“Baaad to the Bone”

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Introduction:

Understanding that sheep bear weight on each individual claw is paramount to understanding sheep foot pathology. The weight bearing surface is the outer edge of the hoof wall, as it is in cattle. Similarly, like cattle, it is inferred the medial claw on the forelimb and the lateral claw on the pelvic limb are the main weight bearing claws of the feet. [2] With hoof trimming, the purpose is restoration of the natural shape of the hoof to ensure proper weight distribution. Most sheep require hoof trimming due to insufficient exercise to keep their hoof at the optimal shape[6]. Pathology of the hoof, which in turn leads to lameness, is one of the most significant diseases in sheep. Important diseases that lead to lameness include foot rot, contagious ovine digital dermatitis, ovine interdigital dermatitis, and foot abscesses[1,3,8].

Foot rot in sheep is one of the biggest foot issues for producers. For sheep, foot rot is caused by *Dichelobacter* (*Bacteroides) nodusus, Actinomyces pyogenes* and *Fusobacterium necrophorum*[8,10]. Foot rot can present with signs including foul smell, discharge, reddened tissue, generalized swelling of feet, possible toe spreading and some degree of lameness[3,7].

Contagious Ovine Digital Dermatitis (CODD) was first reported in the United Kingdom in 1997. It is a similar disease process to bovine digital dermatitis (BDD) in cattle. Colloquially, BDD is referred to as hairy heel wart[1]. Contagious ovine digital dermatitis and BDD have similar microorganisms including *Treponema medium, Treponema phagedenis,* and *Treponema pedis.* The exact causative agent of CODD is unknown. CODD is worldwide but reported most commonly in the United Kingdom and the Republic of Ireland with fifty percent of farms affected. In addition, CODD has been shown to have a strong correlation with foot rot and was often misdiagnosed as foot rot before the distinction. The primary distinction between CODD and foot rot is a majority of the herd is affected with CODD quite rapidly[1,8]. Reduction of

pathogen transfer in CODD (*Treponema*) was greatly reduced by wearing and changing gloves and using common antiseptics, such as hand soap or iodophors, on tools that are used on feet between animals and even between feet of the same animal to limit fomite spread[1,6].

Ovine Interdigital Dermatitis (OID), also known as scald, is typically caused by *Fusobacterium necrophorum,* a common microorganism of gastrointestinal flora. Ovine interdigital dermatitis commonly causes inflammation and superficial to mild lesions in the interdigital skin. Clinical signs of OID are hair loss and exudative inflammation of the interdigital skin without the underrunning of the claw horn. The key difference between OID and foot rot is the lack of involvement of the claw horn[8].

Foot abscesses are an important differential diagnosis as they typically only affect one foot, unlike foot rot where more than one foot is affected. They develop in wet or moist conditions, similar to foot rot. To distinguish between foot rot and foot abscesses, there are several factors to consider[3]. Abscesses typically present with swelling near the coronary band with green/cream colored discharge. Additionally, abscesses are hot to the touch, have an odor, and eruption of abscess near the coronary band can occur. Whereas with foot rot, it typically affects more than one foot, there is no swelling, no purulent debris, no heat, no odor, no break in the coronary band, and typically spreads through a flock[3]. If a sole abscess is not addressed early in the disease process, it can progress to septic arthritis and/or osteomyelitis of the distal intertarsal joint. When an abscess progresses to septic arthritis, surgical intervention is typically warranted.

History and Presentation:

On June 18, 2019, the MSU-CVM Ambulatory Service examined an approximately 2-year-old, intact female Suffolk/Hampshire cross ewe (tag number 1706). She was a breeding ewe with a history of being down in the pasture for an unknown period. Upon arrival, 1706 was non-weight bearing lame on her left forelimb but would become ambulatory if approached. She was referred to MSU-CVM Food Animal Service for further diagnostics and to determine the cause of her lameness.

On physical examination, 1706 was bright, alert, and responsive. She weighed 63.5 kg with an ideal body condition score of 3/5. Her heart rate was within normal limits at 78 beats per minute. Her respiratory rate was elevated at 190 breaths per minute, and her temperature was markedly elevated at 105.0 F. On cardiopulmonary auscultation, there were no murmurs, arrhythmias, crackles, or wheezes appreciated. Her mucus membranes were pink with a capillary refill time of less than 2 seconds. Normal gut sounds were appreciated with approximately 1-2 ruminations per minute. Urination and defecation were reported as normal. She was completely non-weight bearing on her left forelimb. Her left forelimb was swollen and warm to the touch at the level of the coronary band of the lateral claw extending to the pastern. There was a small amount of purulent debris coming from the coronary band, and an abscess was suspected.

