Interpretation of distal limb nerve blocks in the horse

Diagnostic analgesia of the distal limb is frequently performed in equine practice to localise lameness. The specificity of blocks has been widely investigated and it is important that clinicians understand the established blocking patterns and limitations for these blocks in order to correctly advise clients on diagnosis, further imaging and prognosis. This article examines the evidence relating to interpretation of distal limb blocks. https://doi.org/10.12968/ukve.2021.5.3.104

Judith Findley BVM&S MSc CertAVP (ESO, ESST) Dipl ECVS MRCVS, Donnington Grove Veterinary Hospital, Oxford Road, Newbury, RG14 2JB. judithfindley@hotmail.com

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A large proportion of equine lameness is attributed to problems of the distal limb. Diagnostic analgesia frequently forms an important part of the lameness investigation.

Commonly performed distal limb peri-neural blocks include:

- Palmar digital nerve block
- Abaxial sesamoid nerve block
- Low-4-point nerve block
- Lateral palmar or lateral plantar nerve blocks.

Commonly performed intra-synovial blocks include:

- The distal interphalangeal joint
- Navicular bursa
- Proximal interphalangeal joint
- Metacarpo/tarsophalangeal joint
- Digital flexor tendon sheath.

It is important that clinicians are not only able to perform the techniques but are also able to accurately interpret the results.

In recent years, the perceived specificity of equine diagnostic analgesia has been brought into question by experimental studies involving the injection of contrast material and dye, and through correlation of lesions and patterns of diagnostic analgesia using advanced imaging techniques. This article discusses the evidence for perceived specificity of distal limb diagnostic analgesia, along with potential pitfalls in interpretation.

General considerations in the interpretation of diagnostic analgesia

For diagnostic analgesia to be correctly interpreted, the horse must have a consistent lameness from which an improvement can clearly be seen. It can be difficult to appreciate an improvement in very low grade or inconsistent lameness. In these cases, an objective gait analysis system may be useful to confirm whether lameness is present, which limb is affected and the phase of stride (Keegan, 2007). Alternatively, continuing to lightly work the horse may result in a more consistent lameness. In some cases lameness may be appreciated by a rider but not seen 'in hand', but if the rider can appreciate a clear difference then it may be possible to proceed with nerve blocks. Conversely, some severe lameness does not show good resolution following diagnostic analgesia, for example, subsolar abscesses may show an incomplete response to analgesia of the foot. Diagnostic analgesia in severe lameness should be undertaken with caution as there is a potential to create catastrophic injury such as displacement of a non-displaced fracture. Lesions involving subchondral bone pain may respond incompletely to intra-articular blocks. If bone pain is suspected, a peri-neural block may result in better resolution of pain.

Local anaesthetic should be placed accurately, with consideration given to the anatomical landmarks for the specific block. Ease of injection, along with egress of synovial fluid, is important to confirm correct placement of intra-articular or intra-thecal blocks. Inaccurate placement of the local anaesthetic may cause incorrect assumptions to be drawn about whether the lameness could be localised to that region. For example, deposition of local anaesthetic outside the peri-neural fascia may result in delayed diffusion to the nerve (Nagy, 2009) by which time a further block may have been placed, confusing the interpretation. If there is minimal improvement in lameness after 10 minutes the clinician should consider waiting longer before continuing with the lameness assessment or further diagnostic analgesia, in case delayed diffusion confuses the results.

It is also important to ensure an appropriate volume of local anaesthetic is used. Ideally, this is the minimal effective volume, often 1.5–2ml per site in lower limb peri-neural blocks (Bassage and Ross, 2003). Using larger volumes increases diffusion of local anaesthesia which increases the potential of desensitising adjacent structures, thereby reducing accuracy of the interpretation. Using insufficient local anaesthetic may result in a false negative response. Testing the efficacy of the block by checking for skin sensation may help to determine whether the block has desensitised the region, but this might not be consistently repeatable in all cases. Silva et al

(2015) identified that a proportion of horses in whom lameness was alleviated using lidocaine, or in one case bupivacaine, did not lose skin sensation.

The time point at which the response to diagnostic analgesia is evaluated is also important. Peri-neural local anaesthesia should be effective within 5 minutes (Fürst, 2006). It is important that lameness should be re-evaluated within 5–10 minutes to minimise the likelihood of diffusion desensitising adjacent structures and reducing the accuracy of interpretation (Bassage and Ross, 2003). The choice of local anaesthetic may influence the response to distal limb blocks, since the speed of onset and duration of activity are variable. The author uses mepivacaine which has a rapid onset of action (>5 minutes) and an intermediate duration of action.

