15 YEARS OF MRI: PRACTICAL LESSONS FOR IMAGING AND MANAGEMENT OF FOOT LAMENESS

DR. FILIP VANDENBERGHE
Assoc. LA ECVDI, VETERINARY HOSPITAL BOSDREEF, BELGIUM

Introduction

The distal limb remains one of the most common anatomical regions of potential pathology inducing lameness in the horse and thus limiting the sports career of the active athlete. Lameness is considered the number one cause of loss of competition days in all disciplines of the equestrian sports. The last 15 years the financial budgets in equestrianism have grown significantly and a more professional approach and management has been introduced. As a consequence in equine veterinary medicine the value of a correct diagnosis can not be over-emphasized. Correct diagnosis is the cornerstone of appropriate treatment and management. Advanced imaging such as magnetic resonance imaging is widely available and more easily accessible and has revolutionized our understanding of distal limb pathologies. Previously unknown causes of lameness have now been visualized. A lot of experience has been built up already with MRI, but in that process a lot of work still needs to be done and our understanding changes as an ever ongoing process. Advanced diagnostic imaging has questioned the way we perform our clinical examination, including diagnostic anesthesia. It has given birth to new treatments and has documented better wether to choose for conservative of surgical treatment.

Clinical examination / diagnostic anesthesia

The clinical examination of the lame horse is essential and the starting point of any further investigation. With the introduction of any new diagnostic tool, the risk is there to bypass the clinical exam too quickly and jump to false conclusions based on static images. Going back to the clinical exam, in relation to the anamnesis, with the knowledge of further advanced imaging is bringing us closer to solving the problem. Horses are today ofter presented earlier in the disease process with clinical symptoms much more discrete and difficult to asses. The introduction of objective motion analysis systems, such as the inertial sensor system (®Equinosis, Lameness Locator) or the 3D camera system (®Qualysis) is helping us picking up the slightest asymmetries in the locomotion of the horse. Nevertheless the interpretation of the obtained data requires the human brain of an experienced orthopedic clinician.

Especially in equine medicine diagnostic anesthesia is a very important part in the clinical work up. Localizing pain, and thus lameness, to a specific anatomical region forms the base of further imaging of the region. Highly sensitive and specific diagnostic imaging such as magnetic resonance imaging has helped us to critically review the use of diagnostic anesthesia and what we thought we were blocking for years. The first 'block' to be questioned was the anesthesia of the digital palmar/plantar nerves at the base of proximal sesamoid bones (abaxial sesamoid block). Historically this anesthesia was considered to desensitize the foot and pastern. We do know the metacarpo/metatarsophalangeal joint is anesthetized just as well. Many horses with a positive abaxial sesamoid block or high pastern block are still referred for an MRI of the foot. In many cases the primary cause of lameness will be located in the fetlock region. The palmar/plantar digital nerve block low in the pastern at the axial side of the proximal margin of the collateral cartilages is considered to desensitize the podotrochlear apparatus, the sole and the DIP joint, rather than only the palmar half of the foot. Although Schumacher et al. (2004) showed no significant effect on the PIP joint or higher, when performed at the proximal margin of the collateral cartilages, there's evidence of significant pathology of the proximal first phalanx and the condyles of the third metacarpal/metatarsal bone; blocking out on a palmar/plantar digital nerve block. In absence of significant pathology visible in the foot on MR, obtaining images of the fetlock are advised, even in horses with a positive response to the PD block. A low 4 point anesthesia (low palmar/plantar) anesthesia is considered to desensitize the proximal metacarpal/metatarsal region as well. It's important to state that sensory fibers pass in both directions of the ramus communicans to connect the medial and lateral palmar nerves. When a low 4 point is performed the palmar nerves should be blocked distally of the ramus communicans or a low volume of anesthetic solution should be placed over the ramus (Schumacher et al., 2012). Intra-synovial anesthesia of the DIP joint desensitizes the DIP joint, but as well the palmar digital nerves as they pas the proximo-palmar pouches of the joint. The collateral ligaments of the DIP joint are desensitized by DIP joint anesthesia in only a small percentage of horses. The podotrochlear apparatus, the toe and the distal part of the digital flexor tendon sheath might as well be blocked. Diagnostic anesthesia of the navicular bursa on the contrary has not shown to influence DIP joint related pain. There's anecdotal report of intra-synovial anesthesia of the DIP joint alleviating pain from the proximal first phalanx. An important remark should be made that significant MR detected pathology of the proximal phalanx might potentially be clinically silent. And not contributing to the lameness.

