Pulmonary lesions in slaughtered sheep in Western Iran: gross and histopathological findings

Mohammad Hashemnia*, Abdolali Chalechale and Elham Malmir

Department of Pathobiology, School of Veterinary Medicine, Razi University, Kermanshah, Iran

Corresponding author at: Department of Pathology, School of Veterinary Medicine, Razi University, P.O. Box: 67156-85414, Kermanshah, Iran. Tel.: +98 83 38322599-8329540, e-mail: hashemnia@shirazu.ac.ir.

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Keywords
Lung lesions,
Histopathology,
Sheep,
Iran.

Summary
This study was conducted with the objective of identifying the types of gross and histopathological lesions in lungs of sheep slaughtered between March 2013 to February 2014 at Kermanshah abattoir, west of Iran. A total of 1,200 slaughtered sheep lungs was inspected during the study period. Pulmonary macroscopic lesions were detected in 492 (41%) carcasses. Lesions were further subjected for histopathological examinations. On microscopic examination, thirteen different lesions were observed. The observed lesions included bronchopneumonia (32.52%), pulmonary emphysema (10.36%), hydatid cyst (10.16%), interstitial pneumonia (8.73%), abscess (8.13%), congestion (7.11%), atelectasis (6.91%), anthracosis (5.08%), pleurisy (4.06%), bronchiectasis (3.45%), verminous pneumonia (2.23%), pulmonary adenomatosis (0.60%) and melanosis (0.6%). A significant ($P < 0.001$) higher number of cases were observed in winter compared to the other seasons. This study demonstrates that lung disorders represent a serious problem and in Iran causing severe economic losses to livestock industry. The presence of some zoonotic agents may also pose health risk to meat consumers in Western Iran. So designing of serious prevention and treatment programs is very important in our region.

Lesioni polmonari nelle pecore macellate nell'Iran occidentale: rilievi macroscopici e istopatologici

Parole chiave
Iran,
Istopatologia,
Lesioni polmonari,
Pecora.

Riassunto
Questo studio è stato condotto con l'obiettivo di identificare i tipi di lesioni, macroscopiche e istopatologiche, in 1.200 polmoni ovini macellati tra marzo 2013 e febbraio 2014 a Kermanshah, a ovest dell'Iran. Sono state rilevate lesioni polmonari in 492 (41%) carcasse. Le lesioni sono state ulteriormente sottoposte a esami istopatologici dettagliati. All'esame microscopico sono state osservate tredici diverse lesioni. Le lesioni rilevate sono state: broncopolmonite (32,52%), enfisema polmonare (10,36%), cisti idatidea (10,16%), polmonite interstiziale (8,73%), ascesso (8,13%), congestione (7,11%), atelettasia (6,91%), antracosi (5,08%), pleurite (4,06%), bronchiectasie (3,45%), polmonite verminea (2,23%), adenomatosi polmonare (0,60%) e melanosi (0,6%). La più alta prevalenza di lesioni polmonari è stata osservata in inverno, con differenze significative rispetto alle altre stagioni ($P < 0,001$). Le patologie polmonari rappresentano un problema serio nell'Iran occidentale: possono continuare a essere un ostacolo allo sviluppo dell'industria zootecnica e, per la presenza di agenti zoonotici, possono comportare rischi per la salute dei consumatori. In questa regione, pertanto, la progettazione di programmi di prevenzione e di trattamento è molto importante.

Introduction

Respiratory diseases occur frequently in all species of domestic animals. Pathogenesis is generally multifactorial, and the diseases appear depending on the interaction of infectious micro-organisms, host defense, environmental factors and stress (Roy 1990, Wikse and Baker 1996, Lacasta *et al.* 2008). In all major sheep-producing countries respiratory diseases represent the most serious sheep problem and can be an important cause of death and economic losses due to reduction of productivity, treatment costs and vaccination programs (Goodwin *et al.* 2004).

Age, geographic location, nutrition and climate are determining factors on the type of microorganism causing respiratory diseases. In addition, rearing systems, stress factors, climatic changes, unhygienic conditions, sudden changes in feed and a low level of herd health status are stated as predisposing factors to micro-organism infection (Azizi *et al.* 2013).

The infectious agents associated with respiratory diseases of sheep include bacterial agents (*Mannheimia haemolytica, Pasteurella multocida*), viral agents (PI3 virus, Respiratory syncytial virus and Ovine adenovirus) and parasites (*Dictyocaulus filaria, Muellerius capillaries, Cystocaulus ocreatus, Protostrongylus rufescens* and hydatid cyst). *Mycoplasma ovipneumoniae* and *Mycoplasma arginini* are also incriminated as a cause of respiratory disease condition in sheep (Sharp and Nettleton 2000).

The viral and mycoplasma agents usually cause low grade respiratory disease with mild signs after an extended period of infection (Martin 1996). Mortalities and acute clinical signs are mostly associated with bacterial agents particularly *Mannheimia haemolytica* (Sharp and Nettleton 2000).

Sheep is one of the main sources of red meat in Iran. The pastures of the Kermanshah Province (West of Iran) are an important part of the national economy for sheep production. Because of the important economic impact on the sheep industry, pulmonary diseases have been extensively studied in the field and also experimentally in many countries (Azizi *et al.* 2013). In order to understand and design a better control strategy, there is still a need for identifying the causes of respiratory diseases of sheep in each region.

Therefore, this study was conducted with the objective of identifying the types of gross and histopathological lung lesions of slaughtered sheep in Kermanshah province, west of Iran and also to determine the prevalence of each disease to provide baseline data for the future monitoring.

