Bovine Septic Arthritis
of the Distal Interphalangeal Joint and Facilitated Ankylosis
A Case Report

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Introduction

Lameness is an economically significant and often times terminal event for many cattle. Often, the cause of lameness can be localized to the foot; more specifically the lateral claw of a hind foot. Septic arthritis, one of the more debilitating causes of foot lameness, accounts for 12 percent of American feedlot cattle lameness cases (3). Septic arthritis can result from sepsis or trauma (3). This disease often evolves from easily treatable causes of lameness such as sole ulcers, sole abscesses, or interdigital phlegmon (5). The effects of septic arthritis are dramatic. It causes irreversible, deleterious changes to joint function and may serve as a precursor to, or be indicative of, a more severe systemic disease such as *Mycoplasma bovis* or *Histophilus somni* (3). Often, cattle are culled as a result of this disease. Unless diagnosed early, surgery is typically indicated for successful treatment. Digit amputation is most commonly performed and is more economical for short term (average one year) salvage. While more expensive, facilitated joint ankylosis has gained popularity citing favorable long term results and return to production.

History and Presentation

"YSC So Lovin Me", or "Love Me", as her owners call her, is a 7 year old Simmental retired show cow presented to Mississippi State University's Animal Health Center Food Animal Service on February 27, 2017 for chronic lameness. The owners first noted the lameness in the left hind limb around calving (January 21, 2017). She was treated with 30mL of Florfenicol (40mg/kg) subcutaneously (SQ) three times prior to presentation. Love Me presented to MSU-AHC for further evaluation on Monday, February 27 and was accompanied by her calf.

Love Me presented with a grade 3/5 lameness due to observable short-stepping, reluctance to walk, and arched back standing and at a walk. Hoof examination revealed a swollen, warm left lateral heel bulb. A sole ulcer was noted on the left rear lateral claw at the

sole-heel junction. Debridement revealed a large abscessed area. During exploration of the abscessed area, bone was palpated, and involvement of the distal phalangeal joint space was identified. Radiographs were taken of the foot, and septic arthritis was diagnosed based on clinical signs, exploration of the tract, and radiographic changes. The owner was offered several treatment options; culling, amputation of the digit, or ankylosis of the joint. On average, digit amputation gives the animal approximately a year prior to being culled (4), before the ligaments in the adjacent digit break down, which would give Love Me time to raise her calf. Facilitated ankylosis would provide the best chance at return to long-term production and pasture soundness.

The owner was strongly attached to Love Me, and wanted to give her the chance to produce more show calves and to live a long, happy life, so she decided on facilitated ankylosis. The feet were trimmed, dried, and a wooden block was placed on the sound toe using polymethylmethacrylate (PMMA) to improve comfort by allowing her to take more weight off of the afflicted toe. To perform the ankylosis, the limb was aseptically prepared by clipping and scrubbing the dorsal and palmar aspects of the joint areas. A tourniquet was placed on the limb, and lidocaine was given intravenously to complete a regional limb block. A drill and bit was used to drill the plantar aspect of the joint space at the heel through to the dorsal surface just proximal to the coronary band, allowing drainage and destruction of the articular cartilage of the DIJ. The tract was flushed with diluted povidone iodine solution, a drain was placed, the site was packed with gauze and silver sulfadiazine ointment, and the foot was bandaged. She was administered 1.1 mg/kg flunixin meglumine IV for pain and inflammation.

Over the next several weeks, Love Me received florfenicol (40 mg/kg SQ q4d for 12 days), to treat the septic arthritis and osteomyelitis in her joint. Meloxicam (1mg/kg PO q24h for 3 days, then q48h for 24 days) was administered for long-term pain control. On March 3, 6, 9,

and 13, the wound was reassessed and flushed with diluted iodine. During this timeframe, a second block was placed on the first block, to enable Love Me to stand more comfortably. The drain in place was removed on March 6. On March 16, the surgical site was healing well and was filled with granulation tissue. Love Me was discharged on March 17, 2017 with instructions to continue Meloxicam every other day until March 26, to keep her confined to a small, dry lot, and to remove the bandage in one week while continuing to monitor for increased signs of pain, inflammation, malodor, or purulent discharge.

Pathophysiology

The most common form of septic arthritis in cattle is a bacterial infection (1). Methods of inoculation of the joint can be penetrating injuries from contaminated foreign objects, injection in adjacent structures, or potentially hematogenous seeding (1). Solar or bulbar abscesses have been found to contaminate the distal interphalangeal joint (DIJ) (1). Hematogenous spread can occur in calves with septicemia. In a retrospective study of 172 septic arthritis cases seen in the University of Montreal's animal hospital from 1980 to 2000, no bacterium was cultured in 40% of the cases, one bacteria in 47% of the cases, two bacteria were cultured in 9% of the cases, and three or more bacteria were cultured in 4% of the cases (3). *Truperella pyogenes* was the most common bacteria isolated in these cases of septic arthritis. With this in mind, culturing the joint does not always prove beneficial or cost-effective for septic arthritis cases.

