Hematogenous Infections of the Musculoskeletal System in Foals

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Hematogenous seeding typically causes septic arthritis in foals. The most common isolates are Streptococcus or enteric bacteria. The diagnostic test should include radiographs and arthrocentesis for culture and cytology. A complete physical exam should be performed on every foal confirmed to have a septic joint in an attempt to localize the initial source of infection. Treatment should consist of broad-spectrum antibiotics and adequate lavage or drainage. Antibiotic treatment is prolonged for several weeks after clinical improvement if osteomyelitis is present or until fibrinogen levels are normal. The prognosis is dependent on the duration of the infection as well as the amount of irreversible structural changes. Author's address: Rood and Riddle Equine Hospital, 2150 Georgetown Rd., P.O. Box 12070, Lexington, KY 40580. © 1998 AAEP.

1. Introduction
Infectious arthritis or osteomyelitis generally affects foals younger than 4 months of age. There are several variables that predispose foals to hematogenous seeding and colonization of bacteria of bone and joints. These infections are often associated with a concurrent or previous illness. Although an infection of the umbilicus has often been identified as a common cause for the sepsis, this is likely overstated. In foals examined for septic arthritis in which an ultrasound of the umbilicus was performed, few have had a concurrent infectious process in the umbilicus; therefore the term navel ill overstates the cause of septic arthritis.

Additional routes of hematogenous exposure to bacteria include gastrointestinal disorders (i.e., diarrhea) or lower respiratory infections. Considering the source of bacterial exposure, it is easy to understand why the majority of musculoskeletal infections in foals are related to enteric bacteria, beta-hemolytic streptococci, and occasionally Rhodococcus equi.

Anatomical predispositions also exist in foals, which are associated with the vascular system in the joints and physeal regions of bones. The blood flow in the immature bone has a metaphyseal vascular loop immediately prior to the transphyseal vessel. This loop has low blood flow, allowing bacteria to settle out and potentially colonize. In addition, there are extensive capillary beds in the synovia that likewise allow the low flow of blood and the colonization of bacteria.

Another predisposing variable in the development of septic arthritis is the level of immunocompetence of the foal to resist infection. The most common predisposing factor is the inadequate transfer of colostral immunoglobulins. Immunoglobulins are an important factor in preventing disease processes and likely increase the number of bacteria required to colonize and progress into a fulminating infection.
ORTHOPEDIC

Bacterial seeding may occur at an early age and require sufficient time to develop clinical signs, therefore demonstrating a delayed septic process from an early immunoincompetence.

The type of bacteria, as well as other variables, is important when one is considering septic arthritis. Although difficult to apply to specific situations, the virulence, resistance, and number of bacteria obviously play a role in the development of septic arthritis. These bacterial variables are also important in the effectiveness of treatment and prognosis.

2. Diagnosis

A. Clinical Signs

The most common clinical sign of hematogenous infection in foals is some variable degree of lameness. It is not uncommon to have a history of severe lameness in which the caretaker accuses the mare of having stepped on the foal. In foals with septic phytaxis, however, the lameness is rarely as severe as in septic arthritis, except in the later stages. As a general rule, young foals (2–3 weeks of age) with septic arthritis are much more likely to experience septic polyarthritis, in which multiple joints are involved. This may cause confusion regarding the clinical signs related to lameness, because each limb can cause varying degrees of lameness and a general reluctance to move. Foals 4 weeks or older usually only have single joint involvement, with severe lameness in that limb.

Effusion, with or without periarticular swelling, is another common clinical sign. In some joints, such as the fetlock, carpus, hock, and femoropatellar joints, this is easily recognized. However, in other joints, such as the coffin, pastern, elbow, shoulder, medial and lateral femorotibial, and tarsometatarsal joints, this is much more difficult to palpate. It is almost impossible to appreciate effusion in the coxofemoral and distal intertarsal joints. It is important to compare left and right in determining if pain is present on palpation of these joints. If localized periarticular edema is present, the likelihood of physeal involvement is increased. Cases in which effusion and edema are present but not painful to digital pressure are rarely septic in origin.

