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How to Perform and Interpret Diagnostic Analgesia of the Equine Foot

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Introduction

In recent years, clinical observations, anatomical studies, and results of clinical trials have helped clarify interpretation of the results of regional, intra-articular, and intrabursal analgesia of the foot of horses. These studies also have highlighted the limitations of diagnostic analgesia of the horse’s foot. In this manuscript, we present a summary of current knowledge of the use of analgesia to localize sites of pain in the foot of lame horses.

Choice of Local Anesthetic Agent

Most equine clinicians prefer to use 2% mepivacaine HCL rather than lidocaine HCL for analgesia of the foot because mepivacaine is less irritating to tissue than is lidocaine. The anesthetic effect of mepivacaine, which lasts 90 to 120 minutes, makes this agent valuable for examining a horse thought to have multiple sites of pain in one or more limbs causing lameness. Lidocaine, which has an anesthetic effect of only about 30 minutes, might be the preferred local anesthetic agent when different techniques of diagnostic analgesia are likely to be used during the lameness examination of a horse thought to have only a single site of pain causing lameness. Because of its potential to incite significant inflammation, we prefer not to administer lidocaine in joints of the lower portion of the limb. When either local anesthetic agent is administered, either perineurally or into the small synovial structures of the lower portion of the limb, onset of analgesia usually occurs within 5 minutes.

We believe that after anesthesia of a synovial structure or the digital nerves of the foot, the horse’s gait should be evaluated relatively quickly (i.e., between five to 15 minutes) because of the ability of local anesthetic solution to rapidly diffuse and desensitize unintended structures. Substantial proximal diffusion of contrast medium after perineural injection of the digital nerves occurs within 10 minutes of injection. Local anesthetic solution is also likely to diffuse proximally after perineural injection, decreasing the specificity of the nerve block over time.

Volumes of Local Anesthetic Solution Administered for Analgesia of the Foot
To administer a palmar digital nerve block (PDNB), 1.5 mLs of mepivacaine deposited over each palmar digital nerve are sufficient to consistently anesthetize those nerves. Administering larger volumes of local anesthetic solution increases the likelihood of anesthetizing branches of the palmar digital nerve that supply the proximal interphalangeal (PIP) joint. To administer an abaxial sesamoid nerve block (ASNB), 2.5 mLs of mepivacaine deposited over each palmar digital nerve are sufficient to consistently anesthetize those nerves and the dorsal branches of the digital nerve that lie in close proximity. Administering larger volumes of local anesthetic solution increases the likelihood of anesthetizing branches of the palmar digital nerve that supply the metacarpophalangeal (MCP) joint. Five to 6 mL of mepivacaine are commonly administered into the distal interphalangeal (DIP) joint to anesthetize that joint and the navicular apparatus. The toe of the sole is also desensitized, and administering a larger volume of local anesthetic solution increases the likelihood of anesthetizing branches of the palmar digital nerve that supply the heel region of the sole.

Preparation for Injection of Local Anesthetic Agent

Merely cleaning the site of injection with 70% isopropyl alcohol usually is sufficient for perineural administration of local anesthetic solution. When the lower portion of the limb is particularly dirty, however, the injection site should be scrubbed with antiseptic soap. As long as local anesthetic solution is deposited subcutaneously, complications from poor aseptic technique are unlikely. The clinician should be aware, however, of the potential for disastrous results when a non-sterile technique is used, and a needle is misdirected into an adjacent synovial structure, such as the digital flexor tendon sheath (DFTS) or the PIP joint. The injection site of a synovial structure should be surgically scrubbed, but one study showed that clipping of hair over the injection site is not necessary for aseptic arthrocentesis, as long as the site is scrubbed for at least seven minutes. When administering a drug intra-synovially, we prefer to draw the drug from an unused bottle. We do not routinely administer an antibiotic intrasynovially along with local anesthetic solution. Amikacin is a good choice of antibiotic for clinicians that prefer to administer an antibiotic along with local anesthetic solution because 500 mg of amikacin administered into a normal joint provides a concentration above the reported MIC for most equine pathogenic bacteria for 72 hours with minimal inflammatory effects.

