Medical Procedures in Neonatal Foals

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Abstract

Performing medical procedures on the farm is often necessary to obtain a timely diagnosis and outline an appropriate treatment plan. Preparation and familiarity with these procedures is critical to obtaining accurate information. Minimal special equipment is needed for the procedures described.

Ultrasound of the umbilicus

Infection of the umbilical remnant structures is common in foals less than 6 weeks of age.[1] The external portion of the umbilical remnants may be swollen or moist, or may appear normal, rendering gross appearance of the stump minimally useful in diagnosing "navel ill". Sonographic evaluation of the umbilicus is recommended for all foals with palpable umbilical stump abnormalities, bacteremia, septic arthritis, septic physitis, pneumonia, fever of unknown origin and elevations in white blood cell count, serum amyloid A and/or fibrinogen of undetermined origin. Because the umbilical structures lie close to the body

wall in the caudoventral abdomen, ultrasonography is easily performed in young foals. After 8 weeks of age, the structures regress toward the pelvic brim and become difficult to visualize.[2]

The internal umbilicus is comprised of four umbilical remnants: the umbilical vein, paired umbilical arteries, and the urachus. The umbilical vein provides afferent blood from the placenta to the fetus, and courses cranially from the external stump to the liver. The umbilical vein atrophies over time and becomes the falciform ligament of the liver. The umbilical arteries provide efferent blood flow from the fetus to the placenta and course caudally from the stump to the bladder. The arteries course along the sides of the bladder, eventually becoming the round ligaments of the bladder. The apex of the bladder is connected to the allantoic cavity by the urachus in fetal life.[3]

Foals can be positioned in lateral recumbency or restrained standing for ultrasound of the umbilicus. Sedation may be required for some foals, typically midazolam (0.05-0.1mg/kg IV) or butorphanol (0.05 mg/kg IV). Clipping the hair on the ventral midline from the xiphoid to the inguinal region allows for good contact between the probe and the skin. This step is not necessary for all foals. Ultrasound coupling gel is applied to the probe and/or the region of interest. A 5.0 MHz or greater linear array transducer is best for scanning the umbilicus. The depth is set at 5-6cm, given the superficial location of the umbilical structures. Power and gain are adjusted as needed to provide a clear image in the near field.

Holding the transducer perpendicular to the spine immediately cranial to the umbilical stump, the umbilical vein is visible 1-2 cm deep to the skin surface. This image is a cross sectional view of the umbilical vein. It appears as a thin walled ovoid structure. Following the vein cranially to the liver in this plane, measurements are normally 0.5-1.0cm diameter.

Larger foals will have larger internal structures (1.0-1.3cm diameter) and smaller foals may have smaller measurements (0.3-0.5cm diameter). The umbilical vein is typically largest just cranial to the umbilical stump and near the liver. The umbilical arteries are imaged caudal to the external stump, also 1-2cm deep to the skin surface. The right and left umbilical arteries appear as thick-walled vessels and may be asymmetrical in size in normal foals. Normal diameter of the umbilical arteries in a neonate is less than 1.3cm. The arteries may pulsate in the first day post partum and they may have an echogenic center if filled with clotted blood. Just cranial to the apex of the bladder, the arteries are imaged together with the urachus. Collectively, these three structures at this location should measure 2.5cm in diameter or less. The arteries diverge along the lateral aspects of the bladder and are measured separately at this level, disappearing at the caudal aspect of the bladder. The urachus extends from the umbilical stump to the apex of the bladder but is often collapsed and difficult to image.[1] When filled with fluid, it is easily recognized as abnormal. A valuable view of the urachus is made in long section at its attachment to the bladder at the apex. In the case of a patent urachus, communication between the bladder and the urachus is imaged.

The external umbilical stump is imaged by holding the tip and scanning along its length in both short and long axis planes. Small fluid pockets which may be unrecognizable grossly are discerned sonographically. Hyperechoic flecks within the tissue or within a fluid pocket indicate gas bubbles, consistent with anaerobic infection. Size standards have not been established for the umbilical stump as there is considerable variation in size among various breeds. However, scanning the stump is a valuable portion of the umbilical ultrasound and should not be overlooked.

Infection of the internal umbilical remnants results in sonographic changes that have been well correlated with surgical findings.[4] Enlargement of the structures occurs with infection, but because size variation exists among foals, more specific sonographic abnormalities must be used in many cases to discern infection. Intraluminal distension with hypo- or hyperechoic fluid may be seen. The presence of small gas echoes suggests anaerobic infection. Blood clots from traumatic foaling or inappropriate tearing of the umbilical cord may be indistinguishable from infection. For this reason, ultrasound findings should be correlated with history, clinical signs, and laboratory data.

Retention enema for meconium impaction

Meconium impaction is reported to be the most common cause of colic in neonatal foals, occurring more frequently in colts than fillies. This predisposition is presumed to be due to a narrower pelvic inlet in colts.[5] Meconium is composed of materials ingested in utero: intestinal epithelial cells, mucus, amniotic fluid, bile, and water. Evacuation of meconium begins within three hours of birth in the normal foal and is followed by passage of yellow pasty, digested milk feces. Meconium impaction or retention occurs when attempts to defecate are unsuccessful or incomplete evacuation of meconium occurs.