The numerous villosities within joints aid in the establishment of bacteria in the joint space within the synovial membranes (1). Bacteria have deleterious effects on the cartilage, synovial membrane, and synovial fluid; but their largest effect involves the immune system. When bacteria enter the joint space, they are destroyed by neutrophils, and enzymes are released.

These enzymes are elastase, cathepsin, gelatinase, and collagenase, which are responsible for destruction of other bacteria, cartilage, and cartilagenous components within the joint. As neutrophils are destroyed, they and the inflamed tissues, release free radicals which further damage the articular components. This destruction leads to inflammation and increased vasodilation, allowing greater permeability of the vessels whereby mediators arrive at the site of infection (1). These mediators consist of kinine, coagulation factor, complement cascade, and fibrinolytic cascade, which arrive and stimulate the synoviocytes and chondrocytes. The chondrocytes are stimulated to release mediators such as matrix metalloproteinases (MMPs), which serve to decrease the production of proteoglycan, thereby causing deterioration of the physical properties of cartilage to compress normally, resulting in more fragile cartilage (6). Fibrin then accumulates on top of the cartilage and synovial membranes, decreasing the nutrient accessibility from synovial fluid to the cartilage (1) (6). The resulting infection and inflammation is seen clinically in patients.

Diagnostic Approach/Considerations

Diagnosing septic arthritis can prove difficult, as the bovine digit contains multiple areas of tissues susceptible to trauma such as tendons, joints, ligaments, bone, and corium. The animal with a septic joint will present with non-weight bearing lameness, heat from the affected joint, swelling, and pain (1). Often the animal will present with a decreased body condition, due to decreased ambulation and ability to obtain feed. Taking a stepwise approach to diagnose septic arthritis is beneficial. Often times the first diagnostic method is simply evaluating the animal's stance, posture, gait, symmetry, and hoof conformation (1). In more chronic cases of septic arthritis, the animal will have a taller heel and longer wall on the affected digit from trying to

place less weight on the painful digit (1). The limb should be palpated to assess any swelling, pain, joint effusion, instability, or defects.

Arthrocentesis of the joint is an excellent way to examine cytology of the synovial fluid, as well as perform a culture to identify which microorganisms are present for antimicrobial administration. Sterile technique must be maintained in order to prevent contamination of the sample, as well as prevent iatrogenic infection (1). Culture of the synovial fluid aids in determining appropriate antimicrobial therapy, though *Mycoplasma* spp. is often missed, due to its fastidious nature (1). Blood culture tubes have helped preserve fastidious bacteria for culture, though *Mycoplasma* spp. is inhibited by some of the components of the culture bottle, and often leads to false negatives. Polymerase Chain Reaction (PCR) has shown promise to quickly aid in determining which organisms are at the source of the septic arthritis, however, it is mainly useful to look for specific pathogens, mainly *Mycoplasma* spp. (1).

Radiographs are an excellent way to visualize osseous changes in the limb; however it is important to note that changes seen on radiographs lag behind approximately 10-14 days from the process in the bone (1). Acute cases demonstrate swelling of the soft tissues, as well as the possibility of gas present in the tissues, coupled with increased articular space. Chronic cases are more easily visualized on radiographs, as bony changes demonstrate subchondral bone lysis, decreased joint space, osteomyelitis, periosteal reaction, and bony proliferation (1). Adult cattle tend to develop severe bone neoformation, whereas calves generally develop bony lysis (1).

Ultrasonography provides better visualization of soft tissues, and allows the practitioner to visualize increased synovial volume and any echogenic material in the synovial fluid, which could indicate an increased amount of fibrin present. On ultrasound, cartilage appears anechoic due to the increased water it contains and the subchondral bone will appear hyperechoic. Any

lysis or defect present will alter the pattern and contour of the structures as it appears on the ultrasound image (1).

Treatment and Management

Three important aspects of treatment for septic arthritis exist and include decrease the bacterial load present, control the inflammation process, and manage patient comfort (1). No single approach is ideal for septic arthritis since the location of infection, individual patient, and owner compliance vary greatly from case to case.