Materials and methods

Field study area

The study was carried out in Kermanshah slaughterhouses, the western province of Iran, from March 2013 to February 2014 during the wet and dry seasons. Kermanshah province is located between latitude 33°35′ N and longitude 45°47′ E with altitude 1,350 m above sea level. Kermanshah has a moderate and mountain climate and the annual rainfall is 500 mm. The average temperature in the hottest months is above 22 °C. An average population of 1.2 million sheep lives in these provinces.

Sample collection

The animal population involved in this study was all sheep which were slaughtered in the Kermanshah slaughter house. Three hundred carcasses were randomly examined for 3 different day/each season. A total of 1,200 samples were collected. No details of sex, breed or husbandry conditions of the sheep were available, and all the animals were submitted for routine slaughter. Lungs, which had macroscopic lesions, were collected and sampled for histopathological studies. Prevelance rates were determined according to the type of lesion and season of collection.

Pathological investigation

Tissue samples 1 cm^3 in thickness were fixed in 10% neutral-buffered formalin for histopathological examination. The samples were then dehydrated in graded ethanol and embedded in paraffin. Sections 5 µm in thickness were stained with haematoxylin and eosin and examined by an ordinary light microscope.

Statistical analysis

Chi square test was used for comparison of the prevalence rates of lesions between the different seasons. Data were analyzed by SPSS software, version 16 and $P < 0.05$ was accepted as statistically.

Results

Pulmonary lesions were detected in 492 (41%) carcasses. In microscopic examination, most lungs had more than one type of lesions and thirteen different types of lesions were observed. The most common lesions were bronchopneumonia, pulmonary emphysema, hydatid cyst, interstitial pneumonia, abscess, congestion, atelectasis, anthracosis, pleurisy, bronchiectasis, verminous

pneumonia, pulmonary adenomatosis and melanosis (Table 1).

Atelectasis was found in 6.91% of the affected cases. In macroscopic examination, the lungs appeared depressed below the surface of the normally inflated lung. The color was generally dark blue and the texture is flabby or firm. The main pattern of lesions was lobular. Microscopically the alveoli were collapsed and the alveolar walls appear parallel and close together.

Table I. *Prevalence of pulmonary lesions in slaughtered sheep in Kermanshah, Iran, between 2013 and 2014.*

Lesions	Number of affected lungs	No. affected/ total affected (%) (n = 445)	No. affected/ Total sampled (%) (n = 1,200)
Bronchopneumonia	160	32.52	13.33
Pulmonary emphysema	51	10.36	4.25
Hydatid cysts	50	10.16	4.16
Interstitial pneumonia	43	8.73	3.58
Pulmonary abscess	40	8.13	3.33
Congestion and hyperemia	35	7.11	2.91
Atelectasis	34	6.91	2.83
Anthracosis	25	5.08	2.08
Pleurisy	20	4.06	1.66
Bronchiectasis	17	3.45	1.41
Verminous *Pneumonia*	11	2.23	0.91
Pulmonary adenocarcinoma	3	0.60	0.25
Melanosis	3	0.60	0.25
Total	492	100	41

Emphysema was encountered on 10.36% (n = 51/492) of the affected lungs. Grossly, the variably sized air bubbles were seen in the interlobular septa and pulmonary parenchyma (Figure 1A). The texture of these lungs was notably crepitus due to the accumulation of air in the pulmonary parenchyma. Microscopically, pulmonary emphysema was characterized by enlargement of air spaces distal to the terminal bronchiole, accompanied by destruction of alveolar walls (Figure 1B).

Pulmonary congestion and hyperemia occurred in 7.11% (n = 35/492) of the lungs. In most cases, the lungs appeared notably red (Figure 2A), and microscopically, blood vessels and capillaries were engorged with blood from hyperemia. In pulmonary congestion, dilation of blood vessels due to the presence of a large number of red blood cells (RBC) inside the vessels and also the presence of a large number of RBC and hemosiderophages out of the blood vessels were prominent (Figure 2B).

Bronchiectasis was encountered in 3.45% (n = 17/492) of the lungs. Grossly, bronchiectasis was characterized by prominent lumps in the lungs resulting from distention of the bronchi with exudate, which results in a concurrent obstructive atelectasis of surrounding parenchyma. Microscopic lesions were similar to a pulmonary abscess except that exudate is contained and surrounded by remnants of a bronchial wall lined by squamous epithelium and not by a pyogenic membrane as it was in the case of a pulmonary abscess.

Bronchopneumonia was detected in 32.52% (n = 160/492) of the affected lungs. In suppurative bronchopneumonia, the gross appearance showed irregular dark red to gray-pink consolidation with

