“Pour Some Sugar on Me”

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Introduction:

The equine hoof is a complex derivative of skin consisting of five unique epidermal tissues; periople, hoof wall, laminae, sole and frog connected to an equally diverse dermis or corium. The equine hoof is capable of withstanding momentary forces of up to 2 times body weight at a gallop.[2] But even this incredible design can come to a crippling stop with a hoof abscess. Hoof abscesses are one of the most common causes of acute lameness in the equine species.[7] The purpose of this manuscript is to review a case presentation, diagnostics, and treatment options of hoof abscesses in horses.

History:

Sugar is an approximately 15-year-old Shire mare who was purchased one year ago by her owner from a sale barn. Sugar presented to the MSU-CVM Equine department on April 16, 2020 for lameness and multiple health abnormalities. She was accompanied by a foal. Upon arrival it was noticed that Sugar had a noticeable lameness on her front right limb. Further evaluation was needed to make a diagnosis.

Physical Exam:

On presentation Sugar was bright and alert. She weighed 1,230 lbs with a BCS of 2/9. A physical exam revealed scarring on her right eye that did not take any stain. Additionally, a cataract was present in the same eye contributing to loss of vision. Her heart rate was 56 bpm, respiratory rate 20 bpm, and a rectal temperature of 100.9 F. Her mucous membranes where pink with a capillary refill time of less than two seconds. Gastrointestinal motility was increased

in all four quadrants. Severe dermatitis was present in all four limbs. This made it difficult to detect any digital pulses. Sugar was given a grade 4 out of 5 (lame at a walk) on the AAEP lameness scale. Differentials for acute lameness include synovial infections, fracture, and hoof abscesses.

Diagnostics:

Upon physical examination, Sugar's feet where cleaned for further evaluation. Two parallel cracks ascended the dorsal region of the toe on her right forelimb. Cracks appeared to be full thickness due to mobility of the hoof wall from the rest of the hoof structure. The foot had a malodorous exudative draining from the distal end of each crack. Hoof testers were used around the solar surface to isolate areas of pain within the foot. Sugar had a strong positive response to hoof testers at the toe region of her front right foot, and moderately positive response at the quarters. Hoof testers are considered positive when the horse moves their limb consistently as light pressure is applied to a specific area. Severity is measured inversely to the amount of pressured applied. Therefore, a strong positive is one where very little pressure is needed to achieve a marked response. A study conducted by Towl et. al described that 87.9% of hoses with hoof abscesses responded to a positive hoof test. The same study also noted 88.2 % of horses have increased digital pulses in cases where foot abscessation is the cause of lameness.[1,8] It was noted that the white line on Sugar's front right foot appeared stretched. Widened white lines at the toe can be a gross indication of laminitis.[10] Due to the grade of lameness in association with the stretched white line laminitis was suspected and radiographs where taken of each limb.

Sugar's right front limb had twenty degrees of palmer rotation of the third phalanx. The margin of the third phalanx was undulating and irregular. Therefore, laminitis and pedal osteitis where diagnosed on her right front limb. On her left front limb, the vascular canals of the third phalanx appeared widened and the margin of the third phalanx was also undulating and irregular. The distal border of the navicular bone was severely undulating with increased synovial invaginations. Navicular degeneration and pedal osteitis where diagnosed in her left front limb.

After radiographs where taken, her right hoof was again evaluated by the MSU-CVM Equine Podiatry department. Due to her laminitis and degree of pedal rotation, care was taken not to remove excessive amounts of sole from the hoof. A hoof knife was used to exfoliate the white line of loose epidermal tissue and evaluate its integrity. After paring away sole, a necrotic tract with exudative drainage was identified. A hoof knife was used to peel back layers of epidermal tissue until the exudate from the abscess was released.

Sugar was diagnosed with a subsolar-laminar abscess of the toe. The dorsal hoof wall was resected using half round nippers halfway up to the level of the coronary band approximately 3 inches in width. Once removed, it revealed black malodourous necrotic tissue. Using a curette, the necrotic tissue was debrided. Gauze soaked with dilute betadine solution was used as a wound dressing. Due to poor sole thickness and considering the amount of hoof wall that was resected, it was elected to place an open heeled keg shoe on Sugar's right front foot to elevate her foot off of the ground and relieve pressure on her sole and distal border of the coffin bone. A piece of bar stock was heated, cut, and forged to fit. The first application of the shoe utilized number 5 slim CITY head nails; however, it was pulled the following day due to

discomfort from sensitive tissue being compressed by the clinches. The shoe was replaced with an aluminum shoe made from 1-inch x 3/8’ aluminum bar stock. It was secured using Equilox acrylic glue and 2” Equicast casting around the hoof wall. A window approximately 3.5 inches wide was cut into the casting material over the dorsal surface of the hoof using a cast saw, to allow access to the underlying tissue. A hoof bandage was applied with betadine-soaked gauze, Kerlix gauze, vet wrap and duct tape to cover the tissue. Sugar was kept in the hospital overnight and discharged the next day with instructions for replacing her bandage daily.