There is conflicting evidence as to whether the administration of sedatives to facilitate blocking in fractious horses may influence the underlying lameness. Multiple investigators have evaluated the effects of drugs, including acepromazine, xylazine, detomidine and butorphanol, on induced and naturally occurring lameness using an objective gait analysis system. Overall, it can be concluded that sedation at the recommended dosage has a minimal effect on lameness evaluation. It is worth noting that most distal limb blocks are evaluated at 5–10 minutes after administration and many of the studies mentioned use much longer time points. The author's preference is to use xylazine at (0.3 mg/kg) to perform nerve blocks in fractious horses with the drug given after limb preparation immediately before placement of the nerve block. The outcomes of published data are summarised in *Table 1*.

Other reasons for poor response to nerve and joint blocks include 'mechanical' lameness, such as fibrotic myopathy, that does not have a clear pain component. Similarly, neurological gait abnormalities may not alter with diagnostic analgesia. The author has experienced less consistent responses to nerve blocks in thick skinned breeds such as cobs. The reason for this is unknown, although it may reflect greater difficulty in palpating landmarks. The author uses an increased needle size and a more regional approach, such as placing an abaxial sesamoid nerve block instead of a palmar digital nerve block.

The digit

The palmar digital nerve block is performed at the level of the heel bulbs (proximal extent of the collateral cartilages) by deposition of 1.5-2 ml of local anaesthetic over the medial and lateral palmar nerves (Bassage and Ross, 2003). The block should be performed as far distally as possible, to avoid desensitising the dorsal branches of the nerve or the back of the proximal interphalangeal joint. The traditional understanding of this block is that it desensitises the palmar or plantar third of the foot and the sole (Stashak, 1987). However, other studies have demonstrated that a wider range of structures may be desensitised by the palmar digital nerve block. Endotoxin-induced distal interphalangeal joint (DIPJ) pain can be ameliorated by a palmar digital nerve block (Easter et al, 2000). Furthermore, blocks performed at the level of the collateral cartilage resulted in an incomplete response to joint pain, although, when performed 2 cm more proximal, complete desensitisation of the joint was achieved (Schumacher et al, 2000). This study also determined that solar toe pain could be eliminated following a palmar digital nerve block. Similarly, Nagy et al (2009) identified proximal diffusion of contrast material in half of palmar digital nerve block, averaging 16 mm at 10 minutes. Placement of the palmar digital nerve block, with local anaesthetic deposition below the proximal sesamoid bones (also known as a basisesamoid block), has been shown to desensitise the suspensory branches, fetlock joint, the distal third metacarpal/tarsal bone and the proximal sesamoid bones (Daniel et al, 2011; Marneris and Dyson, 2014). The author places the palmar digital nerve block as close to the collateral cartilage as possible as the primary block in the evaluation of forelimb lameness, to screen in or out of the foot for a cause of lameness. If lameness is abolished, this will be followed by either imaging or intra-articular blocks at a later time.

Distal interphalangeal joint and navicular bursa

The DIPJ is most frequently blocked using a dorsal approach, with a volume of 6 ml of local anaesthetic. A 1.5 inch needle may be placed either parallel to ground through the common digital extensor tendon at the level of the coronary band or approximately 1.5 cm above the coronary band, medial or lateral to the common digital extensor tendon, angled distal and axial (Bassage and Ross, 2003). Multiple techniques have been described for injection of the navicular bursa (Schramme et al, 2000). The author favours the distal palmar technique to the navicular position, in which the limb is in a non-weight bearing position on a Hickman block and a 9 cm spinal needle is inserted on the midline between the heel bulbs and directed to a point approximately halfway between the dorsal and palmar hoof wall and 1 cm below the coronary band. The needle is advanced until resistance is met and the needle position is confirmed on radiography. A volume of 1-3 ml of local anaesthetic is instilled (Verschooten et

Table 1. Summary of evidence for effect of sedation on lameness grade

Reference	Limbs	Method of lameness	Sedative	Results
Retting et al (2016)	Forelimb and hindlimb	Naturally occurring sound, mild, severe	Xylazine 0.3mg/kg	Hindlimb lameness unaffected at 5, 20 and 60 minutes, mild forelimb lameness decreased at 60 minutes
Junior et al (2019)	Hindlimbs	Metal clamps applied to hind foot	Xylazine 0.3mg/kg or xylazine 0.3mg/kg and butorphanol 0.01mg/kg	Lameness unaffected at 20, 30 and 40 minutes
Taintor et al (2016)	Forelimb and hindlimb	Naturally occurring lameness	Detomidine 10mg or acepromazine 10mg	Lameness unaffected at 5 minute intervals between 5 and 40 minutes
Da Silva Azevedo et al (2015)	Forelimb and hindlimb	Naturally occurring lameness	Xylazine 0.25mg/kg or acepromazine 0.25mg/kg	Lameness unaffected at 5 minutes (number of lame horses decreased but was not statistically significant)

al, 1991). In a comparison of various techniques, this was found to be the most consistently successful method (Schramme et al, 2000).

