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Septic arthritis in horses: Diagnosis and treatment

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Synovial sepsis is a common problem in horses and foals. Septic arthritis and septic tenosynovitis may result in decreased performance or, in severe cases, euthanasia of the animal. Early diagnosis and aggressive therapy can improve the prognosis for survival and athletic ability. With the advent of arthroscopic lavage and regional antimicrobial limb perfusion, a greater proportion of horses with septic arthritis are responding favourably to treatment. This issue of *Large Animal Veterinary Rounds* discusses the diagnosis and treatment of septic arthritis. Two case reports describing successful treatment of synovial sepsis are included at the end of the article.

Synovial sepsis in the horse is a serious clinical problem that can result in permanent loss of athletic function and possibly euthanasia of the animal. Bacteria can enter synovial structures by hematogenous, iatrogenic, or traumatic routes. In Canada, traumatic septic arthritis, as a result of lacerations penetrating into the synovial structures of the lower limb, is most common in adult animals, whereas hematogenous sepsis is most common in neonates. Prognosis for athletic ability is often poor following joint and tendon sheath infections. Therefore, it is extremely important to eradicate the infection before irreversible damage occurs if the horse is to return to athletic function.

Bacterial etiology and sensitivity patterns

Bacterial etiology is dependant on the route of infection. Isolates from joints with iatrogenic sepsis following intra-articular injection commonly yield *Staphylococcus aureus,*[1] whereas isolates from joints with penetrating traumatic wounds are more likely to yield such organisms as *Enterbacteriaceae, Staphylococcus* sp, *Streptococcus* sp, *Pseudomonas* sp, and anaerobes.[1] Organisms isolated from foals with suspected hematogenous sepsis include *Streptococcus zooepidemicus, Actinobacillus equuli, Escherichia coli, Klebsiella* sp, *Salmonella* sp, *Pseudomonas* sp, *Staphylococcus* sp, and anaerobes.[2,4] It is extremely important for the clinician to be familiar with the common synovial bacterial isolates and their sensitivity patterns because treatment is often initiated before the culture and sensitivity results are available. In addition, only 75% of synovial samples from septic joints produce a positive culture.[3] A recent study at the Western College of Veterinary Medicine (WCVM) suggests that gentamicin may be the most effective antimicrobial against isolates obtained from septic joints.[4]

Diagnosis

Clinical signs

The two most common clinical signs in horses with septic arthritis are joint effusion and lameness. In general, the severity of these signs increases with chronicity. Periarticular edema and cellulitis often accompany synovial sepsis making palpation and determination of joint effusion very difficult. As well, many horses with traumatic septic arthritis also have severe lacerations that disrupt the normal anatomy of the synovial pouches. The anatomic location of the affected joint may also limit the ability of the clinician to detect effusion. For example, effusions in joints with small synovial pouches (eg, small tarsal joints) or in joints located deep within soft tissues (eg, coxafemoral joint) are often impossible to palpate. Horses

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with open joints or tendon sheaths may present with minimal lameness because the synovial fluid can drain and the joint does not become tightly distended. Many horses with synovial sepsis will be febrile on presentation; however, animals with acute injuries or with previous treatment by nonsteroidal anti-inflammatory medications may have normal temperatures.

Fluid cytology

Aspiration of synovial fluid from an infected joint or tendon sheath may help confirm the clinical diagnosis of septic arthritis; however, care must be taken in cases where cellulitis or severe periarticular swelling are present. It is extremely important to avoid the introduction of bacteria from infected soft tissues into a synovial structure that is not infected. Joint aspirates are best performed in regions where the joint pouches are easily palpable and where there is no periarticular swelling. Because most cases with synovial sepsis present with some degree of swelling, the clinician must be convinced that effusion is present before attempting an aspirate through swollen periarticular soft tissue. All aspirates must be performed using aseptic technique. In general, turbid fluid samples reflect a high cellular count and are indicative of sepsis. Unfortunately, with synovial sepsis, the fluid cytology parameters of synovial fluid can be extremely variable. Fluid cytology, following experimentally induced *Staphylococcus aureus* infection of tarsocrural joints in horses, revealed total white blood cell (WBC) counts of $> 75 \times 10^9$ cells/L, $> 90\%$ neutrophils, and a total protein of > 50 gm/L.[1] A total WBC count of less than 10×10^9 cells/L does not rule-out sepsis because WBCs may sequester within fibrin deposits in the joint.[3] Only 25% of infected synovial fluid samples have bacteria that are observable on direct smears.[3]