A large array of microorganisms may be present and potentially responsible for the infection of the joint. Antimicrobial therapy can be initiated with empiric treatment, by selecting an antibiotic with a wide spectrum of activity (1). Few studies are available concerning the length of duration of antimicrobial therapy. For cattle, the most common modality is to use antibiotics until clinical signs resolve, and then continue use for an additional 3-4 weeks after clinical signs resolve (1). It is important to select antibiotics which penetrate the site of sepsis, be they systemic, locoregional, or intraarticular. Localized antibiotic therapy may be used to ensure a higher concentration of antibiotics at the site of infection. Gentamicin infused collagen sponges have been used in the DIJ with most cattle reducing lameness in 6-30 months (5). A consideration for using collagen sponges is their relatively high cost and prolonged withdrawal times. A benefit of collagen sponge treatment is that they eventually absorb, which eliminates the need for a second surgery to remove them. Gentamicin infused sponges did not reveal any advantages when compared to direct intra-articular injection of gentamicin (1). PMMA beads containing gentamicin or cefazolin for 2-6 weeks have been shown to help cattle decrease bacterial load and improve soundness; however, PMMA beads are also expensive and must be removed surgically afterward. Additionally, use of gentamicin greatly increases the meat

withdrawal times for food animals, so their use must be considered in only valuable animals not intended to enter the food chain for greater than two years. Administration duration greatly depends on the severity and extent of involvement of synovial, tendinous, and sepsis of the bones (1).

Several surgical treatment models exist for treating septic DIJs to aid in reducing bacterial load including joint lavage with arthrotomy, surgical resection of the distal interphalangeal bone or joint, amputation of the digit, and antibiotic implants for arthrotomy and resection of the DIJ. Joint lavage and arthrotomy should be reserved for acute cases of acute closed arthritis (5) where two needles are placed in the joint; one flushes sterile fluid in, and the other allows the fluid to be flushed out. Antibiotics may be injected into the joint post-lavage. Arthrotomy is used to help preserve the morphology and function of the infected joint.

Surgical resection of the distal sesamoid bone is performed in complicated cases of septic arthritis. These typically have an area of the plantar or palmar sole which has perforated into the corium, resulting in necrotizing tendinitis involving the insertion site of the deep digital flexor (DDF) tendon with purulent podotrochlear bursitis and osteomyelitis of the P3 (5). Removal of the distal sesamoid bone facilitates drainage of the infected joint by exposing the joint surface. Curettage may be used to clean the palmar or plantar aspect of P2 or P3 if they are affected.

Another treatment option is arthrodesis of the DIJ to achieve ankylosis through extensive removal of any septic or altered tissue, including cartilaginous, subchondral, and osseous tissues and bone. This facilitates drainage, debridement, and removal of articular cartilage within the DIJ to allow ankylosis, or fusion of the two distal phalanx bones (1). Facilitated ankylosis is a method of arthrodesis with three possible approaches: solar, bulbar, or abaxial (1). The abaxial approach preserves the functionality of the flexor tendons, and pre-existing healthy heel and bulb tissue. A solar or bulbar approach may be selected when the heel bulb, navicular bone, flexor

tendon sheaths, or DDF muscles are affected, in addition to the septic joint. Once the DIJ is exposed or accessible, the area should be debrided with a curette, hoof knife, or a drill bit (1). The drill should exit the opposite side of the hoof (dorsal surface) approximately 1 centimeter below the coronary band, or above the coronary band, dependent on the clinician's preference (1). Care must be taken to avoid exiting through the corium, as irreversible damage will result in cessation of future horn production. Any necrotic tissue present must be removed or curetted out. Copious lavage is performed to help dislodge bacteria and debris using a diluted betadine solution. The site should be lavaged with a diluted iodine solution every 2-4 days until healthy granulation tissue begins to fill the defect. It is important to maintain immobilization of the joint to improve healing time and fusion of the joint (1). A block placed on the other toe helps with this, as does bandaging to keep it immobile and clean. A rubber drain should be placed to allow the tract to remain open for draining for several days to one week. Cattle will increase in lameness initially for several weeks, but within several months they should become sound (1).

Digit amputation is another option for septic arthritis of the DIJ in which purulent necrotizing arthritis of DIJ, severe osteomyelitis of P3 and P2, tumors of the claw, or other traumatic claw diseases are present (5). Low amputation at the DIJ, in the middle of P2, differs from high amputation, which includes removal of the proximal interphalangeal joint (PIJ) as well as the DIJ, including removal of the distal aspect of the proximal phalanx (P1) (5). With amputation, cattle have a limited survival time, and will be culled from the herd within several years due to the decreased digital stability (1). Heavier animals tend to fare more poorly with this treatment method, as their weight results in more rapid breakdown of the interdigital ligaments. Production longevity of cattle with a digit amputation ranged between 10 and 27 months in one study (1). Another study compared amputation survival time in a herd of lactating dairy cattle following 60 days of milking post-procedure for amputation versus arthrodesis(1).