Pathophysiology:

The equine hoof is made of five types of epithelial tissue that forms a capsule surrounding the inner layers of foot.[9] These five layers are the periople, hoof wall, laminae, sole, and frog. Of these five types, only laminae (white line), sole, and frog can become infected leading to abscess formation.[9,10] Within these three structures, abscesses can form within epidermal tissue or between epidermal and dermal tissue. Arguably, the most common being infection between the layers of the epidermis.[1,7] Infection between epidermal and dermal tissue can be more severe due to potential for bone infection and often lead to longer treatments and possible poorer prognosis for soundness.

Defects in the white line can be associated with infections within epidermal layers of the sole, laminae, and the frog.[10] As bacteria migrate up the loose keratinized layers between the germinal epidermis and cornified epidermis, the horse’s inflammatory response encourages white cells to migrate towards the infected area.[7] Damage to the epidermis by both inflammation and bacteria causes separation of the epidermal layers allowing space for

exudative and purulent fluid to accumulate. Due to the low compliance of the hoof wall, as the fluid accumulates pressure begins to build up rapidly and push on sensitive nerves found throughout the dermal epithelium. Given the dense structure of the stratum corneum, migration of the exudate usually follows tissue planes of least resistance and often manifests at the coronary band or at the heel bulbs of the hoof.[9,10] Other root causes of abscess in the equine hoof include sole bruising leading to hematoma formation and devitalization of tissue, allowing bacteria present on the solar surface the ability to penetrate and migrate underneath the epidermis.[7] This type of abscess is often found in horses with shallow sole depth or who are left unshod in rocky environments.

In extreme cases, infection of the underlying dermal layers of the hoof can happen. Often these are a result of aggressive bacteria or underlying health conditions such as previous infections, laminitis, or penetrating injury.[8,9] Infections of the dermal layers can also lead to osteomyelitis and sequestrum of the distal phalanx. These cases are a medical emergency and without aggressive debridement and antibiotic treatment, often lead to a poor prognosis for soundness.

Horses with chronic laminitis are more susceptible to abscessation.[8] It is postulated that the effects of chronic laminitis, i.e. stretched white line, devitalized laminae, and toe cracks, allow passageway for bacteria to invade sensitive tissue with little response from the immune system.[3] Divergent growth rings, concave dorsal hoof wall, sole drop, and separation of dorsal hoof wall from sole are risk factors associated with abscessation.[6] Bacterial agents commonly associated with these infections include Brevibacterium luteolum, Staphylococcus spp., E. coli, and Alcaligenes faecalis.[6] Samples of laminae where collected from horses in a study by Onishi

et. al in 2012. They found that the bacterial load in horses with chronic laminitis was 100x higher than normal healthy horses, with Gram positive bacteria being the most common. Onishi et. al also described the presence of biofilms in horses with chronic laminitis. The bacteria isolated from the biofilms was most often Staphylococcus equorum and Staphylococcus lentus, the same strains found commonly in infections of catheter sites. Biofilm formation would describe why antibiotic treatment in horses with chronic hoof abscessation is often unsuccessful.[6]

Treatment:

The principles for treatment of hoof abscesses is simple but careful attention should be placed to ensure thorough patient care and to prevent recurrence. The first step in treatment is localizing the pocket of infection. This is achieved using hoof testers and paring or rasping the bottom of the foot to identify a tract. The second step is establishing drainage. This is often achieved with the use of a hoof knife or scalpel blade. By paring back thin layers of sole or white line, one can avoid taking too much tissue and prolonging the recovery time. In cases where a draining tract is not yet present but palpation of the coronary band reveals pending rupture, Animalintex or other poultices can be applied at the coronary band to achieve rupture and drainage. A soak boot containing Epson salt can aid in rupture of laminar abscesses but may prolong treatment with subsolar abscesses which may not be able to drain through the thick solar epithelium and therefore force bacteria to migrate up the hoof wall and rupture from the coronary band.[3]

