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Prevalence and histopathological investigation of pneumonia in slaughtered goats

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Abstract
The present study was conducted to study the prevalence and histopathology of pneumonic lesions in slaughtered goats at Deonar abattoir, Mumbai. From July 2021 to September 2021, a total of 663 goats were examined for gross pneumonic lesions in the lungs of slaughtered goats using systematic random sampling. Pneumonia was found in fifty-one of the lungs. For histological investigation, representative samples of pneumonic lungs were taken. The prevalence of pneumonia was estimated to be 7.08 % based on histological confirmation. On gross examination, the bilateral lobes were determined to be the most afflicted (66.6%). Lesions in the cranial lobes were more common than in the other lobes. Consolidation was discovered in 41 of the lungs (80.39 percent). In 32 of the lungs, emphysema was discovered (62.74 percent). pulmonary congestion and hemorrhages in 30 (58.82 percent) of the lungs. Pulmonary adhesions were discovered in 8 (15.68%) of the cases. In ten of the cases, pulmonary abscesses were discovered (19.60%). Four cases (7.84) had cystic lungs. Suppurative bronchopneumonia was the most prevalent type of pneumonia (47.05%), followed by fibrinous bronchopneumonia (13.7%), pulmonary adenomatosis (9.8%), bronchointerstitial pneumonia (7.84%), hydatidosis (7.84%), and aspiration pneumonia (1.9%). The present study concluded that suppurative bronchopneumonia was the most prevalent type of pneumonia found in the slaughtered goats.

Keywords: Consolidation, congestion, emphysema, abscess, hydatidosis, adenomatosis

1. Introduction
Pneumonia in caprines is one of the most common respiratory infections (Elsheikh and Hassan, 2012) [9]. Pneumonia in goats causes substantial monetary misfortunes to farmers (Tijjani *et al.*, 2012) [18]. The most common causes of pneumonia in goats are contagious caprine pleuropneumonia (CCPP), *Pasteurellosis*, and PPR (Abraham *et al.*, 2015) [2]. Bacteria like *Pasteurella* spp., *Streptococcus* spp., and *Staphylococcus* are the most prevalent causative agents of pneumonia, in goats (Yesuf *et al.*, 2012) [21]. Parasites such as *M capillaries* and *D filaria*, cause reduced weight gain and respiratory problems such as bronchopneumonia, sometimes even mortality can be observed. Hydatid cysts caused by *E granulosus* are responsible for the condemnation of organ and zoonotic importance (Soulsby, 2005) [16]. The gross findings of pneumonia vary depending on the type and etiology and include congested to heavy edematous lungs with firm consistency, fibrinous deposits, various degrees of hepatization, atelectasis, exudates from the cut surface of lungs and in the tracheal lumen, tracheal hemorrhages, rib imprints on lungs, pleural adhesions, abscesses formation, and so on. (Tijjani *et al.*, 2012) [18]. Histopathological and histochemical techniques are the foundation of diagnostic pathology, facilitating histological diagnosis of pathological tissue and subsequent management. (Luna, 1968) [13].
The pathological and epidemiological studies can be done to correlate with respiratory diseases in goats. Abattoir surveys and findings from post-mortem meat inspection are commonly used to estimate infection or disease prevalence in farm animal populations (Carroll *et al.*, 2017) [6]. The goal of this study was to bring light to numerous gross and histological changes in the lungs of pneumonic goats that were previously unknown. This provides valuable data for further analyses and etiological identification.

2. Materials and Method
2.1 Sample collection
A total of 663 slaughtered goats were included in the study with 50% expected prevalence, 99% confidence level and 5% desired precision, as per the formula given by (Thrusfield and

Christley, 2018) [19].

$n = 2.576^2 Pexp (1-Pexp)/d^2$

Lungs from a total of 663 slaughtered goats of any sex, age, and breed were screened for the presence of gross abnormalities. Representative lung tissue samples were obtained for further investigations. The present study consisted of regular visits to the Deonar abattoir, Mumbai to observe the goat slaughter. The sampling was done once a week and a minimum of 50 goats were examined every day of sampling. A systematic random sampling method was used to select the goat, whereby every 5th goat walking into the slaughtering area was included in the study.

2.2 Gross and Histopathological examination

The lungs of slaughtered goats associated with pneumonia were recovered and thoroughly inspected for the presence of different abnormalities using visualization, palpation, and the lobe(s) implicated, were noted (Zachary and McGavin, 2012) [22]. The Representative pieces of tissues (4-5 mm in thickness) were then taken from the pneumonic lobes of the lungs and, fixed with 10% neutral buffered formalin, for a minimum of 48 hours before tissue preparation. The tissue samples were processed by the routine method of dehydration in graded alcohol, clearing in xylene and embedding in melted paraffin. 4-6 Micron thick sections were prepared and processed for routine Hematoxylin and Eosin method (Bancroft and Gamble 2008) [4].