Other clinical signs that are common, but not always present, include fever and depression. In normothermic foals, serial monitoring of the temperature is important, because it is not uncommon to have cyclic febrile episodes that may go unnoticed if the temperature is taken only daily. The temperature should also be taken when the foal is depressed, as lethargy and fever are often paralleled.

B. Hemogram

A hemogram should be performed in foals with acute lameness. The most common finding is an increase in the total white blood cell count, with a neutrophilia with a left shift. In addition, foals may have an increase in fibrinogen levels. In foals with increased fibrinogen levels, an examination should be performed to locate chronic disease processes such as pneumonia, septic umbilicus, and osteomyelitis. In the absence of changes in the hemogram, the possibility of infection still exists, and in some instances represents an earlier recognition of the problem.

C. Radiographs

Any foal suspected of having septic arthritis should have quality radiographs taken of the most likely locations to determine if bone involvement is present. Radiographs should be sufficiently exposed and have adequate views to determine if lucent areas are present in the physeal or epiphyseal regions. When the epiphysis is involved, the lucency is usually noted at the subchondral bone. In addition, radiographs should be examined for any periosteal roughening along the margins of the bone. Radiographs also serve as an important indicator for effectiveness of treatment. If a bone lesion is present initially, the radiographs should be repeated every 4 days. It is not unusual to see additional lysis in the second set of radiographs as the bone absorption is delayed behind the degree of infection; however, seeing changes on the third set (day 8) of radiographs is discouraging, because it indicates the treatment may not be as effective as desired. In addition, the type and duration of the antibiotic therapy is likewise influenced by radiographic changes. In instances of osteomyelitis, antibiotic therapy is prolonged when compared with that for septic arthritis without bone involvement.

D. Synovial Fluid Analysis

A synovial fluid analysis is the most important diagnostic test to determine if a septic joint is present. The foal is usually tranquilized or anesthetized, and the arthrocentesis site is prepared for the collection of a sterile sample. An 18-gauge needle is used and a large volume of fluid is collected, if possible. If there is difficulty in obtaining a sample, a larger gauge needle is used, as this is frequently caused by fibrin’s plugging the needle lumen. In order to increase the likelihood of a positive culture, the arthrocentesis should be performed prior to the initiation of antibiotic therapy. The sample should be placed in a sterile tube with no additives (red top) for culture and an ethylenediamine tetra-acetic acid (EDTA) tube (purple top) for cytology, total white cell count, and gram stain. Typical cytology consistent with septic arthritis includes an increased white cell count, usually above 20,000 cells/µl to as much as 300,000 cells/µl, with the majority being mature neutrophils, which may be degenerative. Total protein is usually increased in septic joints, ranging 3.5–7 mg/dl. One should be cautioned, however, in measuring total protein from the EDTA tube. If a very small volume of synovial fluid is added to the EDTA tube, this may falsely increase the total
protein, as EDTA has a total protein of approximately 7 mg/dl.

E. Microbiology

The volume collected for culture should ideally measure at least 5 ml. Obtaining a positive culture from joint fluid can be very difficult. Joint fluid itself has some antibacterial properties that can inhibit bacterial growth. There are three methods of culturing joint fluid. The first method is taking a sample of joint fluid and streaking it across a blood agar medium. The second method is incubating 5 ml of joint fluid in a blood culture vial. Twenty-four or 48 h later, the broth is placed on an agar medium. The third method, which I believe to be the best method of obtaining a positive culture, is centrifuging the sample of joint fluid, removing the supernatant, and culturing the pellet at the bottom of the tube; however, this must be done before the synovial fluid clots. This concentrates the white cell and bacterial component of the joint fluid. In the event a negative culture is obtained, additional joint fluid samples should be submitted prior to subsequent lavages. Bacterial cultures are desired in septic joints because many of the enteric bacteria are developing a resistance to the more routinely used antibiotics. By obtaining a positive culture with a sensitivity, one can more accurately tailor the antibiotic therapy.