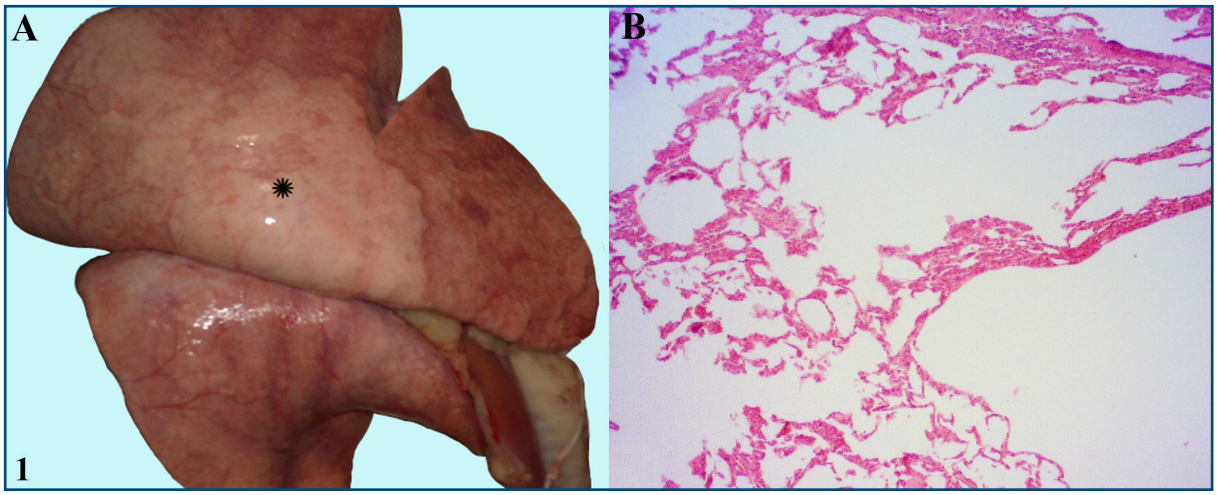

Figure 1. *Pulmonary emphysema in Iranian sheep.* **A)** Macroscopic appearance of emphysema; variably sized air bubbles in the pulmonary parenchyma. **B)** Enlarged alveoli space, accompanied by destruction of alveolar walls (H&E staining; x250).

lobular pattern. The cranial, middle and accessory lobes were the main affected areas (Figure 3A). The pulmonary parenchyma was firm in texture. Histopathologically, abundant neutrophils, macrophages, cellular debris and various amounts of mucus and fibrin were observed within the lumen of the bronchi, bronchioles, and alveoli (Figure 3B). The inflammatory process confined to the individual lobules and normal alveoli were seen adjacent to the alveoli filled with neutrophilic exudates. In the chronic phase, thickening of alveolar walls, mainly by lymphocytes and macrophage infiltration,

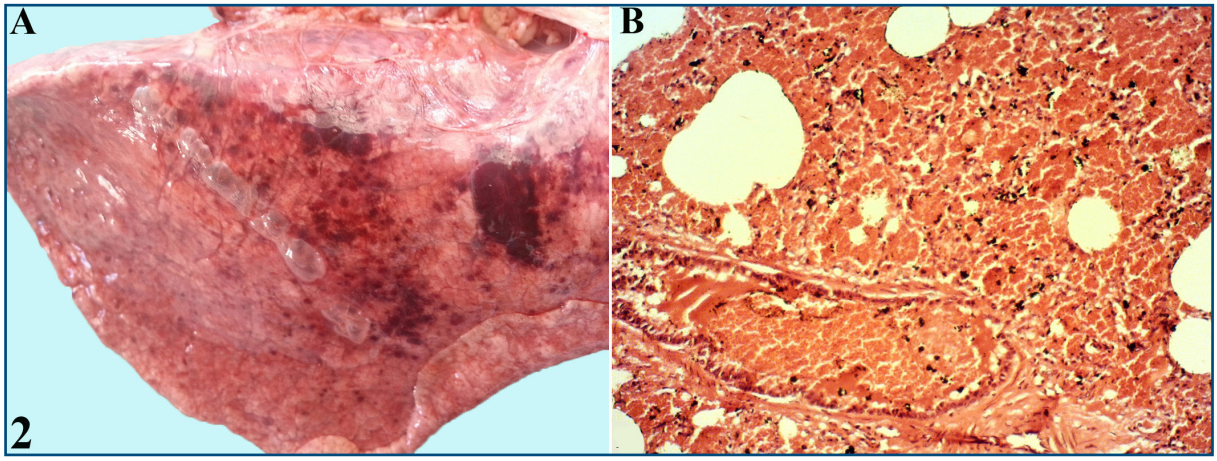

Figure 2. *Pulmonary congestion in Iranian sheep.* **A)** Macroscopic appearance of pulmonary congestion; lung is appeared notably red with hemorrhagic foci on the surface; **B)** Presence of a large number of RBC inside and hemosiderophages out of the blood vessels (H&E staining; x250).