Anesthesia of the Palmar Digital Nerves

For many years, clinicians have believed that a positive response to anesthesia of the palmar digital nerves of lame horses localizes pain to the palmar third of the foot, including the palmar aspect of the DIP joint. Easter et al. found, however, that anesthesia of the palmar digital nerves just proximal to the bulbs of the heel alleviated lameness caused by endotoxin-induced pain in the DIP joint, indicating that the palmar digital nerves innervate the entire DIP joint. This report corroborated an anatomical study that demonstrated that the dorsal branches of the palmar digital nerves do not innervate the DIP joint. Exceptions to the finding of Easter et al. have been observed by one of us (Schramme) in horses with osteoarthritis of the DIP joint where the distal surface and subchondral bone of the middle phalanx are diseased.

Some clinicians describe the proper site for anesthesia of the palmar digital nerves to be anywhere from the proximal margin of the lateral cartilage to the mid pastern region, but others...
believe that it is important to anesthetize the nerves near the proximal margin of the lateral cartilage. One theoretical advantage of anesthetizing the palmar digital nerves as far distally as possible is that anesthesia of the dorsal branches of the palmar digital nerve is more likely to be avoided. According to results of the study by Sack and that of Easter et al., however, the dorsal branches are unlikely to contribute much more than sensory innervation to the dorsal aspect of the coronary band and dorsal laminae of the foot.

A more important reason for depositing local anesthetic solution as far distally in the pastern as possible when performing a PDNB is that more proximal deposition of local anesthetic solution increases the likelihood of causing analgesia of the PIP joint. When a 25-ga, 5/8-in (0.5- x 16-mm) needle is inserted over the palmar digital nerve one centimeter above the proximal edge of the cartilage of the foot and directed distally, the needle tip is placed at the level of the proximal edge of the lateral cartilage for deposition of local anesthetic solution. Insertion of a needle at this site causes local anesthetic solution to be deposited at or slightly below the level of the palmar border of the PIP joint, because the height of the lateral cartilage in relation to the level of the palmar border of the PIP joint is probably similar for most horses. As another precaution to avoid inadvertent analgesia of the PIP joint, we also recommend that no more than 1.5 mL of local anesthetic solution be deposited over each palmar digital nerve.

Semi-Ring Block

A semi-ring block, performed after a negative response to a palmar digital nerve block, is unlikely to result in a positive response because the dorsal branches of the palmar digital nerves contribute little to sensation within the foot. The palmar digital nerve block will already have anesthetized the entire foot, with exception of the dorsal portion of the coronary band and the dorsal laminae of the foot. The use of a pastern ring block performed at mid pastern, however, should be considered as an alternative to the ASNB, because the ASNB may inadvertently partially or entirely desensitize the fetlock joint in addition to the entire foot, which can lead to an erroneous conclusion about the location of the site of pain causing lameness.

Abaxial Sesamoid Nerve Block

Anesthesia of the palmar digital nerves and their dorsal branches, at the level of the proximal sesamoid bones (i.e., an ASNB), desensitizes the foot, the PIP joint, middle phalanx and associated soft tissues, the distal and palmar aspects of the proximal phalanx, and possibly, the palmar portion of the MCP joint.

Performing the nerve block at the base of the proximal sesamoid bones decreases the likelihood of partially desensitizing the MCP joint. Using a small volume of local anesthetic solution (i.e., ≤2.5 mL) and directing the needle distally, rather than proximally, may also decrease the likelihood of partially anesthetizing the MCP joint. Because local anesthetic solution is likely to diffuse proximally after perineural injection, we recommend that the horse’s gait be evaluated within 15 minutes of an ASNB.
Analgesia of the Distal Interphalangeal Joint

Several approaches to the DIP joint have been described and include a lateral approach (Fig. 1); a palmar approach; a dorsal perpendicular approach (i.e., perpendicular to the bearing surface) (Fig. 2); a dorsal parallel approach (Fig. 3a); and a dorsal inclined approach (Fig. 3b). Administering local anesthetic solution into the DIP joint is easily accomplished using a dorsal parallel or inclined approach (rather than the commonly used dorsal perpendicular approach). Mepivacaine administered into the DIP joint desensitizes the DIP joint, the navicular bursa, the navicular bone, the digital portion of the DDFT and the toe region of the sole. When a large volume of mepivacaine HCl (i.e., 10 mL) is administered, the heel region of the sole is also desensitized.

