Pneumonia is a clinical condition arising from an inflammatory response of the bronchioles and alveoli in the lung to infective agents. It is regarded as a disease complex, involving interactions between host (immunological and physiological), multiple agents (bacterial, viral, mycoplasmal) and environmental factors. Pneumonia is a leading cause of economic loss in small ruminant industry throughout the world. It is estimated that pneumonia causes at least 10% mortality in sheep population in India. Despite the fact that endoscopy has been widely used in the diagnosis of diseases of the respiratory tract in cattle, its application in small ruminants is rarely reported. Literature pertaining to the endoscopic evaluation of bacterial infections through bronchoalveolar lavage fluid analysis in sheep and goats is scanty. Hence the present research work was undertaken to document the endoscopic features of respiratory tract in sheep and goats.

MATERIAL AND METHODS

The study consisted of apparently healthy animals (n=24) and clinical cases (n=24). Apparently healthy sheep and goats that were brought to Teaching Veterinary Clinical Complex (TVCC), Veterinary College and Research Institute, Namakkal for routine check-up, deworming and vaccination were subjected for haematology and serum biochemistry. For control group, animals with normal haematology and serum biochemical values were selected (Sheep: 12; Goats: 12). Animals with clinical signs like fever, nasal discharge and cough suggestive respiratory infections were considered for study. As per CPCSEA guidelines, study involving clinical samples does not require approval of Institute Animal Ethics Committee. Apparently healthy animals were sedated using xylazine (@ 0.1 mg/ kg for sheep and 0.02 mg/kg for goats IM) as per standard methods. Animals with pneumonia were sedated by administration of diazepam (@ 0.25 to 0.5 mg/kg slow intravenous). On sternal recumbency, rhino-laryngeal tracheobronchoscopy was done in animals above 8 months of age. Oro-laryngeal tracheobronchoscopy was done in animals less than 8 months of age and in those whose nasal cavity could not accommodate 4 mm diameter Olympus™ flexible videoendoscope. The animals were placed in right lateral recumbency on the table following anaesthesia. Gag was used to keep the mouth open. Patients were placed in such a way that their polls were higher than their nose so that excess saliva and regurgitated material drain out of the mouth. Vital signs of the animals were monitored during the procedure. Atropine (@ 0.05 mg/kg intramuscularly / subcutaneously) was used for treating bradycardia.

Endoscopic evaluation of respiratory tract was performed using Olympus™ [GIF V70] flexible video endoscope with a diameter of 4 mm and a usable length of 100 cm that featured a channel for instruments (diameter 2 mm) and navigation system allowing the endoscope to be moved in two directions (upward 180° and downwards 100°). The use of image and data archiving system allowed digital recording of the endoscopic findings during examination. In case of rhino laryngeal tracheobronchoscopy, the endoscope was inserted into the
ventral nasal meatus and moved forward along the nasal septum up to the region of the pharynx and nasolarynx. The endoscope was passed through the oral cavity into the oropharynx and then into larynx in case of oro-laryngographic tracheobronchoscopy. Upon reaching the larynx, the endoscope was inserted into the trachea and moved forward to tracheal bifurcation and to bronchial areas. The following parameters were evaluated in each region: mucosal surface, color (pink, reddened, anaemic), vascularization, oedema, quantity and a description of any secretions (serous, serous-mucoid, mucoid, purulent, mucopurulent or blood)\(^7\). The flexible video endoscope which had been previously sterilized with 2% glutaraldehyde solution was used for the tracheobronchoscopic investigation. The technique used for bronchoalveolar lavage fluid collection from calves described by earlier workers was slightly modified to obtain BAL fluid from sheep and goats in the present study\(^8\). The endoscope was advanced as caudal as possible through the bronchiole branches. A presterilized catheter was passed through the working channel of the endoscope and was guided to enter through tertiary bronchial divisions till a resistance was felt. Fifteen milliliters of saline was infused through the catheter and the same was aspirated using 50 ml syringe after two breathing cycles. The collected BAL fluid was used for cytology and bacteriological culture.