F. Additional Diagnostic Tests

Other diagnostic tests that may be useful include ultrasound and nuclear scintigraphy. The use of ultrasound is often performed in cases in which periarticular swelling is present, because the amount of joint effusion is difficult to ascertain. In these instances, an estimate of the amount of fluid within the joint can be made. Ultrasound is also helpful in determining if a periarticular abscess is present, for instance, exudate from a physeal infection. Ultrasound may also be able to determine if an excess amount of fibrin is located within the joint, as well as whether small gas bubbles are present, potentially indicating an anaerobic infection. Nuclear scintigraphy is rarely used. However, in challenging cases, usually related to the pelvic region, a nuclear study can be helpful. The technique involves the labeling of white blood cells by using hexamethylpropylene amine oxime (HM-PAO) with technetium. This particular labeling device allows the technetium to be bound to the white blood cell nuclei that are harvested from the foal. These labeled white cells are then re-injected into the foal and allowed 1–2 h to migrate to the area of inflammation. The desired location is then viewed by using a gamma camera. The routine method of performing a nuclear study is with the technetium labeled dicalcium phosphate. Because the phys is much more active in immature animals, the results are difficult to interpret; therefore, labeled white cell studies are simpler to interpret. The use of technetium labeled with white blood cells allows one to determine the location of white cell migration and therefore areas of inflammation. Care should be taken to avoid overinterpreting other signs when studies labeled with white blood cells are used. Determining other sites of infection, such as the umbilicus, spleen, or lungs, is very difficult and often inaccurate. This method, however, is very useful in determining sites of infection in the appendicular skeleton. The largest drawback to the use of labeled white blood cells in nuclear studies is the expense.

3. Treatment

The two most important treatment modalities with infectious arthritis are joint lavage and systemic antibiotics. Joint lavage is usually performed on anesthetized foals to minimize additional trauma and potential contamination. The type of solution used varies; however, an isotonic fluid is typically used. More important than the type of solution is the effectiveness of the lavage and drainage of the joint. On smaller joints, such as the coffin, pastern, and fetlock joints, a volume of 1–2 L is usually sufficient. This fluid is usually applied under pressure with the use of a fluid pump or pressure bag. In addition to lavaging the joints under pressure, the flow of the fluid can be switched, because the lavage may develop a flow pattern through the joint that leaves some areas of the joint underlavaged. By placing several needles in the joint and switching which needle is the ingress and which is the egress, one ensures a better and more complete lavage. In instances in which there is excessive fibrin within the joint, either an open arthrotomy or arthroscopy is recommended. Both procedures allow debridement and decrease the amount of debris within the joint. The arthrotomy is simpler than the arthroscopy in acute early lavage situations, as the majority of fibrin can be removed from the synovial lining with the use of sterile hemostats. Arthroscopy sites are typically left open and the limb is bandaged postoperatively. After the joint has been lavaged, intra-articular antibiotics can be infused into the joint. Amikacin, gentamicin, ceftiofur, and sodium penicillin can be used. The choice of antibiotic is ideally determined after a positive culture has been obtained. In addition, using an antibiotic that is not currently being administered systemically to extend the spectrum is preferable. Many septic joints may require multiple lavages to effectively decrease leukocyte numbers. I will usually repeat lavages until the total leukocyte count is <20,000 cells/µl.