Possible explanations for anesthesia of the navicular apparatus (i.e. the navicular bone and its associated ligaments) after local anesthetic solution is administered into the DIP joint include the desensitization of subsynovial nerves that supply sensory fibers to the navicular bone and its collateral sesamoidean ligaments, or the desensitization of the palmar digital nerves where they lie in close proximity to the palmar pouch of the DIP joint. Additionally, Gough et al. found evidence for diffusion of local anesthetic solution from the DIP joint into the navicular bursa in cadaver limbs, and Keegan et al. demonstrated diffusion from the DIP joint into the navicular bone in vivo. In both diffusion studies, concentrations of mepivacaine found in the navicular bursa or navicular bone were high enough to cause desensitization.

A negative response to intra-articular analgesia of the DIP joint may not eliminate the navicular bone and its related structures as the source of lameness. In a study of 102 horses with chronic foot pain, Dyson found that 21% of horses failed to respond to intra-articular analgesia of the DIP joint but improved significantly after intrabursal analgesia of the navicular bursa. A recent study showed that lesions of the deep digital flexor tendon (DDFT) at the level of the tendon’s insertion to the distal phalanx were more effectively desensitized by administration of local...
anesthetic solution into the navicular bursa than by analgesia of the DIP joint.\textsuperscript{30} Some of the lame horses in Dyson's study\textsuperscript{29} that responded to analgesia of the navicular bursa, but were unresponsive to analgesia of the DIP joint, may have had lesions of the insertion of the DDFT rather than disease of the navicular bone and its related structures.

Ten mL mepivacaine HCl administered into the DIP joint desensitizes the entire sole but a smaller volume of mepivacaine (i.e., $\leq 6$ mL) is unlikely to desensitize the heel portion of the sole.\textsuperscript{7} If lameness is improved by a PDNB, evaluation of the gait after intra-articular analgesia of the DIP joint with a low volume of mepivacaine (i.e., $\leq 6$ mL) (after the effects of the PDNB have dissipated) may help to determine if pain in the soft tissues of the heel region is the cause of lameness.\textsuperscript{7} Pain is unlikely to originate from the sole of the heel if lameness is ameliorated by analgesia of the DIP joint using a low volume of mepivacaine.

![Figure 3.](image)

Figure 3. By using a dorsal parallel approach (a) or a dorsal inclined approach (b) administering local anesthetic solution into the DIP joint is easily accomplished.

**Analgesia of the Navicular Bursa**

A study comparing various techniques for inserting a needle into the navicular bursa showed that a method described by Verschooten\textsuperscript{31} was the most accurate.\textsuperscript{32} Using this method, a 20-gauge, 8.9-cm (3.5-inch), disposable, spinal needle is inserted between the bulbs of the heel just proximal to the coronary band, and the needle is advanced along a sagittal plane aiming for a point 1 cm below the coronary band, midway between the dorsal and palmar limits of the coronary band (Fig. 4). The spinal needle is advanced until the tip of the needle contacts bone, and a mixture composed of local anesthetic solution (2 to 3 mL) and radiographic contrast medium (0.5 to 1 mL) is injected. Flexing the distal portion of the limb may decrease resistance to injection by reducing tension of the DDFT on the navicular bursa. Successful centesis can be assumed if the first several milliliters of local anesthetic solution are easily administered and then, as pressure within the bursa increases, administration becomes more difficult, resulting in
Figure 4. Using the Verschooten technique for centesis of the navicular bursa a spinal needle is inserted between the bulbs of the heel just proximal to the coronary band, and the needle is advanced along a sagittal plane aiming for a point 1 cm below the coronary band, midway between the dorsal and palmar limits of the coronary band.