Once drainage is established, thorough debridement of the tract must be achieved. A small loop knife, probe, or small curette can be used.[3] In chronic cases, medical grade maggots can be used. Medical grade maggots are disinfected fly larvae of the species *Lucilia sericata* (green bottle blowfly) that are used to remove necrotic tissue, reduce bacterial contamination, and enhance healthy granulation tissue.[4] Collagenases and Trypsin-like and chymotrypsin like enzymes breakdown the necrotic tissue.[4] Antibacterial products within the saliva of the larvae have been shown to be effective against S. aureus, Strep A and B, and Pseudomonas.[4] Additionally, Leppage et. al documented that the larvae had an impact on the breakdown of bacterial biofilms, which are often attributed to chronic abscessation.[5] It has also been documented that the larvae induce growth enhancement by stimulation of fibroblast and degradation of fibronectin into smaller more bioactive fragments.[4] Maggots should be left in a wound for 2-4 days. After 4 days, larvae either die or migrate out of the wound to pupate.[4] Maggot therapy is a minimally invasive way to debride an infected area and stimulate growth in severely affected patients when disease is present and causes minimal disturbances to the foots architecture.[4] When surgical debridement is necessary. Anesthesia can be achieved by using a lidocaine nerve block at the abaxial location. A tourniquet can be placed to control hemorrhage. The tourniquet should be place at the level of the proximal sesamoids of the fetlock joint. Hoses should also be sedated to achieve patient compliance.

After all the necrotic tissue is removed from the foot, the third phase of treatment is to clean the site.[3] Dilute betadine can be used to flush the affected area. Using betadine-soaked gauze to pack the wound, the foot should be wrapped with cotton gauze. A 12-inch cotton roll can then be used to wrap the distal limb and secured with vet wrap. A soak boot should be

applied to the lower limb using dilute betadine in warm water with Epson salt. The boot can be easily made from used IV bags. Once the foot is placed into the boot, it can be secured using Elastikon tape at the top to prevent any bedding material from getting into the boot, and duct tape can be applied to the bottom to decrease wear on the solar surface. The soak boot should be left on the horse for 48 hours and revaluated daily until complete drainage is confirmed.

In severe cases where resolution is not met within 3-5 days of treatment, antibiotic therapy may be indicated. This is best achieved by regional limb profusion.[7] Regional limb perfusions are the best way to achieve concentrated dependent doses of the antibiotic to an infected area with minimal consequences to gastrointestinal micro-flora. Oral administration of antibiotics is not contraindicated but may lead to diarrhea in the horse and increase the risk of gastrointestinal infection or colic. A culture and sensitivity should be received prior to antibiotic administration; however, Amikacin is almost always used as a first line antibiotic for its broad-spectrum coverage and concentration dependent mode of action. When performing a regional limb profusion, a horse should be sedated, and a tourniquet be placed at the level of the proximal sesamoids. A 20-gauge butterfly needle with extension set should be place in the lateral palmar digital vein approximately halfway between the tourniquet and coronary band in the lateral digital vein. Antibiotics should be diluted to 20-30 mls and be given over a 10-minute span to eliminate potential rupture of the vessel. Once complete, the needle should be removed, and a pressure bandage be applied to the limb for at least 30 minutes. The tourniquet should remain on the limb for 30 minutes post injection. Revaluation of the infected site should be monitored daily.[7]

Most abscesses in the hoof are resolved within 3-5 days, however, if resolution is not met, serious action should be taken immediately. Surgical debridement, maggot therapy, antibiotics, and NSAIDs may be used in treatment.[4,7,8] The contralateral limb should be supported to prevent support limb laminitis. This can be achieved using an Easy-care boot, Soft Ride boot, sand stall, and various types of shoes to decrease breakover and add support. The use of NSAIDs in treating hoof abscesses is controversial. Towl et. al reported the use of NSAIDs did not correlate to shorter treatment times of decreased complication rates.[8] It is even hypothesized that the use of NSAIDs too early in treatment can delay rupture of the abscesses and therefore prolong treatment. However, once drainage is achieved, the use of NSAIDS is often recommended.

Case Outcome:

Sugar's hoof is revaluated every 30 days by the MSU-CVM Podiatry department. She is recovering well with a favorable prognosis. Her foot is currently kept wrapped with bandage changes being performed every four days with sugardine solution being added to the bandage. Sugardine is a combination of betadine and sugar when mixed forms a paste that can be applied to the affected area acting to dry the tissue and prevent infection. It will take approximately one year for Sugar's dorsal hoof wall to grow out. It is not recommended that Sugar be bred again in the future and that her laminitis be treated appropriately to prevent recurrence of hoof abscesses.

Conclusion:

In summary, Hoof abscesses in the horse are a very common cause of lameness seen by veterinarians and farriers.[7] It is routinely diagnosed by clinical signs and the use of hoof testers. Radiographs can be used but are often unnecessary. Treatment for most cases is achieved through a simple protocol of identifying the infection, establishing drainage, cleaning/debriding the infected area and by keeping the affected area clean until epithelization is achieved.[3] In more severe cases, surgical debridement, maggot therapy, and regional limb perfusions may be indicated.[4,7] Care should be taken to prevent support limb laminitis. Chronic abscessation is often caused by underlying conditions such as laminitis, poor sole depth, and white line disease.[6]

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