**RESULTS AND DISCUSSION**

The predominant clinical signs noticed in sheep with pneumonia included nasal discharge (83.3 %), dullness, (66.6 %), cough (66.6 %), anorexia (66.6 %) and fever (58 %). Other clinical signs observed were reluctance to move, low-tone bleating, dyspnoea, lacrimation, extension of head and neck, ptyalism and open mouth breathing. Nasal discharge (83.3%), fever (75 %), tachypnoea (66.6 %), dyspnoea (66.6 %), cough (58.3 %) and anorexia (58.3 %) were the predominant clinical signs noticed in goats with pneumonia. Other clinical signs observed in these goats included extension of head and neck, dullness, open mouth breathing, low tone bleating, lacrimation, reluctance to move and ptyalism. On endoscopic examination revealed that the nasal cavity was lined by a pink, smooth and glistening mucosa. The ethmoturbinate was seen in sheep and goats when the endoscope was advanced, nasopharynx with nasal septum and epiglottis were visualized. When the endoscope was passed through rima oris up to the larynx, oral cavity, oropharynx and epiglottis could be visualized. The laryngeal mucosa was smooth and glistening and a submucosal vascular pattern was evident in the arytenoid cartilages and the dorsal surface of the epiglottis. The epiglottis was in triangular shape, arytenoid cartilages had symmetrical appearance (Fig.-2) and deeper to it was vocal cord. In 41.67% of the sheep (n=5) and goats (n=5) the cross sectional shape of the trachea was drop-shaped (Fig.-3) in dorsal half and round in its ventral half. In three sheep and four goats, the whole trachea was drop-shaped. Four sheep and three goats had round trachea along the entire length. Apical bronchus was seen at acute angle with the trachea (Fig.-4). In both sheep and goats, the tracheal bifurcation had a smooth mucosa and a sharply delineated appearance. When the endoscope was advanced further, segmental and sub segmental bronchi were visualized. Endoscopy of the nasal cavity in sheep and goats with pneumonia revealed mucus (62.5%), threads of mucus (83.33%) (Plate-E) and increased fragility of nasal mucosa (62.5%). Increased submucosal vascularity (41.67%) (Plate- F), petechiae / ecchymotic patches (33.33%), mucus thread (2.92%), mucus secretions (50%), haemorrhage (45.83 %) and mucus plug (12.5%) were noticed during tracheobronchoscopy in animals with pneumonia. The mean total cell count, macrophages, neutrophils, lymphocytes and epithelial cell percentage in BAL fluid collected from apparently healthy animals were 3.12 ± 0.11 x 103 / ml, 80.60 ± 7.21 %, 14.51 ± 2.01 %, 3.9 ± 1.73 %, and 0.51 ± 0.01 % respectively. The mean total cell count, macrophages, neutrophils, lymphocytes, epithelial cells and other cells in BAL fluid collected from animals with pneumonia were 15.22 ± 8.67 x 103 /ml, 36.18 ± 4.16 %, 59.71 ± 9.76 %, 2.62 ± 0.67 %, and 1.52 ± 0.63 % respectively. The bacterial isolates obtained from BAL fluid of sheep with pneumonia were Pasteurella multocida (66.67 %), Pseudomonas aeruginosa (16.67 %) and Klebsiella pneumoniae (16.67 %). Goats with pneumonia had Pasteurella multocida (83.33 %), Pseudomonas aeruginosa (8.33 %) and Klebsiella pneumoniae (8.33 %) as the isolate from the BAL fluid. No pathogenic bacteria could be isolated from the BAL fluid of apparently healthy animals.
Plate -A to F : Explanation to photographs from 1 to 6 as following:
1. Rhinoscopy- Nasal cavity- Ethmoid turbinates
2. Tracheobronchoscopy- Arytenoid cartilage
3. Tracheobronchoscopy- Tear drop shaped tracheal cross section
4. Tracheobronchoscopy- Apical bronchus
5. Rhinoscopy in pneumonia - Nasal meatus- Thread of mucus
6. Tracheobronchoscopy in pneumonia - Trachea - Increased vascularity

Respiratory infections in small ruminants were often resulted from adverse physical and psychological stress combined with viral and bacterial infections. In majority of the incidences, stressors which compromised the defence mechanisms of host and favoured an abnormal multiplication of the bacteria in the upper respiratory tract, particularly in the tonsil that subsequently colonized in the lungs. In human beings, bronchoscopy is commonly used for diagnosis of pneumonia. Being a primary organ of respiration, inflamed lung inadvertently affects the respiratory function. Sheep with pneumonia exhibited nasal discharge, cough, dullness, anorexia and fever as predominant clinical signs. Salient clinical signs that were observed in goats with pneumonia were nasal discharge, fever, tachypnoea, dyspnoea, cough and anorexia. In corroboration, clinical signs like dyspnoea, slight frothing at the mouth, cough, nasal discharge, fever, depression and anorexia were widely documented in sheep with pneumonia. Nasal cavity was lined by a pink, smooth and glistening mucosa. Ethmoid turbinates were seen when bending the tip of the endoscope beside the nasal septum dorsally. Laryngeal mucosa was smooth and glistening. Similar observations were made by some workers on their attempt to evaluate endoscopic sinus surgery in goat. Submucosal vascular pattern in arytenoid cartilage and dorsal surface of the epiglottis were evident. Cross sectional shape of the trachea was either tear drop shaped or round shaped. Apical bronchus had an acute angle with trachea. Distinct carina, segmental and sub-segmental bronchi were appreciated. The endoscopic findings noticed in the present study were similar to the observations of earlier researchers. In animals with pneumonia, mucus, threads of mucus and increased fragility of mucosa were observed in the nasal cavity. Increase in sub-mucosal vascularization, petichial haemorrhages, mucus secretions and mucus plug blocking the bronchioles were evident during tracheobronchoscopy in sheep and goats with pneumonia. These findings were similar to the observations of earlier workers. Some researchers reported that median total cell count, neutrophil, macrophages, lymphocytes and miscellaneous cells percentage in normal sheep were 3.10 x 103 / cu.mm, 2.6 %, 79.8 %, 4.4 % and 8.5 % respectively.
The BAL cytology obtained in the present study was in concurrence with the reports of the previous authors. There was significant increase in total cell count and neutrophil percentage in BAL fluid collected from animals with pneumonia when compared to BAL fluid from apparently healthy animals. Animals with inflammatory lung disease had significantly higher percentages of polymorphonuclear neutrophils in lavage fluids. However, in the initial stages of the respiratory disease complex, multinucleated syncytia were frequently present, neutrophils and bacteria were few in numbers and alveolar macrophages and neutrophils were more, once inflammation was well-advanced. The changes noticed in BAL cytology in the pneumonia are in agreement with the observations of earlier workers. The bacterial isolates obtained in the present study from sheep and goats with pneumonia included *Pasteurella multocida*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*. The predominant organisms isolated from these animals were *Pasteurella multocida*. Some workers reported that the different isolates obtained from pneumonic goats were *Pasteurella multocida*, *E.coli*, *Klebsiella pneumoniae*, *Pneumococcus pneumonia*, *Enterobacter* spp., *Proteus* spp., and *Bacillus* spp. Some researchers in their study on pneumonia in goats, reported that *Pasteurella* spp., represented vast majority of the isolates followed by *Corynebacterium* spp., *Staphylococcus* spp., and *Actinomyces* spp. The observations in the present study were in concurrence with earlier reports.

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**REFERENCES**