Cultures

Following joint aspiration, synovial fluid should be submitted for culture. Submission of 5 ml of synovial fluid in one vial of blood culture medium may be better than a swab in achieving a positive culture.[5] Bacterial isolation is supposedly enhanced by using blood-culture medium due to the inactivation of aminoglycosides and the interference with complement activity and phagocytosis of bacteria by leukocytes.[5] However, experience suggests that blood-culture medium is no more effective than aerobic culture swabs for the isolation of organisms from septic synovial structures.

Radiology

Radiographic examination of each infected joint is recommended in order to evaluate the presence of osteitis, osteomyelitis, and fracture. Horses with acute intra-articular fractures may present with clinical signs similar to horses with septic joints. Adult horses with chronic septic arthritis or foals with hematogenous septic arthritis may have accompanying osteomyelitis. If osteomyelitis is diagnosed concurrently with septic arthritis, the prognosis is decreased and aggressive medical and surgical treatment is required.

Treatment

Aggressive therapy is required for rapid and successful elimination of pathologic organisms. The basis of treatment consists of two very important modalities: joint lavage and antimicrobial administration. The more aggressive the treatment, the higher the success rate for elimination of the infection and the return to athletic ability. Unfortunately, economic constraints often limit the clinician to less aggressive treatments with a poorer prognosis.

Lavage

Joint lavage is indicated in all cases of septic arthritis. Flushing the joint removes fibrin, purulent material, and inflammatory mediators from the synovial space. Lavage is accomplished through needles or with arthroscopic guidance.[3] Through-and-through needle lavage can be performed with the animal standing or under a short-acting, general anesthetic. The technique is usually accomplished by using two 14 or 16 gauge needles placed on opposite sides of the joint. For example, a tibiotarsal lavage could be achieved with 1 needle placed in a plantar joint pouch and the second needle placed in a dorsal joint pouch, thereby maximizing the flow of fluids through the joint space. Fluid is injected by hand with syringes or with a pressurized fluid bag. Through-and-through needle lavage can be readily performed in field situations; however, fibrin clots and foreign material may be left within the synovial structure to act as a continuing nidus for bacteria. Nevertheless, through-and-through needle lavage is often very effective in acute cases before excess fibrin forms. Arthroscopy is the most effective modality for removal of fibrin, foreign material, and thickened synovium from septic joints and tendon sheaths.[3] Chronic cases usually require arthroscopy for effective lavage and fibrin removal. Even in acute situations, arthroscopy is the treatment of choice because foreign material, if present, can be removed and the articular cartilage can be seen and assessed. In cases where subchondral osteomyelitis is present, the lesion can be debrided under arthroscopic guidance.

Regardless of the method used, a sterile, balanced, electrolyte solution is recommended. Most antiseptic solutions create a chemical synovitis that is detrimental to the joint. The addition of antimicrobials to lavage fluids is of little benefit due to the transient contact time. Dimethyl sulfoxide in the lavage solution does not cause irritation within synovial structures;[6] however, the anti-inflammatory and free radical scavenging activity of dimethyl sulfoxide remain open to debate.

Antimicrobial administration

Systemic

Systemic administration of antimicrobials is the most commonly recommended therapy for treatment of septic arthritis. The combination of a cephalosporin and an aminoglycoside provides the best coverage against musculoskeletal infections.[7]

Gentamicin has a good spectrum of activity against both Gram-negatives and streptococci and from the study at WCVM appears to be a better choice than amikacin.[4] Septic arthritis may produce vascular thrombosis and ischemia of the synovium that can limit the delivery of systemic antimicrobials in sufficient concentrations to eradicate the infection.

Intra-articular

Intra-articular administration of antimicrobials achieves high synovial fluid concentrations with relatively low doses. Gentamicin,[8] amikacin,[9] ceftiofur,[10] and cefazolin[3] have been used for intra-articular injection with minimal inflammatory effects on the synovial structures. Synovial fluid concentrations following intra-articular injection of gentamicin and ceftiofur are 10 to 100 times higher when compared to systemic administration.[8,10] Intra-articular antimicrobials are usually administered once daily following joint lavage. Even though intra-articular injection produces high concentrations within the joint, it is also extremely important to achieve high concentrations of antimicrobials in the soft tissues surrounding the synovial structure. At present, there is no evidence that intra-articular administration of antimicrobials produces high concentrations within the periarticular soft tissues of horses with septic arthritis, therefore, systemic therapy is also indicated.