The antibiotic selection is based on culture results. However, in early treatment, or in the absence of bacterial growth, a broad-spectrum antibiotic combination is used. This usually involves penicillin or ampicillin and one of the aminoglycosides, i.e., either gentamicin or amikacin. Table 1 is a list of the drugs and dosages that are used. In instances in
<table>
<thead>
<tr>
<th>Drug</th>
<th>Manufacturer</th>
<th>Dose</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amikacin/Amiglyde 250 mg/ml</td>
<td>Phoenix Pharmaceuticals, St. Joseph, MO 64506; Fort Dodge Animal Health, Ft. Dodge, IA 50501-0518</td>
<td>15 mg/kg IV q 24 h</td>
<td>Gram-negative spectrum; aminoglycoside</td>
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<tr>
<td>Ampicillin</td>
<td>Marsam Pharmaceuticals, Cherry Hill, NJ 80834</td>
<td>20 mg (10–50)/kg IV q 6 h</td>
<td>Gram positive</td>
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<tr>
<td>Cefazolin/Ketazoline 1 g (vial)</td>
<td>Marsam Pharmaceuticals</td>
<td>10–20 mg/kg IV q 12–24 h</td>
<td>2nd generation cephalosporin</td>
</tr>
<tr>
<td>Cefoxitin/Mefoxin 95 mg (IM)</td>
<td>Merial, 4545 Oleatha Ave., St. Louis, MO 63116</td>
<td>20 mg/kg IV q 6 h</td>
<td>2nd generation cephalosporin (administered in IV fluids)</td>
</tr>
<tr>
<td>Ceftazidime/Orfaz 170 mg/ml</td>
<td>Glaxo Wellcome, Inc., Research Triangle Park, NC 27709; Made in England</td>
<td>30–50 mg/kg IV q 6–12 h</td>
<td>3rd generation cephalosporin (administered in IV fluids)</td>
</tr>
<tr>
<td>Ceftiofur/Naxcel 50 mg/ml</td>
<td>Pharmacia &amp; Upjohn, Kansas City, MO 64131-1273</td>
<td>2–5 mg/kg IV q 6–21 h</td>
<td>3rd generation cephalosporin</td>
</tr>
<tr>
<td>Cefurazine/Zinacef 90 mg/ml</td>
<td>Glaxo Wellcome, Inc.</td>
<td>15–30 mg/kg IV q 8 h</td>
<td>2nd generation cephalosporin</td>
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<tr>
<td>Chloramphenicol 100 mg/ml</td>
<td>Fujisawa, USA, Inc., Deerfield, IL 60015-2548</td>
<td>25 mg/kg IV q 6 h</td>
<td>Human health considerations; expense</td>
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<tr>
<td>Chloramphenicol 500 mg</td>
<td>Mortar and Pestle Pharmacy, 3701 Beaver Ave., Des Moines, IA 50310</td>
<td>50 mg/kg (80 cc = 25 g) PO q 6 h</td>
<td>Human health considerations; expense</td>
</tr>
<tr>
<td>Enrofloxacin/Baytril 68 mg (tab)</td>
<td>Bayer Corp., Agriculture Division, Animal Health, Shawnee Mission, KS 66201</td>
<td>2.5 mg/kg PO q 12 h</td>
<td>May influence cartilage development</td>
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<tr>
<td>Erythromycin 200 mg (vials)</td>
<td>Abbott Laboratories, North Chicago, IL 60064</td>
<td>10–30 mg/kg PO q 6 h, q 2 h</td>
<td>May cause hyperthermia &amp; diarrhea</td>
</tr>
<tr>
<td>Ciprofloxacin 200 mg (vials)</td>
<td>Bayer Corp.</td>
<td>5.3 mg/kg IV q 12 h</td>
<td>Administered in fluids</td>
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<tr>
<td>Gentamicin 100 mg/ml</td>
<td>Schering Plough Animal Health Corp., Kenilworth, NJ 07033</td>
<td>6–7 mg/kg IV q 24 h</td>
<td>Aminoglycoside; gram-negative spectrum</td>
</tr>
<tr>
<td>Metronidazole 500 mg (tab)</td>
<td>Sidmark Laboratories, Inc., East Hanover, NJ 07936</td>
<td>15–20 mg/kg PO q 6 h, q 8 h</td>
<td>Anaerobes</td>
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<tr>
<td>Oxytetracycline 200 mg/ml</td>
<td>Pfizer Animal Health, Westchester, PA 19380</td>
<td>8–10 mg/kg IV q 12 h, q 12 h</td>
<td>May cause diarrhea</td>
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<tr>
<td>Penicillin G Procaine 300,000 IU/ml</td>
<td>Butler Company, Columbus OH 43228; Phoenix Pharmaceuticals, Inc.</td>
<td>20,000–40,000 IU/kg IM q 12 h</td>
<td></td>
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<tr>
<td>Potassium Penicillin G 500,000 IU/ml</td>
<td>Marsam Pharmaceuticals</td>
<td>20,000–40,000 IU/kg IV q 6 h</td>
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<td>Rifampin 300 mg (tab)</td>
<td>Ciba-Geigy Limited, Basle, Switzerland, Dist. By Ciba Pharmaceutical, Co. Div. of Ciba Corp., Summit, NJ 07901</td>
<td>5 mg/kg PO q 12 h</td>
<td></td>
</tr>
<tr>
<td>Tetracycline diropanate Potassium/Timentin 3.1 g (vials)</td>
<td>SmithKline Beecham/Pfizer</td>
<td>50 mg/kg IV q 6 h</td>
<td></td>
</tr>
<tr>
<td>Trimethoprim–Sulfamethazine 160 mg (tab)</td>
<td>Manufactured for Goldline Laboratories, Sub. of Zenith, Ft. Lauderdale, FL 33309, By Sidmark Lab.</td>
<td>5 mg/kg PO q 12 h, q 8 h (trimethoprim portion)</td>
<td></td>
</tr>
<tr>
<td>Vancomycin 3 g (vials)</td>
<td>Abbott Laboratories</td>
<td>6 mg/kg IV q 8 h</td>
<td>Good for resistant staph.</td>
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which bone involvement is present radiographically, my first choice of antibiotics is chloramphenicol or enrofloxacin. There are several reasons for the selection of these antibiotics. The first is that, in my experience, lesions involving the bone may be any bacteria, but Salmonella infections are common. Chloramphenicol works intracellularly, obtains a very high bone level, and is usually effective against Salmonella spp. For this reason, chloramphenicol is often an excellent choice when bone lesions are present. It must be pointed out, however, that chloramphenicol poses potential health hazards to the person administering the antibiotic. This risk of exposure can be reduced by using the paste form of the antibiotic while wearing latex gloves. Enrofloxacin is also a useful drug in obtaining high bone levels. There are prior reports in immature dogs that enrofloxacin can cause cartilage aberrations. To my knowledge, there are no such reports at the recommended dosage used in foals. Because both chloramphenicol and enrofloxacin can be administered orally, the antibiotic therapy can be easily extended over a 4- to 6-week duration when osteomyelitis is present. In cases in which Staphylococcus aureus is isolated, which is rare in arthritis of hemotogenous origin in foals, vancomycin is an excellent drug choice, as resistance to this drug is extremely rare.