Refilling of the syringe barrel with local anesthetic solution when pressure on the plunger is released. Another method of determining success of the procedure is to examine the foot radiographically immediately after injecting the bursa, if contrast medium was added to the local anesthetic solution (Fig. 5). Radiographic identification of the contrast medium within the bursa is evidence of a successful bursal injection. Successful centesis of the bursa can also be determined by using ultrasonographic guidance to place the needle. For a transcutaneous, ultrasonographic approach to the navicular bursa, the frog is trimmed to pliable tissue, then soaked in warm water for 30 to 120 minutes; the time of soaking depends on the moisture content of the frog. Then, with the ultrasound probe placed on the frog, the needle is ultrasonographically guided into the proximal aspect of the navicular bursa, using Verschooten’s method of centesis.

Figure 5. A method of determining success of the centesis of the navicular bursa is to examine the foot radiographically immediately after injecting the bursa, if contrast medium was added to the local anesthetic solution. Radiographic identification of the contrast medium within the bursa is evidence of a successful bursal injection.
A positive response to administration of local anesthetic solution into the navicular bursa indicates disease of the navicular bursa, the navicular bone and/or its supporting ligaments, solar toe pain, or disease of the DDFT. Even though analgesia of the DIP joint results in analgesia of the navicular bursa, analgesia of the navicular bursa does not result in analgesia of the DIP joint. Analgesia of the navicular bursa may help differentiate pain associated with disease of the DIP joint from pain associated with disease of the navicular bone and associated structures. Pain arising from the DIP joint can likely be excluded as a cause of lameness when lameness is attenuated within 10 minutes by analgesia of the navicular bursa.

There are at least two possible explanations for the observation that analgesia of the navicular bursa does not cause analgesia of the DIP joint: 1) the site of direct contact between the palmar pouch of the DIP joint and the palmar digital nerves is located at a region proximal to the origin of the deep branches that innervate the DIP joint and the navicular bursa, while the site of direct contact between the navicular bursa and the palmar digital nerves is located distal to these branches (Fig. 6); 2) local anesthetic solution may diffuse more slowly from the navicular bursa to the DIP joint than from the DIP joint to the navicular bursa.

Figure 6. A possible explanation for the observation that analgesia of the navicular bursa does not cause analgesia of the DIP joint is that the site of direct contact between the palmar pouch of the DIP joint and the palmar digital nerves is located at a region proximal to the origin of the deep branches that innervate the DIP joint and the navicular bursa, while the site of direct contact between the navicular bursa and the palmar digital nerves is located distal to these branches.
Many investigations\(^{26,27,39,40}\) found a significant difference between the extent of diffusion of various drugs from the DIP joint to the navicular bursa and the extent of diffusion of these drugs from the bursa to the DIP joint. In one study, 4 times more of a mixture of luxol-fast, blue dye and mepivacaine diffused from the DIP joint into the navicular bursa (65%) than *vice versa* (12.5%)\(^{26}\). In a cadaver study, significantly more mepivacaine was found in the navicular bursa after injection of the DIP joint with mepivacaine than the converse\(^{27}\).

In addition to experimental findings concerning the effect of analgesia of the navicular bursa, clinical observations indicate that a positive response to intra-articular analgesia of the DIP joint and a negative response to intrabursal analgesia of the navicular bursa incriminate pain within the DIP joint as the cause of lameness.\(^{36}\) This clinical observation is valid if solar pain can be eliminated as a cause of lameness.\(^{7,25}\)

The Effect of Time on Interpretation of Analgesia of the DIP Joint or Navicular Bursa

Some clinicians have assumed that improvement in lameness observed within 10 minutes after injection of the DIP joint with local anesthetic solution indicates that lameness is caused by pain in the DIP joint alone. Improvement observed more than 10 minutes after injection would be caused by diffusion of local anesthetic solution into the navicular bursa or around the nerves providing sensory innervation to the navicular bone and its associated structures.\(^{37,41}\) This assumption appears to be invalid because a positive response to intra-articular analgesia of the DIP joint has been observed to occur within 5 to 8 minutes of injection in a majority of horses with navicular disease or experimentally-induced navicular bursal pain.\(^{21,36,42}\)

Results of several trials indicate that the effect of intra-articular analgesia of the DIP joint or of intrabursal analgesia of the navicular bursa on lameness should be assessed soon after injection (i.e., within 10 min) because after this time, the structures that become desensitized by diffusion of the anesthetic solution become uncertain.\(^{7,35,38}\)