Regional perfusion with antimicrobials

Regional perfusion is a technique that produces high concentrations of antimicrobials within the bone and soft tissues of distal limbs.[11-14] This technique involves local delivery of antimicrobials by way of the venous system using either a superficial vein or the medullary cavity of a longbone.[11] A tourniquet is placed proximal to the site of infection and an antimicrobial solution is injected under pressure into the venous system. Pressurizing the venous system is thought to result in diffusion of the antimicrobial into ischemic tissues and exudate.[15] In studies at WCVM and elsewhere, regional perfusion produces peak concentrations of antimicrobials in the distal limb that are 5 to 50 times higher than systemic administration alone.[11-14]

The concept of regional perfusion is relatively new to veterinary medicine. There are many unanswered questions regarding the appropriate choice and dose of antimicrobial, the best perfusion volume, the optimal number of perfusions, and the appropriate interval between perfusions for horses with septic conditions in a distal limb. Currently, it is recommended that the distal limb be perfused once daily for a total of 4 days with 500 mg amikacin in 60 ml of sterile, balanced, electrolyte solution. Gentamicin at a dose of 1 gm in 60 ml of balanced electrolyte solution may be a better choice in some circumstances, but the optimal dose of gentamicin for intraosseous perfusion in the distal limb of the horse has not been determined.

Over the last 10 years, the IV perfusion technique has gained favour, because it does not require special equipment and is readily performed under field conditions. However, several limitations have been encountered with this technique when used for repeated daily perfusions. Many horses with septic arthritis following trauma also present with generalized cellulitis of the lower limb, making localization of a superficial vein extremely difficult. If a superficial vein is localized, its structure is often disrupted by venipuncture, making repeated catheterization difficult. In addition, digital IV catheters are difficult to maintain. The intraosseous perfusion technique eliminates the need to find a vein, repeated venipuncture or catheterization of distal veins, and enables repeated local perfusion with relative ease.[11]

Regional perfusion is readily performed in standing horses. Ideally, the horse should be restrained in stocks so that risk of injury to the veterinarian is minimized. Sedation is administered prior to the onset of surgical manipulations. An alpha-2 agonist and butorphanol combination is commonly administered. For IV perfusion, tourniquet placement will dictate the location for IV access. If the tourniquet is placed distal to the carpus or hock, the digital vein at the level of the proximal sesamoid bone is commonly used. If the tourniquet is placed proximal to the carpus or hock, the cephalic vein (forelimb) and saphenous vein (hindlimb) is preferred. Following surgical preparation, a 20-gauge, 1.5-inch over-the-needle catheter is placed into the vein and an IV extension set is attached to the catheter.

For intraosseous perfusion, local infiltration with 3 ml of lidocaine or carbocaine is performed at the junction of the distal and the middle thirds of the cannon bone, palmar to the lateral digital extensor tendon in forelimbs, and plantar to the long digital extensor tendon in hind limbs (Figure 1). A 2-cm incision is made through the skin and periosteum. The soft tissues are elevated away from the bone with a periosteal elevator, and a 4-mm hole is drilled into the medullary cavity. The male adapter of an IV extension set is wedged into the hole with a pair of needle drivers, using to-and-fro twisting movements (Figure 2). Care must be taken to avoid incorporation of soft tissue into the bone-adaptor interface because this can disrupt the seal and promote leakage of antimicrobial agents.

