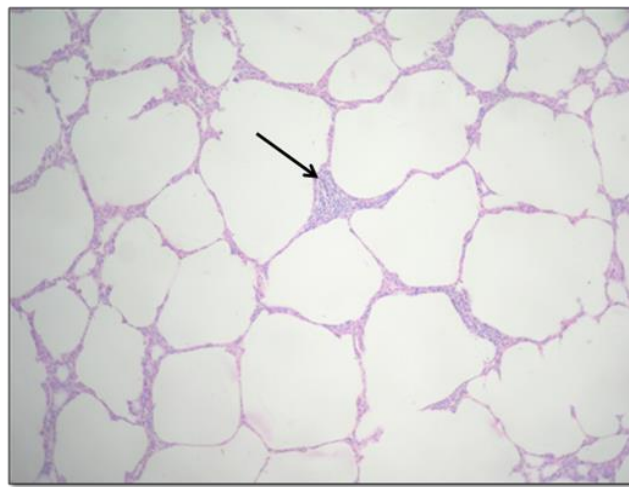


Fig 4: Photomicrograph showing lymphoid aggregates (arrow) in the interalveolar septa, H&E x100

However Al-Tikriti *et al.* (2012) ^[1] located the nodular aggregates in the tunica adventitia of cat lung. Presence of BALT in specific sites along the respiratory tract of Assam local goat might be correlated with the exposure of lung to the hot and humid environments with various microorganisms as well as microenvironments of lung that is loaded with various commensal but pathogenic microorganisms. This view was supported by Luhrmann *et al.* (2002) ^[7] who stated that BALT was strategically placed at sites where they optimally get impacted with the inhaled antigen and confer mucosal immunity at the site. In the present study, presence of BALT was observed in all lobes of lung including the accessory lobe.

Present study showed that the lining epithelium over the BALT follicles were constructed of flattened to low cuboidal, irregular shaped cells along with lymphocytic infiltration of the underlying follicle. Similar observations of lymphoepithelium with flattened cell lining were also reported in human (Pabst & Tschering, 2010) ^[9]. However, Al-Tikriti (2012) ^[1] in cat demonstrated that the epithelium over BALT was simple columnar. In the present study, the follicle associated epithelium (FAE) was found devoid of goblet cells and cilia (Fig.2). Absence of goblet cell was confirmed by PAS-AB staining at pH 2.5. This might be the possible area for entry of antigen to be trapped by the macrophages and dendritic cells as rest of the epithelium were defended by the cilia and mucus secretory goblet cells. This view was supported by Guo *et al.* (2021) ^[15], Tan *et al.* (2019) ^[16], Hwang *et al.* (2020) ^[13] and Hirahara *et al.* (2021) ^[14] who suggested that bronchial submucosal lymphoid follicles functions to distribute antigen-specific antibody-producing cells to the lungs. In adult Assam goat, a mature lymphatic nodule was observed with four distinct compartments, viz., a germinal centre, a zone of small densely packed lymphocytes that capped the germinal centre-the corona, inter follicular region with post capillary venules and an elevated area overlying the corona-the dome. The muscular layer over the lymphoid nodule was discontinuous and was infiltrated with plasma cells, mast cells and lymphocytes. Around the terminal bronchioles, the multiple nodular aggregations were observed and were mostly associated with blood vessels (Fig.4.3). Smaller nodules were observed in subpleural pulmonary tissue. A remarkable aggregations of lymphocyte were also observed in the inter-alveolar septa (Fig.4). BALT in conformity with bronchioles and artery were also reported in cat by Al-Tikriti *et al.* (2012) ^[1], Foo *et al.* (2010) ^[17] and Mikami *et al.* (2025) ^[18] suggested that smaller, less organized BALT-like lymphocyte aggregates can occur in perivascular spaces adjacent to fine airways and vasculature under pathological conditions in mice.

Taken together, the findings demonstrated that the BALT in Assam local goat was well developed. Both intraepithelial lymphocytes (IEL) and site specific lymphocyte aggregates in bronchial and bronchiolar wall as well as in interalveolar septa and acted as ideal site for antigen specific cells to impart immune reaction whenever needed. This view was supported by Randall (2010) ^[11] and Pabst (2022) ^[10] who stated that BALT is a constitutive mucosal lymphoid tissue adjacent to the major airways and can acquire antigens from the airways to induce local immune responses and maintain memory cells in the lung.

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