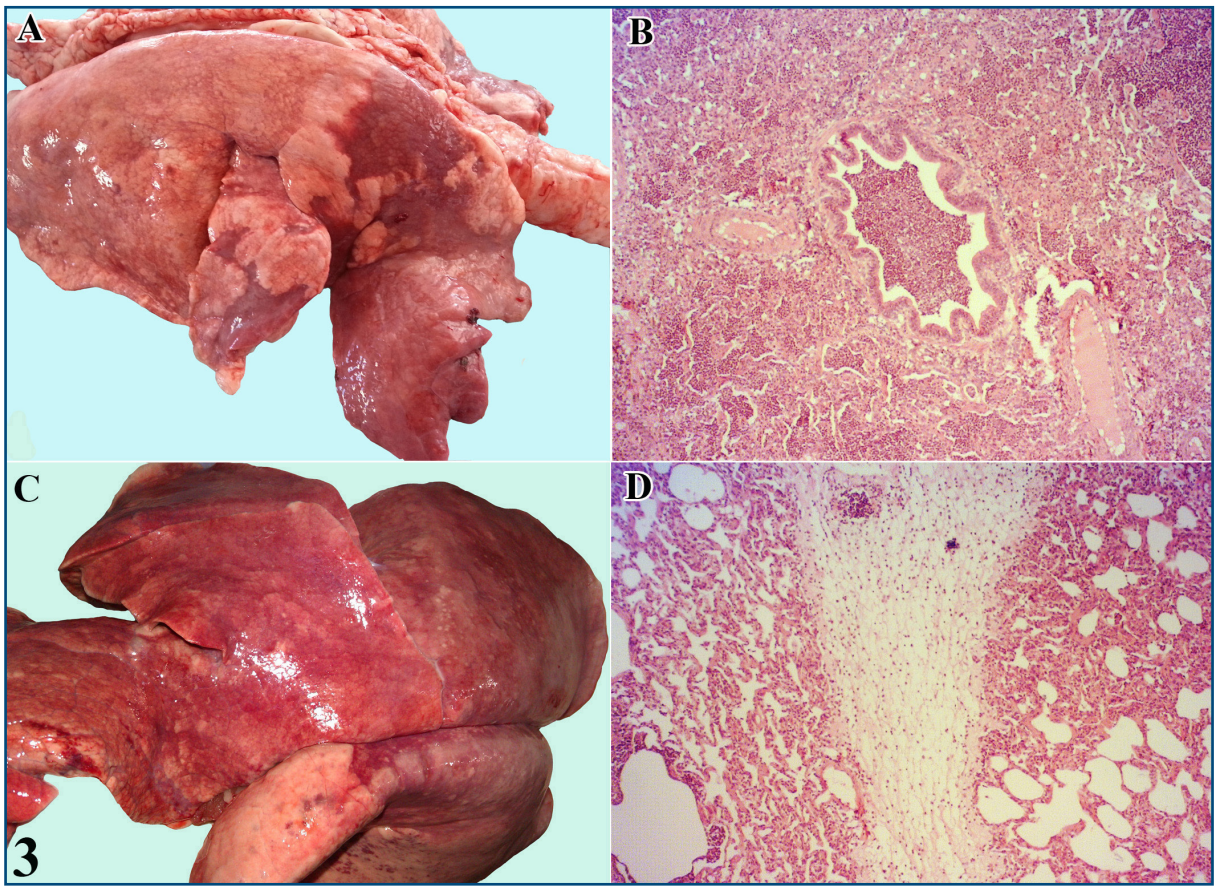

Figure 3. *Bronchopneumonia in Iranian sheep.* **A)** Macroscopic appearance of suppurative bronchopneumonia; dark red consolidation of cranioventral lobes. **B)** Neutrophilic exudation of bronchial lumina and alveoli with cellular debris and various amounts of fibrin (H&E staining; x250). **C)** Macroscopic appearance of fibrinous bronchopneumonia; fibrin was dominant and the lesions were lobar in nature. **D)** Fibrinous and neutrophilic exudation within the alveoli and interalveolar septa (H&E staining; x250).

hyperplasia of goblet cells in the bronchiolar epithelium were a common finding.

Macroscopic lesions of fibrinous bronchopneumonia were similar to suppurative bronchopneumonia except that fibrin was dominant and the lesions were lobar in nature (Figure 3C). The distribution of the lesions was almost cranioventral. Microscopically, presence of multifocal areas of necrosis and variable amounts of fibrinous exudate in the lumen of the alveoli and bronchioles was the predominant feature. Interlobular septa and pleura expanded because of fibrinous and neutrophilic exudation (Figure 3D).

Forty three animals (8.73%, *n* = 43/492) showed interstitial pneumonia. Failure of the lungs to collapse, the occasional presence of rib impressions on the costal surfaces and the lack of visible exudates in airways were the important gross features of interstitial pneumonia. The affected lungs were enlarged and were diffused red to pale in appearance. The texture of the lungs was elastic or rubbery (Figure 4A). On a cut surface, the lungs were more 'meaty' (having the texture and appearance of raw meat) and had no evidence of exudate. Histologically, the lesions were characterized by a marked increase in mononuclear cells in the interalveolar septa and presence of varying numbers of macrophages within the alveolar lumina (Figure 4B). In some cases, hyperplasia of pneumocyte type II was seen. There was no obvious exudate in the alveolar spaces and airways.

Anthracosis occurred in 5.08% (*n* = 25/492) of the lungs. Grossly, the lungs were usually speckled with fine 1- to 2-mm-diameter subpleural black foci. Microscopically, fine black carbon granules were observed within macrophages in the lung parenchyma. Additionally, carbon pigment presented within the alveolar walls or as black peribronchiolar or peribronchial foci (Figure 5).

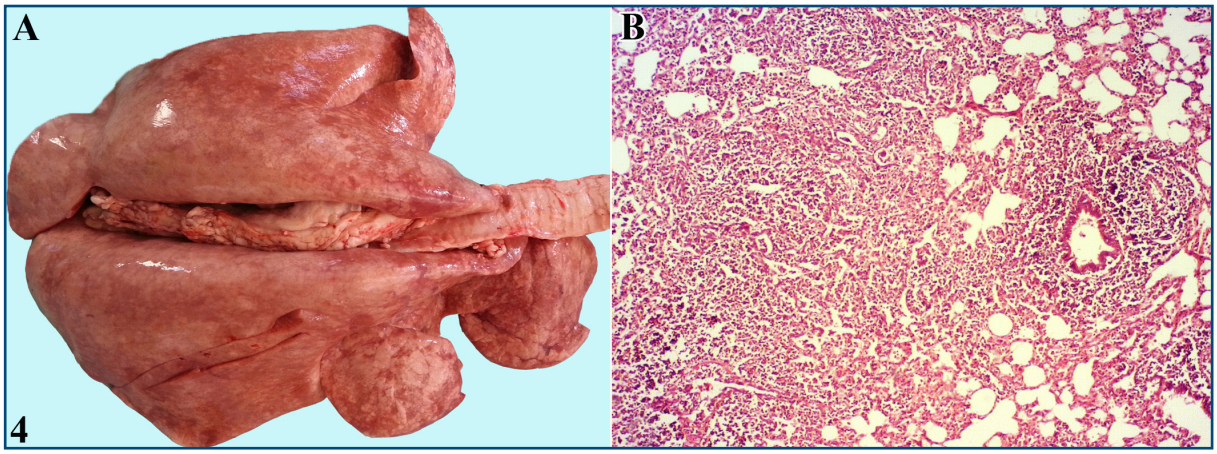

Figure 4. *Interstitial pneumonia in Iranian sheep.* **A)** Macroscopic appearance of interstitial pneumonia; affected lung is pale, enlarged, uncollapsed and rib impressions are observed on diaphragmatic surface. **B)** Presence of a marked mononuclear cells in the interalveolar septa and varying numbers of macrophages within the alveolar lumina (H&E staining; x250).