3. Result and Discussion

In the present study, the prevalence of pneumonia was recorded as 7.69% (51 samples) on gross observations of 663 lung samples of slaughtered goats. Histopathological examination of the representative lung tissue samples revealed 47(7.08%) lungs were positive for pneumonia. A comparable study to the present investigation was performed by Azizi *et al.,* (2013) [1], Asare *et al.,* (2016) [3] and Eneojo *et al.,* (2019) [10], in goats and found the prevalence of pneumonia in slaughtered goats as 4.2%, 4.07% and 3.95% respectively. In the present investigation, the slaughtered goats were clinically apparently normal, however, but suffering from subclinical pneumonia which was detected on gross examination of lung samples and confirmed by histopathological examination. One of the possible reasons for the findings of subclinical pneumonia in the present study could be ascribed to animals' exposure to environmental stressors, the widely used extensive system of goat husbandry, and poor management practices such as starvation, lack of cleanliness and hygiene, and overcrowding, which promote disease susceptibility.

In the current investigation classification of pneumonia, was done based on both histological findings and gross observation. A total of seven categories of pneumonic lesions were made Suppurative bronchopneumonia, Fibrinous bronchopneumonia, Bronchointerstitial pneumonia, interstitial pneumonia, Hydatidosis, aspiration pneumonia and pulmonary adenomatosis as shown in Table 1. Suppurative bronchopneumonia was found in 24 lungs with the highest prevalence of 50.98% followed by fibrinous bronchopneumonia in 7 lungs (13,7%). Bronchointerstitial pneumonia was reported in 4 lungs (7.84%), interstitial pneumonia was found in 2 lungs (3.94%) and Hydatidosis was noticed in 4 lungs (7.84%) and pulmonary adenomatosis was noted in 5 lungs (9.80%). Aspiration pneumonia was reported in 1 lung (1.96%) and the remaining 4 lungs (7.84%) were showing miscellaneous lesions like pulmonary edema, atelectasis, pulmonary emphysema, and pulmonary hemorrhage.

Table 1: Prevalence of types of pneumonia (%)

S. No.	Type of Pneumonia	No. of lungs affected	% Affected
1.	Suppurative Bronchopneumonia	24	47.05
2.	Fibrinous Bronchopneumonia	07	13.7
3.	Bronchointerstitial pneumonia	04	7.84
4.	Interstitial Pneumonia	02	3.9
5.	Pulmonary hydatidosis	04	7.84
6.	Aspiration Pneumonia	01	1.96
7.	Pulmonary adenomatosis	05	9.8
8.	Miscellaneous	04	7.84
	Total	51	100

On gross examination bilateral lobes *i.e.,* right and left lungs were found affected mostly (66.6%) followed by right lungs (21.56%) affected more than the left ones (11.76%). similar findings are in agreement with the concurrent study of Verma *et al.,* (2014) [20] who reported that 82% of lungs in pneumonic goats were affected bilaterally and the recorded right lung was more prone to be affected as compared to the left one. Consolidation was seen in 41 (80.39%) lungs. The emphysema was seen in 32(62.74%) lungs. Pulmonary congestion and hemorrhages were observed in 30(58.82%) lungs out of 51 pneumonic cases. Pulmonary adhesions were observed in 8 (15.68%) cases out of a total of 51. Lung abscesses were seen in 10 cases (19.60%). Similarly, Dar *et al.,* (2012) [7] observed that 18.9 % of lungs had abscesses out of 1455 lungs examined for pathological studies. While 4 cases (7.84) showed cystic lungs in which 3 lungs revealed sterile cysts and one lung showed fertile cysts. Similarly, Singh *et al.,* (2017) [17], reported that 7.04% of lungs showed cysts out of 240 lungs of sheep and goats examined for lung lesions. The hydatid cysts were having insidious pathology and their occurrence varies with age older goats are more likely to be infected than younger ones.

In the present study Suppurative and fibrinous bronchopneumonia were identified in 24(47.05%) and 8(15.68%) lungs. This was in agreement with the findings of earlier studies Mekibib *et al.,* (2019) [15], Yesuf *et al.,* (2012) [21], and Azizi *et al.,* (2013) [1] also reported a higher prevalence of bronchopneumonia as 56.19%, 56.93% and 44.33%, respectively compared to other types of pneumonia. the histopathological examination revealed that the bronchioles and bronchi were filled with suppurative exudate. The alveolar lumens revealed increased cellularity and fibrin strands. Neutrophilic infiltration along with a few mononuclear cells was observed in and around the alveoli. The interalveolar septae and interlobular septae were thickened and distended due to the proliferation and infiltration of purulent exudate. The pleura linings showed thickening due to the infiltration of inflammatory cells. The abscesses were surrounded by fibrous connective tissue capsules and filled with eosinophilic exudate. In some cases, gram-positive and gram-negative bacterial colonies were also noticed in the lumen of alveoli and the cytoplasm of neutrophils and alveolar macrophages. the gross and microscopic findings of the present study were in agreement with the earlier reports by Dar *et al.,* (2012) [7].