The intra-articular DIPJ block is reported to desensitise a wide range of structures including the articular surfaces of the joint, the navicular bursa, navicular bone, the ligaments associated with the navicular apparatus, the distal portion of the deep digital flexor tendon and the sole (Schumacher et al, 2001; Pleasant et al, 1997; Schumacher and Schramme, 2019). The palmar digital nerves are located in close proximity to the capsule of the DIPJ. Using a larger volume of local anaesthetic may result in diffusion of the block over a larger area, extending to the heel bulbs and palmar/plantar regions of the foot. It may also result in partial desensitisation of the collateral ligaments of the DIPJ (Schumacher et al, 2001). A cross-over effect has been identified between blocking the DIPJ and the navicular bursa, as blocking one structure results in desensitisation of the other (Dyson and Kidd, 1993). In a cadaver study, Gough et al (2002) determined that mepivacaine reached an analgesic concentration in both structures, regardless of which it was initially injected, in 50% of limbs. Transport of substances occurs between the joints using a combination of passive diffusion and active transport. In cadaver limbs, active transport will not be occurring, therefore the rate of diffusion of substances may be much higher in live animals. Similarly, diffusion of corticosteroid to an effective concentration has been demonstrated both when the DIPJ and the navicular bursa are injected (Pauwels et al, 2008). Other in vivo work has confirmed that blocking the DIPJ eliminated pain from the nerve block within 5-8 minutes (Pleasant et al, 1997). These authors hypothesised that the effect may the result of direct diffusion of local anaesthetic between synovial structures or a result of desensitisation of the deeper branches of the palmar digital nerves which are in close proximity to both the DIPJ and the navicular bursa (Pleasant et al, 1997).

Conversely, Schumacher et al (2003) hypothesised that a navicular bursa block would result in desensitisation of the DIPJ, similarly to DIPJ block desensitising the navicular bursa. However, this was not proven, with a navicular bursa block failing to block endotoxin-induced lameness of the DIPJ up to 20 minutes post-injection. The effective dose of local anaesthetic required to alleviate lameness in this endotoxin model was not discussed and it is possible insufficient local anaesthetic was instilled. In summary, both the DIPJ and the navicular bursa blocks should be evaluated after 5 minutes to reduce the likelihood that diffusion will result in misinterpretation of the response, should the desensitised structures result in an abolition of lameness. It is the author's opinion that a positive response to a navicular bursa block can be considered more specific than that of a DIPJ block.

Proximal interphalangeal joint

Diagnostic analgesia of the proximal interphalangeal joint (PIPJ) is performed much less commonly than other distal limb blocks. It is a low motion joint and the most common clinically significant lesion identified is osteoarthritis which may not block completely to the joint as a result of subchondral bone pain. The joint may be approached via the dorsal or palmar pouches. The author favours the dorsal approach in which the horse is weightbearing and a 20G 1.5 inch needle is inserted at the dorsolateral aspect of the joint, lateral to the common digital extensor tendon and distal to the distal palmar process of the proximal phalanx (Bassage and Ross, 2011). Depending upon the level at which a palmar digital nerve block is performed, the joint may be blocked partially (Schumacher, 2004). The dorsal branches of the palmar digital nerves and the nerve branches that enter the nutrient foramen of the proximal phalanx and contribute to subchondral bone pain should be blocked by the abaxial sesamoid nerve block (Schumacher et al, 2013).

Abaxial sesamoid nerve block

The abaxial sesamoid nerve block is performed at the level of the proximal sesamoid bones using a volume of 1.5-2 ml of local anaesthetic over the medial and lateral palmar/ plantar nerves (Bassage and Ross, 2003). The abaxial sesamoid nerve block is traditionally thought to desensitise all structures within the hoof, PIPJ and up to the mid-proximal phalanx. However, the abaxial sesamoid nerve block can desensitise lesions associated with the fetlock region as well as the foot and pastern (Dyson and Murray, 2006). The author has seen this most clearly demonstrated during magnetic resonance imaging (MRI) examinations, in which lameness is abolished following an abaxial sesamoid nerve block and there have been no significant findings during MRI of the foot, with further imaging of the fetlock revealing lesions such as short incomplete fractures of the proximal phalanx (Daniel et al, 2011). Therefore, it should be used with caution as a screening tool to rule out foot lameness, unless used as part of a systematic series of peri-neural or intra-articular blocks working from distal to proximal.