The use of nonsteroidal anti-inflammatory drugs in foals is debatable and should be cautioned for two reasons. The first is the possible potentiation of gastric ulcers. This obviously can be somewhat neutralized by the administration of antiulcer medications. The second reason for caution is that, in foals, the administration of nonsteroidal anti-inflammatories often makes profound improvement in regard to the degree of lameness. This improvement can lead one to develop a false sense of effectiveness of the treatment. In addition, it also limits the ability to evaluate ongoing febrile episodes that may be present.

In joints where bandaging is applicable, such as the coffin, pastern, fetlock, carpus and hock, a bandage is used, especially if periarticular edema is present. In cases involving the upper limbs (i.e., the elbow, shoulder, stifle, and hip), bandaging is impossible, but stents can be sutured over arthroscopy sites.

In cases in which infection involves the distal limb, the carpus, or the hock and below, regional perfusion is also often used. Regional perfusion is accomplished by placing a tourniquet at the level of the midcannon bone, allowing the digital artery and digital vein to become engorged. A 22-gauge needle is inserted into either the digital artery or the digital vein and an extension set is attached to the needle. One must take great care not to go through the vessel, and therefore the needle is rarely seated all the way to the hub. Once the extension set has been attached, an attempt is made at aspiration. If blood can easily be aspirated, a volume of fluid containing antibiotics is instilled into this closed vascular system. I have used four drugs for regional perfusion, these being amikacin, gentamicin, ceftiofur, and sodium penicillin. Typically, I will administer a complete systemic dose of antibiotics in this method, adding 2–3 mL of 2% lidocaine and q s to a volume of 30 mL with lactated Ringer’s solution. Once the full volume of fluid is instilled into the closed vascular system, a total of 5–10 min is allowed before the tourniquet is released. The theory behind the use of regional perfusion is to increase the tissue level of antibiotic versus systemic administration. When the fluid is administered in a closed vascular system, closed capillary beds near the vicinity of the infection may also be opened under pressure. To increase the success of digital perfusion, the intended vessel has to be cannulated immediately after the tourniquet is applied. If too much time is allowed from the time of the placement of the tourniquet to cannulation, the vessel will collapse, making it much more difficult to cannulate. It is helpful to shave a very small spot over the top of the vessel to allow for better visualization of the vessel. This technique can also be used for infections of the tarsus and of the carpus, utilizing the saphenous and cephalic veins, respectively. In these instances, a tourniquet is applied above and below the joint to better isolate the vascular system in that region. This technique has also been especially useful in foals with septic arthritis of the distal tarsal joints, in part because of the difficulty in establishing adequate lavage of these joints.