Bronchointerstial pneumonia and interstitial pneumonia were reported in 7(4.84%) lungs and 2(3.92%). Bronchointerstitial and interstitial pneumonia is majorly associated with the characteristic pathological finding observed in Peste des Petits Ruminants Virus (PPR) infection in small ruminants mostly goats. Caswell and Williams, (2007) [5] and Khan *et al.*, (2018) [12]. Although interstitial pneumonia was rarely reported due to environmental stress factors in small ruminants and goats generally it is related to Caprine arthritis encephalitis virus (CAEV) Caswell and Williams, (2007) [5]. In the present study even though the virus isolation was not performed based on the subclinical nature of this pneumonia and characteristic histopathological findings, the observed cases could be infected with CAEV. However further investigation is required on this aspect as the prevalence of these subclinical viral diseases in goats remains underreported. Furthermore, due to CAEV's higher similarity with ovine lentivirus (OvLV) and the viruses' interspecies transmission, a comparative phylogeny of small ruminant lentiviruses is required. Caswell and Williams, (2007) [5].

In the case of bronchointerstitial pneumonia, the microscopic lesions revealed intermixed lesions of both bronchopneumonia and interstitial pneumonia. Bronchioles and bronchi were filled with serous exudate. Alveoli were mostly empty. Interstitial tissue showed infiltration of inflammatory cells like neutrophils, alveolar macrophages, and lymphocytes. In some cases, hyperplasia of BALT was noticed due to the proliferation of lymphocytes. While in lungs with interstitial pneumonia the histopathological examination revealed that blood vessels were engorged with erythrocytes. Alveolar lumens were empty but in some alveoli erythrocytes' were filled along with serous fluid. Inflammatory reactions were noticed around the bronchi and bronchiole. The interalveolar septae were thickened due to the accumulation of macrophages and few lymphocytes and neutrophils and the proliferation of fibrous connective tissue. Similar gross and histopathological changes were noticed by Jarikre *et al.*, (2016) [11].

Pulmonary Hydatidosis was reported in 4(7.84%) lungs. In the case of Pulmonary Hydatidosis, the alveoli were filled with serous exudate and some collapsed due to cystic structures'. Cysts were present with germinal layers and distinct fibrous brood capsules. Infiltration of neutrophils along with mononuclear cells and eosinophils was seen. Similar gross and histopathological findings were noted by Singh *et al.*, (2017) [17].

In lungs affected with Aspiration pneumonia, the severe zones of inflammatory cells were seen around the bronchioles and the alveoli around the bronchiole were filled with the neutrophils and a few macrophages and lymphocytes. Aspirated feed particles were noticed in the bronchiole.

In the present investigation pulmonary adenomatosis was observed in 5 cases (9.8%). On histopathological examination, a typical adenoid pattern was shown due to papillary projection in the lumen of alveoli due to the proliferation of epithelial cells. Similar gross and histological findings were in agreement with the earlier reports of Devi *et al.*, (2016) [8] and Mishra *et al.*, (2018) [14]. The occurrence of pulmonary adenocarcinoma in goats is quite uncommon. It's possible that goats' exposure to JSRV (Jaagsiekte sheep retrovirus) infection results from their common rearing with sheep. Mishra *et al*., (2018) [14].

On histopathological examination, some lung tissue samples did not reveal pneumonic changes, hence grouped under miscellaneous conditions like pulmonary emphysema, hemorrhages, congestion, atelectasis, and edema accounting for 4 lungs (7.84%). A similar classification was also given by Mekibib *et al.*, (2019) [15] who examined a total of 864 goat lungs and reported pneumonic lesions in 158(18.8%) sheep and goats on gross observations, however, after histopathological examination recorded pneumonia in 148(17%) lungs and miscellaneous conditions in 10(6.3%) lungs.

4. Conclusion

Based on the results it can be concluded that suppurative bronchopneumonia was the most prevalent type of pneumonia found in goats. The gross observations could be used to identify subclinical pneumonia in slaughtered goats however histopathological examination was a more reliable examination to identify and classify pneumonia. The presence of a considerable percentage of pulmonary adenomatosis revealed possible entry of retroviral infection in the Indian caprine population with mostly subclinical manifestation which requires further investigation.

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