The study indicates 44.9% of cattle were removed from the herd with amputation, versus 0% removed with arthrodesis (1). Milk yield in this study was also greater in cows who underwent arthrodesis versus amputation.

For all of these procedures, large arteries in the foot need to be ligated if they are at risk for bleeding, otherwise, pressure bandages must be used to minimize continued blood loss after the tourniquet has been removed (5). Regardless, adequate drainage needs to be maintained for exudate to leave the infected site and to ensure no maceration of the tissues occurs. Wooden blocks are routinely used on the sound toe after surgery to minimize contact with the ground, which decreases risk of reinfection and minimizes further trauma to the surgery site. Systemic antibiotic therapy is commonly used in conjunction with surgical treatment, as *Truperella pyogenes, Streptococcus* spp., *Staphylococcus* spp., *Fusobacterium necrophorum, Bacteroides* spp., and *Escherichia coli* have been commonly identified in bovine cases of septic arthritis (1). Animals with joint lavage or arthrotomy procedures benefit from antibiotic administration for 7-21 days post-procedure (5). Personal reports from clinicians have shown that a wide variety of antimicrobials are effective post-procedurally including penicillin, ampicillin, fluoroquinolones, or cephalosporins (5).

Pain management is paramount for the animal peri-procedurally. Local anesthesia can be achieved during the procedure through intravenous (IV) regional anesthesia with use of a tourniquet, which also aids in hemostasis during the procedure (5). Local anesthesia is more reliable than nerve blocks and also has a faster onset which is ideal when the patient is in lateral recumbency in a tilt table. Controlling pain pre-procedurally and post-procedurally is beneficial since it improves feed intake and demeanor, and accelerates the healing process and return to productivity (5). Nonsteroidal Anti-Inflammatory Drugs (NSAIDs) are effective in reducing inflammation to help control pain, however they must be used with caution since they have

disastrous gastrointestinal and renal effects when used improperly (3). Though phenylbutazone is an excellent drug for managing musculoskeletal pain, specific guidelines must be followed according to the type of food-producing animal in question. Flunixin meglumine is another possibility, though there are few existing studies examining the efficacy specifically for septic arthritis in cattle. Several studies have shown promise for dairy cattle after having an experimentally induced synovitis in reducing pain and discomfort (3). Meloxicam is preferred by many clinicians, and is commonly used to treat post-surgery pain in digit procedures (3). Corticosteroids are another option for managing inflammation, though the clinician must be conscious of the immunosuppressive effects which can occur at higher doses. Studies have been performed where septic arthritis was induced, and treatment with intraarticular corticosteroids injection in conjunction with systemic antimicrobial drugs proved to be an effective way to manage the inflammation and infection (3).

Case Outcome

Love Me remained in the hospital for three and a half weeks to have bandage changes, wound flushes, and to monitor how the ankylosis site was healing. Prior to being discharged, the wound appeared to be healing exceptionally well Love Me was not sent home in a cast because the owner said Love Me would be kept in a small, clean, and dry lot. Love Me was discharged 19 days after her initial presentation with a clean bandage, and instructions to remove the bandage in 5 days and then keep the foot as clean and dry as possible. She was sent home on 1mg/kg Meloxicam orally every other day for 9 additional days.

Love Me returned 17 days after her discharge on April 3, presenting with left hind limb lameness, the same concern in the same limb she initially presented with in February. On presentation, Love Me was short stepping with the left limb. Two abscesses were noted on the

left lateral claw when Love Me was tabled, and one at the previous surgical site of the heel and one at the caudal aspect of the interdigital space. A Penrose drain was placed, and bandages were changed and the site was flushed every 48 hours over the next week. Love Me was given ceftiofur crystalline free acid (6.6mg/kg SQ) and Meloxicam once more. The owner admitted Love Me had been out in a muddy pasture, which could explain the rapid onset of infection, particularly since the site had been healing so well prior to discharge. A cast was placed on the foot prior to discharging to help keep the area clean and dry. Instructions were given for monitoring the cast and she was instructed to return in three weeks for cast removal.

At cast removal, the wound was healing well, and only a minor abscess was present, which was opened to drain. Love Me was sent home with instructions to keep her in a clean dry paddock for two more weeks, and then she would be able to return to her normal pasture. Love Me is currently still healing, as reported by the owner. She still does better with comfort and swelling when she is confined to a small dry lot, than when she is out in the pasture. Time will tell how the joint will complete its healing process.

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