If bone lesions are radiographically apparent, and periarticular edema is present, an ultrasound is generally performed. In the instance that fluid can be found subcutaneously in the area of periarticular swelling, a small incision is made to permit good drainage. If necessary, a Penrose drain can be inserted to maintain adequate drainage. Curettage of the area is minimal to avoid additional damage to healthy cartilagenous cells of the physe. In instances in which bone involvement is present in the epiphysis, curettage is generally not performed. In protracted cases, arthroscopy may be helpful in determining the extent of cartilage damage in the area directly related to the lysis. If cartilage damage is present in these locations, curettage may be helpful. In these instances, however, the prognosis is considered worse, because of the structural change that has occurred to the weight-bearing portion of the joint. In foals with positive R. equi infections, rifampin and erythromycin, ground as a paste, can be placed into the lytic area as a means of local therapy.

4. Specific Joints

A. Coffin and Pastern Joints

The coffin joint is typically lavaged with the foal in lateral recumbency by placing a needle in either the medial or the lateral aspect of the long, or common
digital extensor tendon. A second needle is then placed directly above the immature cartilaginous wing of the third phalanx on the palmar–plantar aspect of the second phalanx. This needle is directed at a 45° angle, aiming for the far solar margin of the hoof. In infections, the use of the palmar approach is quite simple because of the extent of joint distention. In addition, a digital perfusion is used in foals with septic coffin joints to increase the level of interstitial antibiotic.

The pastern joint is handled in a very similar fashion to the coffin joint, with the needle placed in both the dorsal and the palmar–plantar aspect of the joint. This joint is more difficult to lavage than the coffin joint because of its very restricted joint capsule. Likewise, in this joint, digital perfusion is often performed.

B. Fetlock Joint

The fetlock joint is a fairly common joint to become infected. Radiographic lesions involving the bones of the fetlock joint usually occur in either the medial or the lateral condyle of the third metacarpal–metatarsal bone and are best seen on an anterior to posterior view. The proximal sesamoid bones may also have an area of isolated infection. The areas of lysis within the sesamoids can vary but are usually located on the apical or axial region of the sesamoid bone. Lavage of this joint is relatively easy, with needle placement in both the dorsal and palmar–plantar aspect of the joint. It is especially important in this joint to reverse the flow of fluids, as the palmar–plantar pouch can become very distended and adequate lavage can be difficult. If an arthrotomy is performed, it can be performed in either the palmar–plantar pouch or in the dorsal aspect, or potentially in both locations if fibrin deposits are extensive. When fetlock involvement, like that of the coffin and pastern joints, occurs, regional perfusion is often performed.

C. Carpus

The radiocarpal and the middle carpal joints do not communicate, so infection can involve one or both. When the carpus is involved, a joint fluid sample should be obtained from both the radiocarpal and the middle carpal joints to make sure that both are not involved concurrently. Radiographic lesions are usually located in the distal radius or in the cuboidal bones. Needle placement is performed on either the medial or the lateral aspect of the extensor carpi radialis tendon and on the palmar aspect for the middle carpal joint in the area of the distal one third of the accessory carpal bone. This area is usually easily palpated, once the joint is maximally distended. The palmar approach for the radiocarpal joint is at the level of the proximal one third of the accessory carpal bone. This area, likewise, can easily be palpated once the joint has been maximally distended. Arthrocentesis is usually performed at the site of the needle placement in the dorsal aspect of the joint. The carpus can be a challenging area to resolve infection because of the number of articulations, crevices, and palmar carpal ligaments. Regional perfusion is sometimes performed in this joint but is likely reserved for cases with protracted infection and ideally situations in which a positive culture has been obtained.