Additional factors suggested to predispose foals to retention of meconium include maternal malnutrition, delayed colostral intake with loss of its laxative effect, prematurity, dystocia, and dehydration.[6] Most impactions occur in the rectum and/or small colon at the pelvic inlet but can extend to the dorsal or transverse colon. Discomfort is initially exhibited by decreased nursing, tail flagging/swishing, and restlessness. As

discomfort advances, abdominal distension, frequent posturing to defecate, rolling, and lying in dorsal recumbancy are seen. Diagnosis is based on clinical signs and detection of firm stool in the rectum on digital palpation, abdominal distension with lack of fecal production and radiography of fecal masses in the abdomen.

Simple meconium impactions resolve with one or more enemas, such as commercial phosphate enemas, soapy warm water enemas, glycerin, or mineral oil enemas. Because phosphate containing enemas can result in hyperphosphatemia, these should be used judiciously. Repeated enemas of any type often result in rectal mucosal irritation and swelling. Additional therapy recommended for impactions that do not resolve with simple enema administration include pain control, IV fluids, and mineral oil by nasogastric tube. Those impactions which are not resolved medically require surgical intervention. With the risk of post-surgical complications in neonatal foals-namely adhesions- medical management is generally preferred. Acetylcysteine enemas were first described in human medicine for treatment of meconium plug syndrome.[7] The procedure has since been described for use in foals.[8] When first line therapies do not resolve meconium impaction acetylcysteine retention enema may be administered.

For this procedure, foals are sedated and placed in lateral recumbancy. Midazolam (0.05-0.1 mg/kg IV) is often adequate, but occasionally the addition of butorphanol (0.02-0.05 mg/kg IV) and/or xylazine (0.3-0.5 mg/kg IV) are warranted. A well-lubricated 30cm Foley catheter with a 30cc balloon is inserted 2.5-5cm into the rectum. The balloon is slowly distended with saline until the rectum is occluded. Rapid filling of the balloon may result in rectal mucosal damage and trigger a pain response in the foal. A solution of 4% acetylcysteine is prepared using either 20% solution of acetylcysteine or 100g

powdered N-acetyl-cysteine. To achieve a 4% solution, 40mL of the 20% solution are mixed with 160mL of sterile water. Because acetylcysteine's activity increases with increases in pH, 20g of sodium bicarbonate (4 teaspoons baking soda) should be added to the 200mL solution to achieve an optimum pH of 7-9. A commercial kit (EZ Pass, ARS, Chino, CA) is also available for preparing acetylcysteine enemas. The final solution is administered via the Foley catheter by gravity flow. This is easily achieved by pouring the solution into the case of a 60mL catheter tip syringe which is attached to the Foley. Rapid injection can result in rectal tears and is not recommended. The Foley is then clamped with a hemostat and left in place for 30-45 minutes. During this time, IV fluids can be administered to maintain normal hydration and glucose. Additionally, a single dose of an analgesic (flunixin meglumine 1mg/kg IV or butorphanol 0.01 mg/kg IM) is administered to reduce pain associated straining once the foal is awake. After 30-45 minutes of retention, the cuff is deflated, and the Foley removed. This procedure may be repeated in 12-24 hours if needed.

Acetylcysteine achieves its effect by cleavage of disulfide bonds and decreasing the viscosity of meconium. Thirty minutes of contact are required for the mucolytic effect and it is the mucolytic effect that is increased with increased pH. The use of acetylcysteine retention enemas has been shown to improve the rate of successful medical therapy compared to traditional therapies alone.[9,10]

Septic arthritis and osteomyelitis: diagnosis

Foals can develop septic osteomyelitis or septic arthritis secondary to trauma or hematogenous spread of bacteria. The latter is more common, owing to the neonatal foals' inherent susceptibility to infection. In addition, foals that do not receive adequate

immunoglobulin levels from colostrum are at high risk of developing septicemia. Fifty to ninety percent of foals with septic joints were found to have partial (400-800 mg/dL) or complete (<400 mg/dL) failure of transfer of passive immunity in two retrospective studies.[11,12]

Omphalophlebitis or "navel ill", gastrointestinal disorders and lower respiratory disease are additional means of hematogenous dissemination of bacteria. Anatomical predispositions also exist in foals. Rapid growth of immature bones and joints requires increased blood flow through transphyseal blood vessels to the metaphysis, physis, and epiphysis. Low oxygen tension and pooling of physeal blood in synovial capillaries allows for bacterial colonization. This can impair blood flow and result in thrombosis and ischemic necrosis of the growth plate and/or joint. Normal production and drainage of joint fluid then becomes impaired, negatively affecting cartilage metabolism since cartilage derives nutrients from synovial fluid.