Initial Diagnostic Approach:

Due to severity of lameness, radiographs were obtained to determine extent of injury and if bony involvement existed. There was generalized soft tissue swelling of the left forelimb around the 4th digit/lateral claw from the distal interphalangeal joint to the carpal phalangeal joint. The most severe swelling was at the level of the middle phalanx, specifically the proximal aspect of the coronary band. No bony involvement was observed at that time, although it was

suspected. No evidence of gas shadowing consistent with an abscess was present on the radiographs, however, an abscess did rupture at the coronary band soon after completion of the radiographs.

Medical Management/ Case Progression:

On initial presentation on June 18, 2019, a hoof abscess was presumptively diagnosed along the coronary band on the lateral claw of her left forelimb. It was lanced further to relieve pressure and facilitate drainage of purulent material. She was administered Florfenicol at 40 mg/kg subcutaneously q96h and Meloxicam at 1 mg/kg administered q24h orally. Her foot was soaked daily in a zinc sulfate and betadine solution and the defect near her coronary band was flushed with betadine solution for 7 days.

On the fifth day of her hospitalization, her improvement was minimal and more advanced disease was suspected. She was sedated for further evaluation. Laxity of the distal interphalangeal joint was appreciated laterally and medially, most likely due to degeneration of the lateral collateral ligament. The wound was explored, and distal interphalangeal joint involvement was suspected. Radiographs revealed widening and lysis of the distal interphalangeal joint. While she was sedated, the joint was aspirated, and malodorous purulent joint fluid was drained. It was determined the hoof abscess had progressed to septic arthritis of the distal interphalangeal joint. Due to the severity of the septic arthritis, amputation was considered and recommended, however, it was declined at that time. Facilitated ankylosis was chosen in effort to save the digit and prolong herd retention. A bone curette was used to facilitate ankylosis of the distal interphalangeal joint of the lateral claw on the left forelimb. A 3/8 inch penrose drain was placed from the lateral aspect to the medial aspect of the coronary band. It was then flushed with approximately 500 ml of betadine solution and then packed with Silver

Sulfadiazine Cream. A block was shaped to the size of the medial claw and was attached with an adhesive called Epibond. The injured claw was then bandaged with a modified Robert Jones bandage. Bandage changes and flushing of the joint occurred every 3 days.

Sixteen days post-operatively, the bandage and drain were removed, and the wound was flushed with a dilute iodine solution. The wound was packed with Silver Sulfadiazine Cream and a cast was placed. Immediately after placing the cast, 1706 began to toe touch and was discharged later that day.

On July 11, 2019, 1706 had a recheck examination. She was weight bearing when walking, however she continued to hold her left forelimb up while standing. Her cast was inspected, and additional packing was added to provide a better fit.

On July 25, 2019, radiographs were obtained of her left forelimb and periosteal proliferation was noted within the distal interphalangeal joint. While ankylosis was progressing, the cast was re-applied and recommended she continue to wear it while she heals.

On August 7, 2019, the cast was removed and 1706 was able to bear weight when standing and walking. She had developed a sole abscess on the medial claw, which was cleaned and debrided. Oxytetracycline paste was applied to the granulation beds forming on her left lateral claw and a bandage was placed on her distal limb. Her owners were instructed to keep her in a dry, confined area and limit movement for approximately 2 weeks. The bandage was to be removed in several days.

For several months, 1706 continued to ambulate well and improve. However, on October 4, 2019, 1706 was brought to MSU-CVM Food Animal Department for a 4/5 lameness on her left forelimb. Her left forelimb was swollen distal to the carpus. Radiographs determined that she had again developed septic arthritis in her distal interphalangeal joint and there was evidence

of osteomyelitis and new bone proliferation of the third phalanx. Due to the severity of her infection, a lateral claw amputation was performed.

A sterile scrub was performed using Chlorhexidine and alcohol. A tourniquet was placed just below the carpus, and a lidocaine block was administered via the dorsal metacarpal vein. A second sterile prep was performed after administration of the lidocaine. The lateral claw was amputated using a # 20 scalpel blade to incise down to the bone, and gigli wire was used to cut through the middle of the second phalanx. Silver Sulfadiazine Cream was applied on a piece of gauze that was placed on the amputation site. A bandage was placed around the surgical site and continued to the distal aspect of the carpus. For the next several days, 1706 underwent multiple bandage changes. By seven days post-operation, 1706 was ambulating well on her left forelimb and was discharged from the hospital.

Diagnosis:

1706 was diagnosed with a foot abscess that progressed to septic arthritis of the distal interphalangeal joint of the lateral claw on the left forelimb. Diagnosis of an abscess is most often made on physical exam, where the animal is usually non-weight bearing lame, febrile, and can be confirmed after the abscess is lanced[3]. If physical exam alone is not conclusive, gas shadowing on radiographs provides further evidence that an abscess is present. If the infection has progressed, septic arthritis is possible[15]. Septic arthritis can be diagnosed based on cytologic analysis of joint fluid. The joint fluid will be an abnormal color, less viscous, and have degenerative neutrophils present. An increased total protein is also suggestive of a septic process[15].