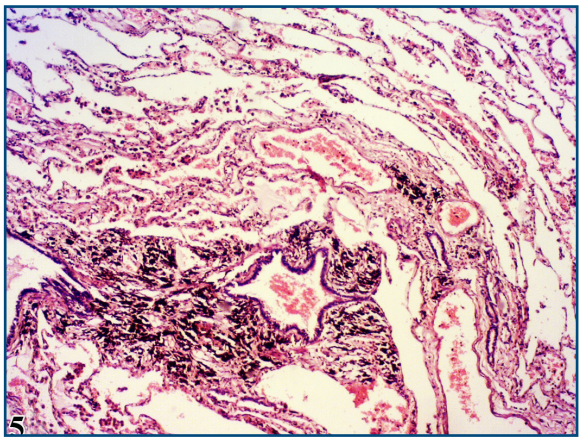

Figure 5. *Anthracosis in Iranian sheep.* Fine black carbon granules (within macrophages) in the lung parenchyma.

Figure 6. *Pulmonary abscesses in Iranian sheep.* Single or multiple abscesses containing viscous odorless pus ranged from 0.5 to 8 cm in diameter.

Pulmonary abscess was seen in 8.13% (*n* = 40/492) of affected lungs. The abscesses containing viscous white-yellow odorless pus ranged from 0.5 to 8 cm in diameter and occurred as single or sometimes multiple instances in one or more lobes (Figure 6). Some of them were very large and involved an entire pulmonary lobe. Histopathologically, liquefactive necrosis, numerous neutrophils, mononuclear inflammatory cells and fibrous connective tissue were observed from the center to the outside of lesions, respectively.

Figure 7. *Macroscopic appearance of pleurisy in Iranian sheep.* Inflammation of the pleural and fibrinous adhesions between the parietal pleura and the lung surface.

The occurrence of pleurisy was 4.06% (*n* = 20/492) in this study. This lesion was characterized by an inflammation of the pleura and fibrinous adhesions between the parietal pleura and the lung surface (Figure 7). Histopathologically, thickening of the pleura due to the formation of granulation tissue and fibrosis was observed.

Verminous *Pneumonia* was detected in 2.23% (*n* = 11/492) of affected sheep lungs. Multifocal, subpleural nodules (2 to 5 mm) were grossly visible on the caudal lobes of 8 lungs. These nodules were varied from soft and hemorrhagic to gray-green and hard or even calcified (Figure 8A). On microscopic examination, a focal, eosinophilic, and granulomatous reaction was prominent in the subpleural alveoli where the adults, eggs, and larvae resided (Figure 8B). These parasites were diagnosed as *Muellerius capillaris*. *Protostrongylus rufescens* was detected in the bronchioles of 2 lungs (Figure 8C). Also in another case, a few numbers of immature,

