Histopathological Findings of Foot-Rot Disease Which Causes Deaths in a Sheep Flock

Turan Yaman, Ahmet Uyar, Omer Faruk Keles & Zabit Yener

ABSTRACT

Background: Foot-rot is a contagious bacterial infection of the feet of sheep that causes lameness. This infection leads to major economic losses in wool, meat, and dairy industries throughout the world. Pathogenesis of foot-rot can be described as the damage of the interdigital skin, invasion of fecal bacterium Fusobacterium necrophorum, and finally the involvement of Dichelobacter nodosus in the infection. In the worst cases, the disease becomes widespread, and systemic bacterial infections may occur. The present study aims to describe macroscopic and histopathological findings of foot-rot lesions formed in the foot, heart, liver, and lungs to draw attention to these aspects of the disease.

Case: The material of the study consisted of a 3-year-old sheep. The investigation was composed of the disease history; post-mortem examination; and histopathological analysis of lung, liver, heart, and foot lesions. At the anamnesis, it was reported that the diseased animal had lameness and weakness with other clinical symptoms, and approximately 10 infected sheep had died within a 1-week period. At necropsy, malodorous ulcerative lesions between the nails; focal-disseminated foci in the liver, lung, and heart; yellowish matte thickening in the heart valves; and hydropericardium were detected. After necropsy, tissue samples taken from the skin, lungs, spleen, kidneys, and liver were fixed in a 10% buffered formalin solution, paraffin embedded, sectioned, and stained with hematoxylin and eosin. Giemsa staining was done to detect the agents in the tissues. The slides were examined and photographed using a light microscope. Histopathological examination revealed that ulcerations between the nails were lesions shaped as the result of the foot rot disease. The focal-disseminated lesions in the internal organs were the foci of metastatic-embolic inflammation originating from the lesions between the nails. Rod-shaped bacteria were detected in foot, liver, and lung tissues by Giemsa staining.

Discussion: Foot-rot has important economic and welfare impacts. A number of researches on the characterization of agents, regional incidence, pathogenesis, and macroscopic characterization and classification of lesions in the nail have been carried out on footrot disease. In the present case, the disease became systemic and numerous sheep died. Systemic infections are characterized embolic-metastatic inflammations formed in major vital organs such as the liver, lungs, brain, heart, and kidneys as the result of the vasculitis formed in the veins in the inflamed region, where the agents are spread by the bloodstream. Histopathologically, granulomatous foci were seen in the liver and lungs. In the middle of these foci were collapsed leukocytes and agents, and the surrounding area was composed of Langhans, foreign body giant cells, and mononuclear cells. Treatment with systemic infections is quite difficult. The disease can be treated, but the cost of treatment and care is very high. For this reason, foot-rot disease is among the most expensive sheep diseases requiring costly treatment. Because we believe foot-rot disease not only causes lameness but also leads to high mortality rates in sheep flocks, we presented the pathological findings to draw attention to these aspects of the disease. As far as we can investigate, no case reports have presented both macroscopic and microscopic findings of the disease that have formed in nails and internal organs.

Keywords: foot-rot, liver, lung, histopathology, sheep.
INTRODUCTION

Foot-rot is a common and contagious bacterial disease of sheep that causes lameness [19]. This disease leads to major economic losses in wool, meat, and dairy industries and reduces sheep welfare [15,20]. Foot-rot lesions show a clinical course that always starts at the interdigital skin, causing extensive necrosis and ulceration [6,9]. Humid and rainy climates, malnutrition and poor foot care and trauma are effective as predisposing factors [8]. Eventually, it results with the separation of the hoof horn from the sensitive tissue of the claw, with a gray scum in the formed cavity and a characteristic smell [12].

The disease occurs with the synergistic action of the *Dichelobacter nodosus* (*D. nodosus*) and *Fusobacterium necrophorum* (*F. necrophorum*) bacteria [11,20]. *D. nodosus* is a rod-shaped, Gram-negative, anaerobic bacterium that has proteases and keratinases that cause the disruption of nails [5,16]. This factor is the primary causal agent of footrot disease [6,19]. *F. necrophorum* is considered to be essential for the induction and progression of the disease [12]. It initially causes a mild and superficial localized dermatitis (interdigital dermatitis) and produces a number of toxins that cause necrosis of the superficial layer of the interdigital skin [12,18]. In severe cases, infection progresses to the foot joints and also inflames them. Thus, the disease becomes widespread, and systemic bacterial infections may occur [3]. This case report describes macroscopic and histopathological findings of foot-rot lesions formed between the nails and in the foot, heart, liver, and lungs to draw attention to the importance of foot-rot disease, which causes death in a sheep flock.

CASE

A 3-year-old sheep was brought dead to the Faculty of Veterinary Medicine of Yüzüncü Yıl University. According to the sheep owner’s statement, the disease had started approximately 1 week earlier and spread in the flock. After the owner had observed lameness and weakness in the flock, 10 of 85 sheep had died. It was also reported that no results were obtained from the treatment. After necropsy, tissue samples taken from the skin, lungs, spleen, kidneys, and liver were fixed in a 10% buffered formalin solution, paraffin embedded, sectioned, and stained with hematoxylin and eosin. Giemsa staining was done to detect the agents in the tissues. The slides were exam-
Table of Contents

1. Introduction
2. Materials and Methods
3. Results
4. Discussion

1. Introduction

Foot-rot disease, caused by *Dichelobacter nodosus*, is a common and severe condition of the feet of ruminants, leading to significant economic losses. The disease is characterized by the presence of necrotic lesions in the interdigital region, affecting the integrity of the hoof. In this study, we report on the histopathological findings of foot-rot disease which caused deaths in a sheep flock and discuss the implications of these findings.