Analgesia of the Digital Flexor Tendon Sheath

Synoviocentesis of the digital flexor tendon sheath can be performed by placing a 20- to 22-gauge needle into one of the sheath’s several pouches (Fig. 7). Access to these pouches is not difficult when the sheath is distended with synovial fluid but is difficult when it is not. An approach through the palmar/plantar annular ligament of the fetlock was found to be reliable for consistent synoviocentesis of the DFTS.\(^{43}\) Using this approach, the fetlock joint is flexed to a dorsal angle of 225°, and the needle placed through the skin at the level of the midbody of the lateral proximal sesamoid bone, through the palmar annular ligament, 3 mm axial to the palpable palmar border of the lateral proximal sesamoid bone and immediately palmar to the palmar digital neurovascular bundle (Fig. 8). The needle is inserted in a transverse plane and advanced at an angle of 45° to the sagittal plane, aiming toward the central intersesamoidean region, to a depth of 1.5 to 2.0 cm. This technique resulted in reduced time and fewer attempts required for successful entry when compared to the proximal lateral approach. In addition, the synovium in this location is less villous, cellular, and mobile than in the proximal pouch, and therefore, synoviocentesis is less likely to result in synovial hemorrhage. Ten mL of local anesthetic solution provides adequate desensitization of the DFTS.
Figure 7. Synoviocentesis of the digital flexor tendon sheath can be performed by placing a 20- to 22-gauge needle into one of the sheath’s several pouches (a). In this photo (b) a needle has been placed in the palmar pouch of the sheath.

A recent study demonstrated that pain induced in the toe and heel regions of the sole, pain associated with synovitis of the DIP joint, and pain associated with synovitis of the navicular bursa were not significantly attenuated by intrathecal analgesia of the DFTS. It is, therefore, logical to assume that analgesia of the DFTS desensitizes only structures that are contained within or border on the sheath itself (i.e., the superficial and deep digital flexor tendons, the straight and oblique distal sesamoidean ligaments, and the annular ligaments of the fetlock and pastern).

Figure 8. The palmar axial sesamoidian approach to the digital flexor tendon sheath is reliable for consistent synoviocentesis. Using this approach, the fetlock joint is flexed to a dorsal angle of 225°, and the needle placed through the skin at the level of the midbody of the lateral proximal sesamoid bone 3 mm axial to the palpable palmar border of the lateral proximal sesamoid bone and immediately palmar to the palmar digital neurovascular bundle (a). The needle is inserted in a transverse plane and advanced at an angle of 45° to the sagittal plane, aiming toward the central intersesamoidean region (b).
Diagnostic Analgesia of the Digital Portion of the DDFT

Significant abnormalities of the digital portion of the DDFT were identified in 30 of 72 horses with foot pain using magnetic resonance imaging. An ASNB abolished or improved lameness in all 30 horses, but a PDNB, analgesia of the DIP joint, and analgesia of the navicular bursa each ameliorated lameness in only about two-thirds of these horses.

Because lameness caused by disease of the DDFT within the foot often failed to improve significantly after analgesia of the palmar digital nerves, the DIP joint, or the navicular bursa, we believe that a portion of the DDFT within the foot receives its sensory supply from more proximal deep branches of the medial and lateral palmar digital nerves that enter the DFTS. Improvement of lameness in horses with similar lesions of the DDFT after intrathecal analgesia of the digital synovial sheath has been described.

Performing intrathecal analgesia of the DFTS on horses with lameness that is unchanged after anesthesia of the palmar digital nerves but resolves after an ASNB, may be useful. Resolution of lameness after intrathecal analgesia of the DFTS justifies clinical suspicion of a lesion within the digital portion of the DDFT.

Clinicians should be aware that techniques of diagnostic analgesia of the horse’s foot might provide misleading information concerning the site of pain causing lameness because of possible variations in digital neurological anatomy or misdirection of a needle during administration of local anesthetic solution. In spite of the specific guidelines laid out in this paper, results of articular or bursal analgesia or regional anesthesia of the foot may need to be interpreted with at least some degree of skepticism.

References


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