Following IV or intraosseous access, a 3-cm-wide rubber tourniquet fashioned from an automobile tire inner tube is placed around the limb. The tourniquet can be placed either proximal or distal to the carpus or hock depending on the site of synovial sepsis. If the veterinarian chooses to place the tourniquet proximal to the hock, then a pair of soft spacers (such as gauze rolls) should be placed between the gastrocnemius tendon and the deep digital flexor muscle before the tourniquet is applied. Following tourniquet application, 10 ml of lidocaine is injected into the limb through the extension set. This is immediately followed by perfusion with an appropriate antimicrobial in 60 ml of sterile, balanced electrolyte solution (Figure 3). Types and dosages of antimicrobials used in regional perfusion include 500 mg amikacin,[11] 125 mg amikacin,[12] 1 gm gentamicin,[12,14] and 10 million IU of potassium penicillin.[16] The perfusate is injected by hand with a 60-ml syringe. There is a moderate amount of resistance when injecting into the intraosseous space; therefore, a hand-held syringe driver helps

Figure 1: Location of intraosseous perfusion portal at junction of middle and distal one-third of cannon bone.

expedite the procedure. The tourniquet is removed 30 minutes following the initiation of perfusion. When performing repeated daily intraosseous perfusion, the skin incision is left open and the limb is bandaged between perfusion sessions. Each day following the initial perfusion session, the soft tissues are separated with hemostats to expose the cortical hole. The extension set is then wedged into the hole as previously described.

Figure 2: IV extension set following insertion into cannon bone

Figure 3: Manual injection of perfusate into cannon bone

Case reports

The following case reports describe joint lavage and intraosseous antimicrobial perfusion in two different circumstances. The first case describes aggressive therapy using arthroscopic aided lavage with intraosseous perfusion in a referral institution. The second case describes needle lavage with intraosseous perfusion in a primary care facility.

Case 1

A 16-year-old castrated, male Quarter horse was referred to the WCVM for a 3-day history of non-weight bearing lameness on the left hindlimb. The horse had sustained a laceration over the plantar aspect of the left-hind pastern 17 days prior to referral. Treatments on the farm included a trimethoprim sulphonamide antibiotic combination, phenylbutazone, and open-wound management with poultices. On presentation, the horse was non-weight bearing on the left hindlimb with a laceration midway between the fetlock and the heel bulb that extended into the digital flexor sheath. Synovial fluid was aspirated from the digital sheath for cytology and culture. Cytology revealed a WBC count of 27.6 x 10^9 cells/L, a total protein of 69 gm/L, and a differential of 91% neutrophils. Based on the clinical exam and cytology, a diagnosis of septic digital flexor was made. The horse was immediately placed under general anesthesia and tenoscopy of the left hind digital flexor sheath was performed. Fibrin was manually removed under arthroscopic guidance and the sheath was flushed with 5 L of lactated Ringer's solution (LRS). Following arthroscopic lavage, a tourniquet was placed distal to the hock and intraosseous perfusion using 500 mg amikacin in 60-ml LRS was performed as previously described. The tourniquet was removed after 30 minutes. The limb was bandaged and the horse recovered from anesthesia without incident.

The next day, the horse continued to be non-weight bearing. An indwelling epidural catheter was placed in the second coccygeal space and 0.17 mg/kg xylazine with 0.1 mg/kg morphine diluted to 35 ml in sterile saline was administered through the catheter. The horse was then sedated and standing regional intraosseous perfusion with 500 mg amikacin was performed as previously described. The epidural and the standing regional perfusion were repeated once a day for a total of 3 days. On day 3, the results of aerobic, anaerobic, and enrichment cultures were negative. On day 4, the horse was bearing full weight on the left hindlimb after the epidural was discontinued. The wound over the digital flexor sheath had sealed. The horse was monitored for an additional 2 days and was discharged. There was a mild left hindlimb lameness at the walk. Additional antimicrobials were not administered following the intraosseous perfusion treatments. A follow-up 18-months later revealed that the horse was sound.

Case 2

A 4-year-old Quarter horse mare was presented to the WCVM with a 1-week history of non-weight bearing lameness of the left hindlimb following a laceration over the fetlock. The horse had received penicillin and phenylbutazone on the farm. On presentation, the horse was toe-touching lame on the left hindlimb with a granulating laceration over the craniolateral aspect of the fetlock. A 20-gauge, 1.5-inch needle was placed in the medial plantar joint pouch of the fetlock and 0.5 ml of serosanguinous fluid was aspirated. The joint was then injected with 20 ml of LRS. Fluid exited through the granulation tissue, confirming that the laceration had penetrated the fetlock joint. The joint was flushed through the indwelling needle with an additional 500 ml of lactated Ringer's solution. The owners could not afford arthroscopic-guided lavage and opted for a through-and-through needle lavage with intraosseous perfusion. The horse was sedated and intraosseous access was performed as previously described. A tourniquet was placed distal to the hock and the limb was perfused with 500 mg amikacin in 60 ml of LRS. The tourniquet was removed in 30 minutes and the horse was placed on 1 gm of oral phenylbutazone. On day 2, the horse was fully weight bearing, but obviously lame at the walk. Standing regional intraosseous perfusion was repeated on a daily basis for a total of 4 treatments. The horse was maintained on 1 gm oral phenylbutazone daily for the duration of the perfusion treatments. On day 5, the horse had a mild lameness at the walk and the wound over the fetlock had sealed. The horse was discharged with 1 gm oral phenylbutazone daily for 10 days and 30 mg/kg oral trimethoprim sulphonamide daily for 7 days. On follow-up 1-month later, the horse was sound.