2. Materials and Methods

Samples were collected from the affected sheep flock and subjected to histopathological examination. Tissue specimens were taken from lesions and stained with hematoxylin and eosin for microscopic analysis.

3. Results

Histopathological examination of the tissue specimens revealed various pathological changes. These included inflammatory reactions, necrosis, and bacterial proliferation. Notably, embolic-metastatic granulomatous pneumonia and granulomatous hepatitis were identified. In the heart, degenerative-necrotic changes were observed, characterized by leukocyte infiltration and the presence of rod-shaped bacteria.

4. Discussion

In this manuscript, we reported pathological findings of foot-rot that led to death in a sheep flock. Foot-rot is a difficult-to-treat disease, often occurring in Equidae and ruminants, with necrotic lesions that can lead to severe economic losses. Treatment can be costly, and delayed care can result in the spread of the disease.

Systemic infections associated with foot-rot often involve embolic-metastatic inflammations in vital organs such as the liver, lungs, heart, and kidneys. Treatment is challenging due to the complex nature of the disease and the high cost of care. The severity of foot-rot may vary depending on the virulence factors of *D. nodosus* strains. Benign strains may cause interdigital skin inflammation, whereas virulent strains can lead to severe necrotic lesions.

Macroscopic examination of the skin in the interdigital region and along the corona revealed a pinkish, blue necrotic mass formed by leukocytes and possibly by agents. Around the mass was an inflammatory reaction formed by macrophages and the giant cells of the foreign body and Langhans. In the heart, examination identified degenerative-necrotic changes in myocardial cells, as well as a metastatic valvular endocarditis table characterized by leukocyte infiltration diffused in the interstitium (Figure 5B). Rod-shaped bacteria were detected in foot, liver, and lung tissues by Giemsa staining.

**DISCUSSION**

In this manuscript, we reported pathological findings of foot-rot that led to death in a sheep flock. Foot-rot is often a difficult-to-treat disease that occurs in the feet of Equidae and ruminants, with necrotic lesions [15]. Sheep with foot-rot cannot walk, they lose weight, and their milk yields decrease. If treatment and care are delayed, the foot-rot will become wormed, and the animals that fall into cachexia will die. In severe cases, deaths are related to the spreading of the disease [3].

Systemic infections are characterized by embolic-metastatic inflammations formed in major vital organs such as the liver, lungs, brain, heart, and kidneys as the result of the vasculitis formed in the veins in the inflamed region, where the agents are spread by the bloodstream [3]. Treatment with systemic infections is quite difficult. The disease can be treated, but the cost of treatment and care is very high. For this reason, foot-rot disease is among the most expensive sheep diseases requiring costly treatment [3].

The severity of foot-rot may vary depending on the virulence factors of *D. nodosus* strains [1]. Benign strains of *D. nodosus* cause interdigital skin inflammation, which is impossible to distinguish clinically from interdigital dermatitis caused by *F. necrophorum*. In benign footrot infections, spontaneous regression occurs even in the most affected animals after normalization of the environmental conditions [12]. Malignant footrot is characterized by the separation of the corneal tissue and deeper parts of the hoof. In this latter case, virulent strains produce proteases that allow the corneal tissue of the nail to deteriorate [7]. The initiation of detachment is a consequence of protease enzyme activity prepared by *D. nodosus* organisms [10].

Macroscopic examination first reveals that the skin in the interdigital region and along the corona becomes red, swollen, and moistened with a sticky...
exudate. The amount of the emerging exudate gradually increases and becomes malodorous. Then, this inflammation spreads to the heel. In addition, the infection continues to progress with necrosis of the sole and results in erosive-ulcerative dermatitis [17]. A bad smell, characteristic of anaerobic bacterial activity, accompanies the development of clinical findings with an accumulation of gray pasty scum between the sensitive dermis and epidermal horn [10]. In this case, similar macroscopic findings in the nails were detected. Also, focal-disseminated metastatic-embolic foci in the liver, lung, and heart; yellowish matte thickening in the heart valves; and hydropericardium were detected.

Microscopically, at onset, there is a moderate leukocyte infiltration in the granulosum and spinosum layer of the epidermis of the nail. A mild inflammation, recognized by a leakage of fairly rich edema with the inflammatory cells, is seen on corium ungulae. As all these events progress, necrosis develops in the upper parts of the epithelial tissue. In progressive cases, ulceration and extensive coagulation necrosis occur [3]. In the present case, ulcerations and large coagulation necrosis areas were presented. Around these necrosis areas was a line of intense leukocyte and bacterial proliferation. As a result of systemic infection, granulomatous foci were seen in the liver and lungs. In the middle of these foci were collapsed leukocytes and agents, and the surrounding area was composed of Langhans, foreign body giant cells, and mononuclear cells. We think that these foci are the result of metastasis of Dichelobacter nodosus. Because the foci of Fusobacterium necrophorum are characterized by areas of coagulation necrosis.

A number of researches on the characterization of agents [4], regional incidence [14], pathogenesis [13], and macroscopic characterization and classification of lesions in the nail [2] have been carried out on foot-rot disease. In the present case, the disease became systemic and numerous sheep died. Because we believe foot-rot disease not only causes lameness but also leads to high mortality rates in sheep flocks, we presented the pathological findings to draw attention to these aspects of the foot-rot disease. As far as we can investigate, no case reports have presented both macroscopic and microscopic findings of the disease that have formed in nails and internal organs. Also, this information provides an improved understanding of the course and pathogenesis of foot-rot.

REFERENCES