D. Elbow Joint

Effusion can usually be palpated along the lateral aspect of the limb at the area of the collateral ligament. Radiographs of the area should include a lateral view as well as a cranial to caudal view. The most common locations for lesions are within the physis as well as the caudal aspect of the condyles. The needle placement can be cranial or caudal to the lateral collateral ligament. Once the joint is distended, a needle can also be inserted into the more proximal aspect of the joint on the caudal aspect of the joint. This is done in the area between the distal humerus and the olecranon, as this is a very large pouch.

E. Shoulder and Bicipital Bursa

Radiographs of the shoulder should include a lateral view. This can be done with a portable unit by laying the foal down on the affected side and placing the plate next to the shoulder. When the limb is positioned in extension and pulled down, the radiographic beam hits the involved limb from the medial side. The most common lesions are located in the physis of the scapula or humerus. The most important location to examine is the caudal aspect of the proximal humeral physis. For arthrocentesis to be performed, a needle is placed in the notch formed between the cranial and caudal prominences of the lateral tuberosity of the humerus. The egress needle is positioned approximately 3 cm caudal and 1 cm distal to the ingress needle. Normal joint fluid is very viscous, much like that of the coxofemoral joint. For the bicipital bursa to be tapped, a needle is placed directly under the bicipital tendon and is directed toward the bicipital groove.

F. Tibiotarsal Joint

The tibiotarsal joint is likely the easiest joint in which to obtain effective lavage. Needle placement is on the dorsal medial or dorsal lateral aspect of the tibiotarsal joint and on the plantar medial or plantar lateral aspect of the joint in the plantar pouches. Radiographic lesions, if present, are usually located on the medial or lateral malleolus. In addition, care should be taken to evaluate the physis of the calcaneus, as septic physitis is often present in this location. In the tibiotarsal joint, a volume of 2–3 L of fluid is usually sufficient. The flow of the fluid, however, should be changed during the flush to allow for the directional change of the flow pattern within the joint. In protracted cases, regional perfusion is occasionally used with the tibiotarsal joint. Likewise, an arthrotomy can be performed, as well as
arthroscopy, to determine the extent of damage and to remove fibrin debris from the joint. This is easily accomplished when a 1-cm-long incision is placed at any of the four locations described for needle placement.

G. Tarsometatarsal–Distal Intertarsal Joints
The tarsometatarsal and distal intertarsal joints probably represent the most difficult infections to resolve. Joint samples can be obtained from the tarsometatarsal joint over the proximal extent of the lateral splint by inserting the needle into the plantar pouch. It is very unusual to obtain more than a drop or two of fluid from this joint, which makes obtaining a positive culture very difficult. Therefore, a cytology should be performed to determine if the joint is infected, leaving a very small amount for culture. Lavage of this region is also challenging, in that needle placement is very difficult. The first needle is placed in the plantar pouch previously described. Once the joint has been distended, an attempt for needle placement is made on the medial aspect of the hock, directly above the cannon bone. Likewise, a needle should be placed into the distal intertarsal joint directly proximal to the needle in the tarsometatarsal joint between the central and third tarsal bones.

H. Femoropatellar Joint
When interpreting radiographs of the femoropatellar joint, one should note that the medial trochlear ridge appears rough until the foal is approximately 6 months of age. This roughening should not be overinterpreted as an infectious process. The most important location to evaluate in the femoropatellar joint is along the cranial aspect of the distal femoral physis, just caudal to the trochlear ridges. In this location a lucency can usually be seen either entering the metaphyseal or the epiphyseal bone plate. In addition, lesions in the patella can likewise occur. Patellar lesions are usually circular or cystlike and fairly close to the joint margin. The femoropatellar joint is typically lavaged with the foal in dorsal recumbency, with the limb placed in slight flexion. The needle is inserted between the middle and the medial patellar ligaments for joint fluid collection. Additional needles are ideally placed caudal to the vastus medialis and vastus lateralis directly proximal to the patella. This area is most easily identified prior to distention of the joint by palpating the cranial border of the femur on either the medial or the lateral aspect of the limb. A finger is placed in this location in which the joint is maximally distended. A 16-gauge needle or catheter can be placed in this location. In this fashion, the superpatellar joint pouch can be more effectively lavaged. An arthrotomy is usually performed either between the medial and middle patellar ligaments or between the middle and lateral patellar ligaments, using a sterile hemostat to remove fibrin.