Prognosis

The prognosis for return to athletic function is variable and depends on:

- the age of the horse
- the synovial structure affected
- the chronicity of the infection
- the pathogenicity of the organism.

Survival rates are lowest in foals; one report suggests that only 45% survive to be released from the hospital. The prognosis for survival is often lower in foals because of failure of passive transfer and concurrent disease such as septicemia.[1,17] In another report, only one-third of foals that were discharged from hospital went on to perform athletically.[18] The prognosis is higher in adult horses, with an 85% survival rate and a 50% return to athletic ability following treatment for septic arthritis.[1] Septic tenosynovitis has been reported to have a higher survival rate compared to septic arthritis.[1] In general, the prognosis for both survival and athletic ability should improve when aggressive therapy (eg, arthroscopic lavage and regional perfusion) is employed.

The prognosis for survival and athletic ability decreases as the number of problems multiplies (eg, multiple joint sepsis and concurrent osteomyelitis). Anatomic location will also affect prognosis. For example, the prognosis for the small tarsal joints is better because these joints can fuse as sequelae of post-sepsis degenerative joint disease. Degenerative joint disease of a high-motion joint, such as the coffin joint, is detrimental to the functioning of the horse. Chronic infections often have a poorer prognosis due to the effects of long-term inflammation, as in joint capsule fibrosis and degenerative joint disease.

Summary

With the advent of new treatment modalities for septic arthritis and tenosynovitis, the prognosis for survival and athletic ability is improving. Even though clinical success has been achieved with regional perfusion alone, it must be remembered that the prognosis is maximized when this technique is combined with arthroscopic lavage. If arthroscopy cannot be performed due to financial constraints, then regional perfusion with antimicrobials is more effective than systemic administration of antimicrobials alone.

Dr. Troy Butt graduated from WCVM in 1997 and enrolled in a 1-year surgical internship at Young-Crawford Veterinary Clinic at Innisfail, Alberta. He then returned to WCVM and completed a 3-year large animal surgical residency with a concurrent Masters of Veterinary Science degree, followed by a 1-year clinical associate position in Large Animal Surgery. Dr. Butt was certified by the American College of Veterinary Surgeons in 2002 and now is an Assistant Professor of Equine Surgery at Iowa State University.

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Abstract of Interest

Regional perfusion of the equine carpus for antibiotic delivery

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Regional perfusion of carpal tissues by forced intramedullary administration of fluids was evaluated in 10 horses. Results of subtraction radiography after perfusion with a contrast medium demonstrated that perfusate was delivered to the carpal tissues by the venous system. Perfused India ink was distributed uniformly in the antebrachiocarpal and middle carpal synovial membranes. Histologically, the ink was within the venules of the synovial villi. Immediately after perfusion with gentamicin sulfate (1 g), the gentamicin concentrations in the synovial fluid and synovial membrane of the antebrachiocarpal joint were 349 ±240 micrograms/mL and 358 ±264 micrograms/g, respectively. When gentamicin concentrations in the synovial fluid of the antebrachiocarpal joint and serum were measured 0, 0.5, 1, 4, 8, 12, and 24 hours after carpal perfusion, the mean peak gentamicin concentration in the synovial fluid was 589 ±429 micrograms/mL. At hour 24, the mean gentamicin concentration in the synovial fluid was 4.8 ±2.0 micrograms/mL. The resulting peak gentamicin concentration in the serum was 23.7 ±14.5 micrograms/mL immediately after the perfusion; it decreased below the desired trough level of 1 micrograms/mL between hours 4 and 8.

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