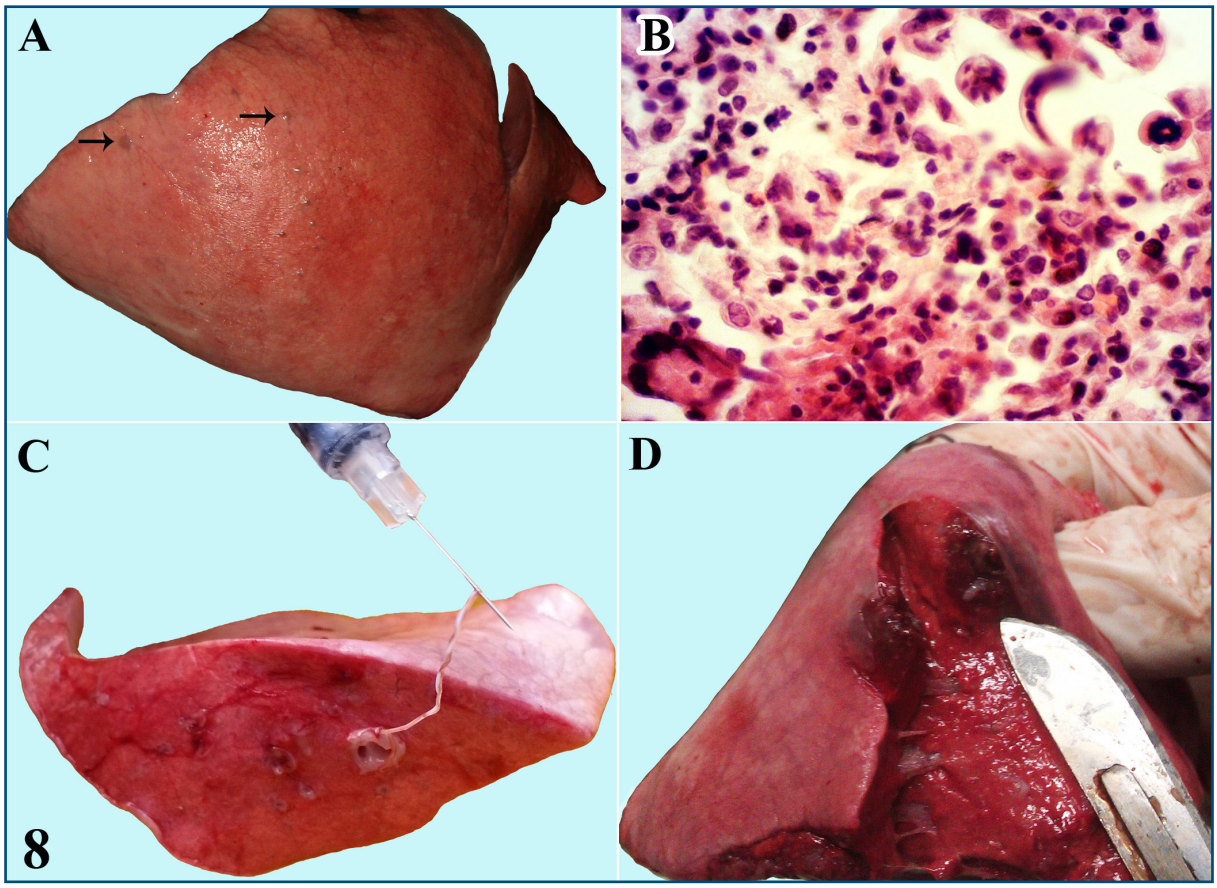

Figure 8. *Verminous* Pneumonia *in Iranian sheep.* **A)** Multifocal, subpleural, hemorrhagic nodules (2 to 5 mm) on the caudal lobes. **B)** Focal, eosinophilic and granulomatous reaction around the larval stages of *Muellerius capillaris* (H&E staining; x1000). **C)** *Protostrongylus rufescens*. **D)** An immature fluke in the pulmonary parenchyma.

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wandering flukes were seen on the cut surface (Figure 8D).

Hydatid cysts were detected in fifty animals (10.16%, n = 50/492). On macroscopic examination, oval and firm cysts containing fluid were present in the pulmonary parenchyma. The cysts were different in size (2 to 10 cm in diameter) and number and were often enclosed by a fibrous capsule (Figure 9A). Histopathologically, the cysts were surrounded by an infiltrate of mixed inflammatory cells, including giant cells and eosinophils and also a layer of granulation tissue in some cases. The cyst wall included fibrous connective tissue, lamellar hyaline layer and thin syncytial germinal layer (Figure 9B).

Ovine pulmonary adenocarcinoma (OPA) was detected in 0.6% (n = 3/492) of the lungs. Grossly, the lungs were enlarged, heavy, and wet and have several firm, gray, variably sized nodules that located in the cranioventral lobes. In one case, the nodules became confluent, and large segments of both lungs were diffusely infiltrated by neoplastic cells (Figure 10A). On cross section, edematous fluid and a copious mucoid secretion were present in the airways. Histopathologically, the nodules consisted of cuboidal or columnar epithelial cells lining airways and alveoli and forming papillary structures (Figure 10B).

Melanosis was detected in three animals (0.6%) as black foci in different size (1 to 4 mm) on the pulmonary surfaces. Microscopically, multifocal accumulations of melanocytes containing dark brown pigments were observed in the interstitial tissue of the lungs.

The seasonal variation of pulmonary diseases is summarized in Table II. The prevalence of pulmonary lesions was significantly ($P < 0.001$) higher in winter, compared to other seasons.

The highest prevalence of bronchopneumonia and interstitial pneumonia were observed in winter, but these differences were not statistically significant when compared to the other seasons ($P = 0.059$ and

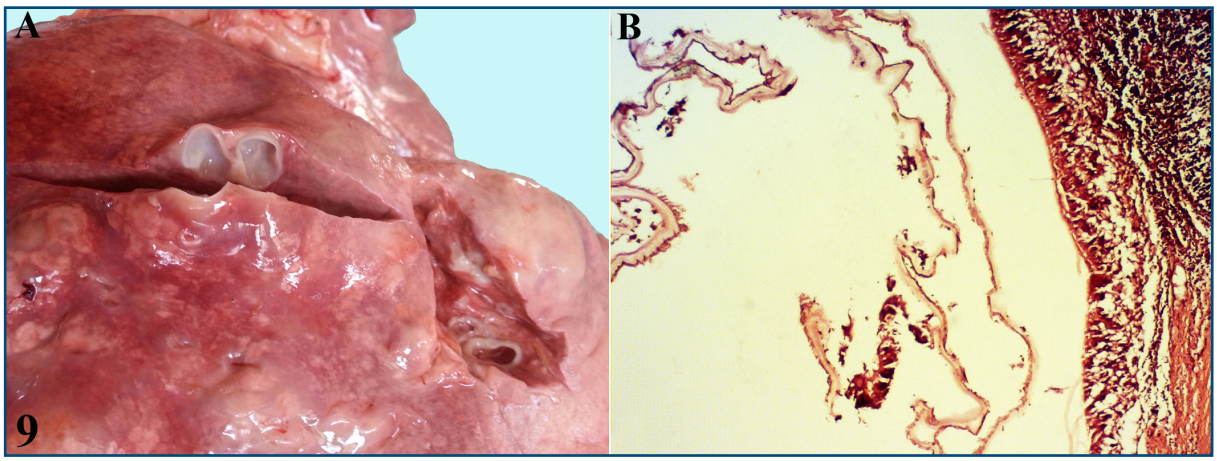

Figure 9. *Hydatid cysts in Iranian sheep.* **A)** Oval and firm cysts, variable in size, containing fluid in the pulmonary parenchyma. **B)** Fibrous capsule bordering the laminated layer of the larva, which is recognized by its cuticle and dense cellular host reaction (H&E staining; x250).