I. Medial Femorotibial Joint
Radiographs of this joint should include a lateral view, a caudal–lateral cranial medial oblique view, and a posterior to anterior view of the stifle. Lesions are uncommon within the bone involving the medial femorotibial joint; however, close attention should be paid to the caudal aspect of the medial femoral condyle. In some instances, a cartilaginous flap can be seen if the film is not overexposed. For arthrocentesis of this joint, a needle is placed just medial to the medial patellar ligament, directly above the tibial plateau. With septic arthritis in this location, a fluctuant bubble can often be palpated in this location. For lavage of this joint, the needle is placed in the above-described position as well as in the caudal aspect of the joint. With the leg in a slight flexion, the tibial plateau can be palpated, as well as the caudal margin to the femoral condyle. In this small crease, a needle can be inserted approximately 0.5 in. (1.27 cm) deep and fluid can be easily obtained.

J. Lateral Femorotibial Joint
Palpation of effusion in the lateral femorotibial joint can be difficult. Palpation should include the cranial lateral margin of the proximal tibia and stifle. Arthrocentesis for the joint sample is obtained by placing a needle just caudal to the lateral patellar ligament at the level of the tibial plateau. For joint lavage, the horse is placed in dorsal recumbency with the stifle in flexion. A needle is placed in the above-mentioned location and the joint is distended. Prior to distention, the caudal margin of the joint can be palpated, extending along the tibial plateau and palpating the small crease between the tibial plateau and the caudal aspect of the lateral condyle. Once the joint is distended, a needle is placed in this location. In addition, the lateral femorotibial joint has a communication under the long digital extensor tendon. This communication occurs through a small groove in the proximal cranial tibia called the sulcus muscularis. This pocket can be quite large and can be palpated when the joint is fully distended. This joint extension is usually palpated on the cranial lateral aspect of the long digital extensor tendon. A needle can be placed in this location for lavage. In addition, if an arthrotomy is to be performed, this is an ideal location. A small, 1-cm incision can be made on the cranial aspect of the long digital extensor and, by blunt dissection with a Kelly forceps, into the distended outpouching of the joint. This arthrotomy site is not closed but is left open because the limb is placed in flexion prior to making the arthrotomy. It is important not to make the arthrotomy on the caudal aspect of the long digital extensor tendon, as the peroneal nerve can be damaged.

K. Coxofemoral Joint
Radiographs of the coxofemoral joint should be taken at the same time as arthrocentesis. The foal is
placed in dorsal recumbency, and dorsal to ventral radiographic views should be taken. Careful attention should be paid to the caudal aspect of the proximal femoral physis. Additional areas of bone involvement can include the acetabulum, the physis of the greater trochanter, and the pubic symphysis. For arthrocentesis, the foal is placed in lateral recumbency with the affected limb up. The area immediately cranial to the greater trochanter is palpated, with the limb placed in mild adduction and in front of the lower limb, and the coxofemoral joint is opened. A 3.5 in. (~9 cm), 18-gauge needle is used and directed in a path to aim for the opposite elbow. Often, one must walk the needle off this intertrochanteric fossa into the joint. When entering the capsule, a firm pop may be palpated as the needle passes through the joint capsule. Fluid is collected in a syringe with positive pressure being applied. The joint fluid in normal hips is fairly low volume but very viscous. For lavage, a sterile extension set is attached to the above-mentioned needle and the joint is distended. The egress needle is then positioned approximately 4 cm cranial to the initial needle and is directed so as to intersect the tip of the ingress needle. Effective joint lavage of the coxofemoral joint can be extremely challenging and difficult. In cases that have had two prior lavage attempts but in which the joint fluid white cell count remains elevated, arthroscopy is recommended.

The arthroscopy portals are identical to the needle placement, however, and a long egress cannula can be used to increase the effectiveness of the lavage.

References and Footnotes


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