When considering blocking of the digit, especially in situations where multiple blocks may not be possible as a result of time constraints or difficulty in performing the techniques because of a horse's temperament, it may be useful to have a direct comparison of the effects of the blocks. Rungsri et al (2014) attempted to assess this is in a clinical population. Horses had palmar digital nerve block, abaxial sesamoid nerve block and DIPJ blocks performed on separate days. A significant limitation of the study was that although the horses had lameness attributed to the digit, no definitive diagnoses were disclosed, this may significantly influence the response to blocks. Overall this study concluded that the majority of horses had an equivocal response to both intra-articular DIPJ and palmar digital nerve block blocks. The majority of horses that had a $\geq$70% response to these blocks improved within 2 minutes of the DIPJ block. In relation to the abaxial sesamoid nerve block and the intra-articular DIPJ block, a greater proportion of horses improved to the abaxial sesamoid nerve block than the DIPJ block. In those cases where the response was equivalent, the DIPJ block required up to 10 minutes. As discussed below, 'lesion-specific' blocking patterns can be seen with various soft tissue injuries, which should be taken into consideration when choosing and interpreting blocks.

The most common soft tissue injuries identified within the hoof capsule include lesions to the deep digital flexor tendon and the collateral ligaments. Many horses that block to the foot are subsequently diagnosed with an injury to the deep digital flexor tendon within the hoof capsule, using MRI. Dyson et al (2003) observed this in 46 horses with deep digital flexor tendon injuries in the foot and reported that pastern lameness was abolished in all horses following placement of an abaxial sesamoid nerve block, while only two thirds responded completely to a palmar digital nerve block, DIPJ or navicular bursa block.

A second commonly diagnosed soft tissue injury of the digit is desmitis of the collateral ligaments of the DIPJ. Similar to the deep digital flexor tendon injuries these horses have been shown to block completely to the abaxial sesamoid nerve block (Dyson et al, 2004). A proportion of horses with DIPJ collateral ligament injuries will improve (although lameness is not abolished) to the palmar digital nerve block (16/18 horses, 87%), while a minority (6/15, 40%) will improve to an intra-articular DIPJ block. The improvement to the palmar digital nerve block and DIPJ blocks may be caused by concurrent synovitis or joint capsule pain. Lesions that are uniaxial may respond to analgesia of just the medial or lateral branch of the palmar digital nerve.

Digital flexor tendon sheath

There are multiple approaches reported for diagnostic analgesia of the digital flexor tendon sheath. The most commonly used is the distal approach, performed at the level of the pastern with the limb flexed or weightbearing, as well as an approach performed at the lateral outpouching of the sheath at the base of the proximal sesamoid bone between the annular ligament and the distal digital manica flexoria (Jordana et al, 2014). An alternate approach is the axial sesamoidian approach, in which the limb is flexed and the needle inserted through the palmar annular ligament on the axial margin of the proximal sesamoid bone at the level of the mid-body of the sesamoid (Jordana et al, 2014). The digital flexor tendon sheath is typically blocked with 10 ml of local anaesthetic solution.

The accuracy of the intrathecal digital flexor tendon sheath block has been evaluated, and Harper et al (2007) demonstrated that an intrathecal digital flexor tendon sheath block did not influence lameness caused by induced synovitis of the distal interphalangeal joint or navicular bursa. A set screw model was also used to induce lameness at the dorsal margin of the sole and there was no effect at 10 minutes post-block but 4 out of 5 horses had improved by one or more lameness grades after 20 minutes. Similarly, Jordana et al (2014) compared skin desensitisation following four approaches to the digital flexor tendon sheath. The study identified that 29/72 (40%) of injections resulted in limb desensitisation. Specifically, of these, 22/29 had complete desensitisation on one heel bulb, most commonly the lateral.