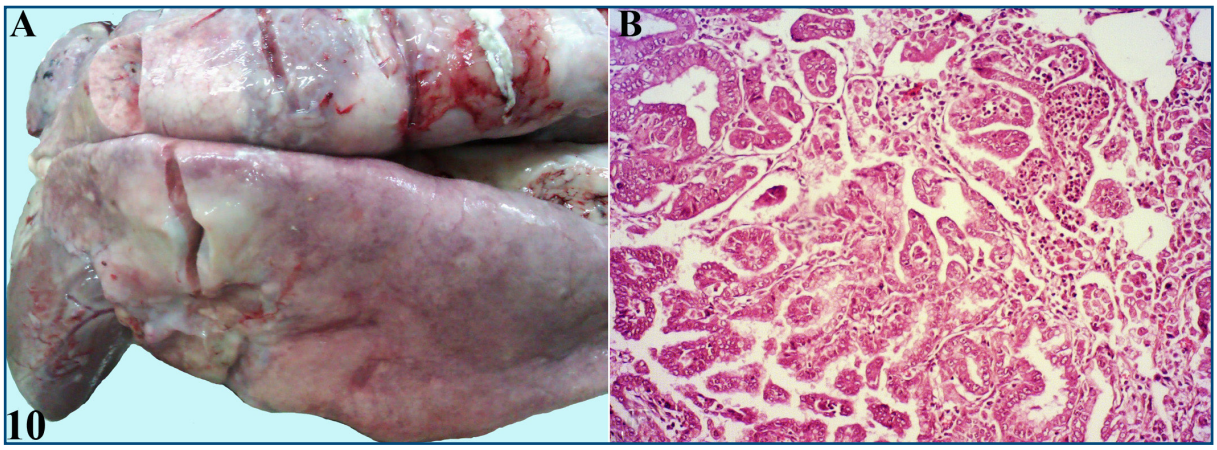

Figure 10. *Ovine pulmonary adenomatosis in Iranian sheep.* **A)** Several firm, gray, variably sized nodules in the cranioventral lobes. **B)** Papillary structures which consisted of cuboidal or columnar epithelial cells lining airways and alveoli (H&E staining; x250).

Table II. *Seasonal prevalence of pulmonary lesions in sheep slaughtered in Kermanshah, Iran, between 2013 and 2014.*

Lesions	Spring		Summer		Fall		Winter	
	Number of affected lungs (%)	Prevalence (%) (n=300)	Number of affected lungs (%)	Prevalence (%) (n=300)	Number of affected lungs (%)	Prevalence (%) (n=300)	Number of affected lungs (%)	Prevalence (%) (n=300)
Bronchopneumonia	40 (33.89)	13.33	27 (28.72)	9	45 (33.08)	15	48 (33.33)	16
Emphysema	9 (7.62)	3	12 (12.76)	4	12 (8.82)	4	18 (12.5)	6
Hydatid cysts	9 (7.62)	3	6 (6.38)	2	21 (15.44)	7	14 (9.72)	4.66
Interstitial pneumonia	13 (11.01)	4.33	5 (5.31)	1.66	9 (6.61)	3	16 (11.11)	5.33
Pulmonary abscess	12 (10.16)	4	11 (11.70)	3.66	9 (6.61)	2.25	8 (5.55)	2.66
Congestion	6 (5.08)	2	7 (7.44)	2.33	6 (4.41)	2	16 (11.11)	5.33
Atelectasis	7 (5.93)	2.33	9 (9.57)	3	10 (7.35)	3.33	8 (5.55)	2.66
Anthracosis	3 (2.54)	1	10 (10.63)	3.33	7 (5.14)	2.33	5 (3.47)	1.66
Pleurisy	6 (5.08)	2	2 (2.12)	0.66	8 (5.88)	2.66	4 (2.77)	1.44
Bronchiectasis	5 (4.23)	1.66	2 (2.12)	0.66	6 (4.41)	2	4 (2.77)	1.33
Verminous pneumonia	4 (3.38)	1.33	2 (2.12)	0.66	2 (1.47)	0.66	3 (2.08)	1
OPA	2 (1.69)	0.66	1 (1.06)	0.33	0	0	0	0
Melanosis	2 (1.69)	0.66	0	0	1 (0.73)	0.33	0	0
Total	118	39.33	94	31.33	136	45.33	144	48

$P = 0.085$, respectively). Cases of pleurisy, atelectasis and bronchiectasis were more frequently observed in the fall, however the diffferences with other seasons were not statistically significant. The highest ($P = 0.013$) number of lungs with hydatid cysts was observed in the fall. Cases of verminous pneumonia, pulmonary abscess and emphysema were more often recorded in spring but their number was not significantly different compared to other seasons ($P > 0.05$).

Discussion

Respiratory diseases are common in various species of domestic animals, particularly the herbivores. Because of its major economic impact on the sheep industry, through consequences such as death, retarded growth and reduced weight-gains in recovered animals, slaughterhouse wastage, drugs and labor costs, respiratory diseases have been extensively studied in countries where livestock industry is an important part of the agricultural sector (Azizi *et al.* 2013).

This study was designed to assess the type and frequency of gross and microscopic lung lesions observed in sheep slaughtered at Kermanshah abattoir, west of Iran. Out of 1,200 sheep lungs examined, 41% were found to be affected with one or more pulmonary lesions.

The fact that only clinically healthy animals are slaughtered implies that the true prevalence of different lung diseases could probably be much higher and many cases are likely to remain unnoticed or undiagnosed because of meat inspectors' personal error, non-cooperativeness of the butchers, use of gross pathology in the diagnosis of the diseases and general poor record keeping.

Other investigators, Azizi and colleagues (Azizi *et al.* 2013) (4.2%), Esmaeilzadeh and colleagues (Esmaeilzadeh *et al.* 2013) (2.18%), Mellau and colleagues (Mellau *et al.* 2010) (7.8%) and Oruc (Oruc 2006) (35.4%), had reported variable prevalence of pulmonary lesions in different sheep-rearing areas, suggesting that respiratory diseases are variable from region to region, depending on managing system, meteorological situations, sanitation, and age.

In this study, bronchopneumonia and interstitial pneumonia were diagnosed in 13.33% and 3.58% of lungs, respectively. This result confirmed that pneumonia continues to be one of the most important causes of sheep morbidity and mortality in Iran (Azizi *et al.* 2013, Esmaeilzadeh *et al.* 2013) and other countries (Haziroglu *et al.* 1994, Martin 1996, Oruc 2006, Mellau *et al.* 2010).