Pathophysiology:

Sheep, like goats, pigs, and cattle, are cloven-hoofed animals. This means the hoof consists of two claws, a medial and a lateral claw. The area between the two claws is known as the interdigital cleft[14]. The proximal phalanx, middle phalanx and distal phalanx make up the most distal portion of the forelimb[13]. Cloven-hoofed animals bear the majority of the weight on their medial claws on their forelimbs and the lateral claw on their hind limbs[2].

There are multiple ways an abscess can develop including foreign body, trauma, and poor husbandry. An abscess is an aggregate of neutrophils that are walled off by a pyogenic membrane within an area of the body. As purulent debris accumulates within an abscess, it will ultimately rupture through a fistula[11]. Most abscesses are formed due to invasion of bacteria, but it is possible for fungi, protozoa, and helminths to cause an abscess to form[16]. Rarely, an abscess can be sterile[16]. Abscesses that are left untreated can become more pathogenic and begin to affect other nearby structures, more specifically synovial joints and ligaments. If this happens, it is called septic arthritis [6].

Septic arthritis is an inflammatory condition that is typically associated with the invasion of microbial organisms into a joint space[9]. Bacterial arthritis is the most common form of septic arthritis in small and large ruminants, with the distal joints being the most affected[9]. There are several less common causes of septic arthritis including iatrogenic, idiopathic, sepsis, poor husbandry, and white line/toe abscess [9,12].

When bacteria invade the joint spaces, they first contact the synovial membrane and localize there[3,6]. This causes an inflammatory reaction and results in synovitis. Synovitis is defined by joint pain, swelling, synovial effusion, and heat[3,6]. The bacterial proliferation induces inflammatory cells to produce hydrolytic enzymes[3,6]. These enzymes are intended to destroy the

bacteria but do not specifically target them[6]. The enzymes also cause damage to normal articular cartilage and subchondral bone. This damage results in erosions in the cartilage, and in advanced chronic stages, causes thickening of synovial tissue, fibrosis of the joint capsule, and degenerative joint disease[6].

Treatment options:

Treatment for septic arthritis in sheep can be managed medically, but typically patients must be managed surgically for adequate treatment. Surgical options are less commonly pursued for economic reasons. When it is an option, facilitated ankylosis or amputation of the affected joint/claw can be performed[5]. These operations are not well documented in sheep but are very commonly performed in cattle.

Medical management is by far the most common treatment in sheep with septic arthritis. If diagnosed early in the disease course, injections of broad-spectrum antibiotics are typically used to treat infections and can be rewarding. Additionally, cleaning of the general area and serial wound lavage has been shown to greatly increase the outcome of medical management[9].

Facilitated ankylosis is indicated if widening of the joint space and small pockets of gas accumulation is observed on radiographs, in addition to soft tissue swelling[5]. In cattle, facilitated ankylosis can be achieved in many ways. The goal of facilitated ankylosis is removing necrotic bone and articular cartilage to promote the fusion of the joint which provides stability[5]. The advantages to this are the animal has a longer production life, superior outcome for heavier animals, the claw is retained for cosmetic reasons, and the limb is more mechanically stable[5]. Disadvantages are that it requires more technical knowledge, is typically more costly, has increased post-operative care, a slower return to full production due to pain induced by the procedure, and the long process of complete fusion[5].

Digital amputation has the same indications as ankylosis and can be chosen based on the preference of the surgeon or client. The amputation can be performed by transecting the distal aspect of the proximal phalanx (most common in cattle), the proximal aspect of the middle phalanx, or disarticulation of the distal interphalangeal joint[5]. The site is chosen based on the area of the claw that is affected by disease. The advantages to this procedure include it is an easier procedure, it is inexpensive, partial or complete removal of infected tissue is obtained, and animals typically return rapidly to production[5]. The disadvantages are that heavy animals (specifically cattle) can respond poorly, their production life is reduced, and there is cosmetic loss[5]. Longevity of animals is also dependent upon which claw is amputated. Main load bearing claws (medial claw of forelimb and lateral claw of pelvic limb) that are amputated show a decrease in longevity due to overloading of the remaining claw[5].

Case Outcome:

Despite doing well for several months without further lameness, 1706's lameness returned in February 2020. The decision was made to cull her from the herd. Despite 1706's original lameness being addressed quickly, a diagnosis of septic arthritis carries a guarded to poor prognosis[15]. Sole abscesses that remain untreated typically progress into septic arthritis. Once a ruminant is diagnosed with septic arthritis, the best treatment option for both the patient's wellbeing and for herd management is facilitated ankylosis of the joint[15]. The animal will be more mechanically stable, have better weight distribution, and will have greater herd longevity[5].

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