Injecting the tendon sheath through the proximal pouch resulted in the highest level of skin desensitisation of the distal limb (n= 10), while using an axial approach (axial margin of the mid-body of the proximal sesamoid bones through the palmar annular ligament) resulted in the lowest (n=3). The same group assessed mepivacaine concentration in the fetlock, interphalangeal joint and navicular bursa after digital flexor tendon sheath injection and determined that while diffusion did occur, the concentration was insufficient to have a clinical effect, although it increased with time (Jordana et al, 2016). The conclusion to draw from both of these studies is that the block is relatively accurate if assessed in a timely fashion at 10 minutes post-administration. Diffusion affecting the palmar or plantar digital nerves is likely observed by 20 minutes.

It has been recognised that the lesions found within the digital flexor tendon sheath may result in differing response to the intrathecal block. Findley et al (2012) and Fiske-Jackson et al (2013) both reported that horses diagnosed at tenoscopy with a torn manica flexoria were less likely to respond completely to intrathecal analgesia, than those with injury to the deep digital flexor tendon. Horses with a manica flexoria injury were more likely to completely block to a low-4-point nerve block. In the author's experience, lameness secondary to constriction from desmitis of the palmar annular ligament may also commonly result in a partial response to intrathecal analgesia.

Low-4-point nerve block

The low-4-point nerve block is used to desensitise the fetlock and distal limb including the fetlock joint, digital flexor tendon sheath, pastern and digit. The medial and lateral palmar and palmar metacarpal nerves are blocked. The palmar metacarpal nerves are blocked at the level of the distal extent of the 2nd and 4th metacarpal/ tarsal bones or 'splint button'. The palmar nerves are blocked between the flexor tendons and the suspensory ligament, just proximal to the proximal reflection of the digital flexor tendon sheath (Bassage and Ross, 2003). A volume of approximately 2 ml of mepivicane is used at each site. In cases where pathology of the palmar condyles of the 3rd metacarpal bone is suspected (such as palmar osteochondral disease in racehorses), just the medial and lateral palmar metacarpal nerves may be blocked. In the hindlimb, the traditional approach to this block has been to additionally block the dorsal metatarsal nerves. In the author's experience this is often resented by the horse. Coleridge et al (2020) determined that there was no difference in the ability to reduce lameness in an endotoxin-induced fetlock lameness model, with or without the dorsal metatarsal nerves being blocked. It should be noted that this model does not account for response to pain within the dorsal or proximal first phalanx which may be seen in racehorses.

In a study in which radiopaque contrast material was injected at the sites of the low-4-point block in the metacarpus, Nagy et al (2010) showed that while proximal diffusion of the contrast did occur it did not extend beyond the mid-cannon region and was therefore considered unlikely to affect structures in the proximal cannon region. A number of studies have identified the potential for accidental placement of local anaesthetic into the digital flexor tendon sheath. This may lead to false negative interpretation of the block. In cadaver limbs injected with a low-4-point block and dissected dye was present in 30% of the digital flexor tendon sheaths (Nagy et al, 2010).

Fetlock joint

The fetlock joint is anaesthetised using either a dorsal or a palmarolateral approach, with a volume of 10ml usually being considered appropriate (Bassage and Ross, 2003). The fetlock joint is a relatively isolated synovial structure. However, intra-articular analgesia may influence the suspensory branches and the sesamoidian ligaments (Marneris and Dyson, 2014). The author usually performs intra-articular fetlock analgesia either based on clinical suspicion following palpation or imaging, or following response to peri-neural nerve blocks, such as negative response to an abaxial sesamoid nerve block with lameness abolished by a low-4-point nerve block, rather than as part of a routine distal to proximal limb lameness investigation. As such, in the author's opinion, concerns regarding diffusion of local anaesthetic are reduced.

KEY POINTS

- A good working knowledge of distal limb anatomy is essential for the correct placement and interpretation of diagnostic analgesia.
- Timely assessment of response to diagnostic analgesia is important as diffusion of local anaesthetic to adjacent structures may confuse interpretation.
- Diagnostic analgesia has consistently been demonstrated to be less accurate than previously believed.
- Diagnostic analgesia should be performed in a logical order according to the suspected lesion and clinical signs.

Conclusions

Our understanding of the complexity of the responses to distal limb analgesia is constantly evolving. The use of objective gait analysis systems and advanced imaging have enabled clinicians to better interpret which anatomical areas and lesions may be desensitised by which perineural and intra-articular blocks. This has largely demonstrated that accuracy of interpretation of intrathecal, intra-articular or perineural anaesthesia has been demonstrated to be less accurate than previously thought.

To correctly interpret analgesia of the equine distal limb, a good understanding of the anatomy of the area being desensitised and attention taken to the time frame at which blocks should be reassessed. EQ

Conflicts of interest

The author declares no conflicts of interest.

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