Pneumonia in ruminants is a complex condition involving interaction between the host (i.e. immunological and physiological), multiple agents (e.g. bacterial, viral, mycoplasma) and environmental factors (Brodgen *et al.* 1998). A number of factors may explain the high prevalence of pneumonic lungs in this region. These include stress factors

such as exposure to dust from the environment or exhaustion during long treks of pastoral livestock in search of pasture and water, parasitism, poor housing and overcrowding (Kusiluka *et al.* 1997, Blood *et al.* 2007).

Emphysema was encountered on 4.25% of the examined sheep lungs. This finding is in disagreement with the report of Mellau and colleagues (Mellau *et al.* 2010) who had observed emphysema in 17.9% of the sheep examined. Pulmonary emphysema in animals is normally secondary to some respiratory disorders like hydatidosis, pneumonic pasteurellosis, mycoplasma infection, leptospirosis and some different cases of septicemia and endocarditis (Herenda *et al.* 2000, Blood *et al.* 2007). Due to a well-developed interlobular septa and lack of collateral ventilation, sheep is susceptible to interstitial emphysema. Sometimes, some cases of emphysema are recorded in slaughter animals due to extensive gasping respiration during slaughter especially when animals are slaughtered without stunning. Furthermore, slaughter of very old animals is reported to be associated with emphysema (Gracey *et al.* 1999).

Hydatidosis was found to be the second most prevalent pathological finding with 4.16% occurrence. Hydatid cysts were distributed most frequently on the caudal lobes of the lungs. Unlike the results of the present study, Shahbazi and colleagues (Shahbazi *et al.* 2014) recorded a prevalence of 1.98% pulmonary hydatidosis in Kermanshah province. However, this variation probably could be ascribed to data collection method.

Based on the literature, Hydatidosis is present in livestock in many parts of Iran. According to abattoir surveys, the mean prevalence of hydatidosis of sheep in different parts of the country has been reported to be 8.1% (Dalimi *et al.* 2002). The differences in prevalence of hydatidosis may be due to differences in environmental conditions that are conducive for the perpetuation of the parasite, like abundance of infected definitive hosts, livestock husbandry, stocking rate, the nature of the pasture and grazing patterns of animals (Ernest *et al.* 2009).

The abscess was observed in 3.33% of the lungs. This rate is much lower than that reported by Azizi and colleagues (Azizi *et al.* 2013) and Mellau and colleagues (Mellau *et al.* 2010) who observed presence of abscesses in 11.9% and 14.3% of sheep, respectively. Pulmonary abscesses arise from focal residues of severe suppurative lesions, lobar bronchopneumonia or from septic emboli lodging in the pulmonary vascular bed. It is documented that *Pasteurella* spp. and *A. pyogenes* are the main causes of lung abscesses in ruminants (Gracey *et al.* 1996, Herenda *et al.* 2000).

The occurrence of atelectasis in this study was 2.83%. Atelectasis is common when collateral ventilation is less. The airless alveoli then collapse under surrounding pressures (Lopez 2001).

Anthracosis was found in 2.08% of the cases. Studies conducted by Esmaeilzadeh and colleagues (Esmaeilzadeh *et al.* 2013) in Southern Iran and Jana and colleagues (Jana *et al.* 2005) in India indicated a prevalence of 1.07% and 2.53% anthracosis, respectively. The occurrence of this pathology is attributed to the dusty environment of the area where sheep are constantly exposed. The presence of pastures near the roads and highways, as well as pollutants originating from factories and dust storms in recent years have played a major role in the occurrence of anthracosis in this region.

Verminous pneumoconiosis was found in 0.91% of the cases. This is much lower than rates reported by of Tabatabayi and colleagues (Tabatabayi *et al.* 1992) and Bouljihad and colleagues (Bouljihad *et al.* 1995) who reported verminous pneumoconiosis in 40.9% and 53% of sheep examined, respectively. This value, however, is higher than that reported by Esmaeilzadeh and colleagues (Esmaeilzadeh *et al.* 2013) who has reported a prevalence of 0.5% in sheep. *Muellerius capillaris, Protostrongylus rufescens* and larval stage of *Fasciola* were the parasites found in this study. Lungworms frequently identified with ovine verminous pneumonias are *Dirofilaria immitis, M. capillaris,* and *P. rufescens* (Armour 1991, Bouljihad *et al.* 1995).

The occurrence of *M. capillaris*, and *P. rufescens* may be partly explained by the difficulty in controlling populations of snails or slugs that act as intermediate hosts in the indirect life cycles of these parasites, and partly by the fact that extensive or semi-extensive rearing conditions for sheep continue to be widespread.

Ovine pulmonary adenocarcinoma was detected in 3 (0.25%) lungs. Similar findings were reported in other studies conducted in Fars (0.22%) and Khuzestan (0.2%) provinces of Iran (Khodakaram-Tafti and Razavi 2010, Esmaeilzadeh *et al.* 2013).

OPA occurs in sheep around the world, with the notable exception of Australia and New Zealand; its incidence is great in Scotland and Peru, but probably low, in North America (Zachary and McGavin 2012).

The occurrence of pulmonary melanosis in this study was 0.25%. Melanosis is an abnormal accumulation of melanin pigments in various organs which causes dark pigmentation of the tissues resulting from a disorder of pigment metabolism (Mellau *et al.* 2010). The rarity of this lesion would in this study suggest that it is likely to be of minor concern and would be expected to appear only sporadically.

In conclusion, the results of this study indicate

that the prevalence of pulmonary lesions in slaughtered sheep is relatively high in Kermanshah province. The high prevalence of the lesions make a lot of economic loss in the animal husbandry industry. So designing of serious prevention and treatment programs is very important in our region. Furthermore, this survey provides baseline data for the future monitoring of these potentially important diseases affecting sheep lungs in the region.

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