The development of septic arthritis or osteomyelitis may be chronic, reflecting a prior septic process, or it may be acute, which is often the case in septicemic foals. In foals that exhibit relatively normal behavior, recognition of septic arthritis or osteomyelitis is not difficult. An observant client may first notice joint swelling or pain on palpation of the affected bone or joint. Lameness takes approximately 8-24 hours to manifest following colonization of the joint with bacteria.[11] In the case of osteomyelitis, lameness is often mild to moderate in severity until the lesion becomes very aggressive. Because lameness caused by a septic joint has been identified as early as 12 hours following parturition, it should be considered in any lame foal less than 1 month of age.[12] Recognition of an infected joint or bone in a septicemic foal can be delayed as they are commonly weak or recumbent.

Increased temperature, serum amyloid A (SAA) and WBC count are inconsistent and tend to relate more closely to the systemic illness. An elevated fibrinogen should prompt the veterinarian to investigate a source of chronic infection. Thorough evaluation of the musculoskeletal system is an important part of the physical exam in a septic foal and should be conducted at least daily. In the recumbent foal, heat, periarticular edema, or pain with palpation or passive motion are early signs of a septic process. Neonates may have multiple joints affected while foals greater than 4 weeks of age more likely have 1 joint affected and will show severe lameness on that limb. All joints can be affected, but the larger joints, such as the stifle, hock, carpus, and fetlocks are most commonly involved.[14,15]

When a septic joint and/or osteomyelitis are suspected, radiographs should be obtained. The contralateral limb can be used for comparison if there is any doubt about normal appearance of a growth plate. Exposure of the radiographs should allow for identification of lucent areas within the physis or epiphysis and periosteal roughening. If bony lesions are not present in the initial radiographs, they should be repeated in 5-7 days, as the process of bone absorption follows infection. Serial radiographs help determine the efficacy of treatment or progression of disease. Because radiography is an insensitive tool for identifying early osteomyelitis, more advanced diagnostics, such as ultrasonography, nuclear scintigraphy, or MRI may be of benefit. Ultrasound of a septic joint can reveal intra-articular fibrin or gas bubbles, the latter indicating anaerobic infection. Periarticular exudate from a septic physis may form an abscess that can be aspirated with ultrasound guidance. Nuclear scintigraphy utilizing radiolabeled white blood cells is more informative than traditional scintigraphy due to the normal activity in the foal's physis. The availability

of scintigraphy and MRI remains limited to referral veterinary hospitals, so alternate methods of diagnosis must be pursued when a septic process is suspected.

Evaluation of synovial fluid helps to confirm a diagnosis of joint sepsis, and this sample should be collected aseptically. Most foals require heavy sedation or anesthesia to safely obtain this sample. Intravenous diazepam is adequate in some foals (weaker foals), while most require xylazine and ketamine for short procedures. The joint fluid should be evaluated cytologically and be cultured for bacteria. Use of blood culture bottles enhances the recovery of bacteria in these samples. When possible, the fluid should be obtained prior to the initiation of antibiotic therapy. Bacterial culture is important as the incidence of antibiotic resistance to commonly used drugs increases. Total protein will become elevated in response to inflammation but WBC count elevation lags behind by 12 to 24 hours following initiation of infection.[17] A total protein level greater than 4 mg/dl and a WBC count greater than 30,000 μL points heavily towards infection, while the same protein level and a WBC count in excess of 100,000 μL is pathognomonic for infection.[18] Synovial fluid lactate has been measured in human medicine for over 25 years and may support a diagnosis of sepsis in equine joints.[17,19] Serum amyloid A (SAA) is a rapid, patient side test that may aid a diagnosis of septic arthritis. This acute phase protein is produced primarily in the liver but also locally by the synovium in response to inflammation and infection. Increased SAA values in both blood and synovial fluid samples were found in horses with septic arthritis, but not in those with non-septic intrasynovial pathology.[18]

Joint lavage and appropriate systemic antibiotic therapy remain the two most important modalities of treatment in cases of septic arthritis and osteomyelitis. Intra-articular antimicrobial infusion, regional limb perfusion, intraosseous regional perfusion, surgical

debridement, and hyperbaric oxygen therapy are additional treatment modalities utilized in treating joint sepsis and osteomyelitis. Though previous reports have cited a guarded to grave prognosis for foals with septic arthritis/osteomyelitis, Neil et al recognized a more favorable prognosis and found that surviving (Thoroughbred) foals have a good chance of reaching the track and racing. [11,12,13] Early and aggressive treatment has been shown to be the most important factor in successful outcomes.[14,15] A 1999 study concluded that 71% of foals treated within 2 days of the onset of clinical signs survived while only 4% of foals survived when treatment began 2 or more days after clinical signs began.[14] Other factors affecting outcome include number of joints involved, additional systemic problems, and degree of bony involvement. Notwithstanding financial constraints of the owner, treatment of septic arthritis/osteomyelitis is worthwhile and very feasible with a dedicated owner and veterinary staff.

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