Intra-synovial anesthesia of the digital flexor tendon sheath is considered to block only structures on direct relation to the tendon sheath. Nevertheless Jordana et al. (2014) showed that dependent on the site of puncture the palmar digital nerves could be desensitized as well due to potential leakage of anesthetic solution. The risk was highest when the tendon sheath was punctured in the proximal recess. There's a small portion of horses with DDFT pathology in the foot that is irresponsive to PDNB, but positive to an abaxial sesamoid block. Those horses may have parts of their DDFT receive its sensory supply from more proximal branches of the palmar digital nerves that enter the DFTS. Those horses may block to an intrathecal anesthesia of the DFTS as well. Intra-synovial anesthesia of the navicular bursa is, if evaluated quickly, quite specific to anesthetizing the podotrochlear region and toe. Because of the potential risk of injuring the DDFT with the classic fluoroscopic guided palmar approach to puncture the bursa, alternative techniques are developed to puncture the navicular bursa with our perforation of the DDFT. Nevertheless the reporting of significant iatrogenic DDFT pathology after centesis of the bursa is limited. Anesthesia of the proximal metacarpal/metatarsal region is obtained by local infiltration of the region or anesthesia of the deep branch of the lateral plantar nerve (for a hindlimb). Not only the proximal metatarsal region is desensitized, but pain originating from the fetlock should be considered.

Diagnostic imaging

Anatomically the equine distal limb can be imaged by all diagnostic imaging modalities available to the equine market: radiography, ultrasonography, MRI, scintigraphy and CT. Radiography and ultrasonography remain the first modalities of use. Modern digital equipment deliver high level images with a large amount of very valuable diagnostic information in a cost effective way. The use of contrast angle ultrasonography brings extra information compared to normal ultrasonography. Contrast angle ultrasonography is ultrasonography where the beam is intentionally positioned obliquely to the orientation of the tendon fibres, with the limb in flexion or standing. Especially in the evaluation of the proximal suspensory ligament it allows a better detection of the peripheral margins of the ligament and the lining between the fat/muscle bundles and the ligamentous part of the ligament. Chronic scarring in the ligamentous part is better picked up on angle contrast scanning. Doppler ultrasonography in equine tendons and ligaments is documented poorly, but can be an aid in the monitoring of tendon healing. The introduction of magnetic resonance imaging in the early years of this millennium has provoked a major boom in our diagnostic capabilities. Especially with the widespread availability of standing MRI. MRI is considered the gold standard in distal limb diagnostic imaging.

Nevertheless there's some important limitations. Due to lack of contrast and lack of super imposition subtle periarticular new bone formation, osteophytes, enthesiophytes and osteochondral fragmentation are difficult or impossible to detect on MR images. Plain radiography or computed tomography is superior in these conditions. CT is preferred over MRI in the evaluation of bonestructure and bonedensity, but lacks the potential of visualizing fluid, the so called 'bone edema'. In the case of comminuted fractures CT is of very valuable use in the pre-surgical planning of internal osteosynthesis and even per-operative guidance of implant placement.

Treatment options

New or refined understandings in the different pathologies of the distal limb implemented new or more adequate treatment options. An overview of the recent approach to the most common pathologies in the distal limb will be presented. In the foot over 60% of all cases have the main pathology in the navicular region (navicular bone, bursa and DDFT). Endoscopic evaluation and surgical debridement of the navicular bursa and DDFT, originally increased the succes rate of bringing horses back to their original level of work. More precise lesion typing, case selection and intrabursal medication with adequate rest and rehabilitation, further improved the succes rate and surgery has been waived a bit again. Better MRI documentation of navicular region pathology allows a better case selection and higher succes rate for surgical neurectomy. Surgical interventions in the foot are rather uncommon, except for acute wounds and nail penetrations. MRI has shown that previously thought harmless findings such as ossification of the collateral cartilages can predispose to significant collateral ligament pathology of the DIP joint and the palmar processes of the distal phalanx such as chronic bruising and stress fractures. Adaptive shoeing and appropriate sole padding helps in the management of keeping those horses active and sound. The digital flexor tendon sheath is a region where surgical endoscopic evaluation is of major help in the diagnosis of mild longitudinal tearing of the border of the DDFT, often starting at the level of the manica flexoria. Even with angle contrast ultrasonography and MRI it can be difficult to appreciate subtle, but important, fibrillation. Previously considered primary desmitis of the annular ligament is only present in a minority of cases. Neurectomy of the deep branch of the lateral plantar nerve and fasciotomy is a common used 'end stage' surgical treatment in the management of chronic proximal suspensory disease. As known to be more of a syndrome often the metatarsal nerves are included in the pathology and show neuritis.

References

1. Schumacher J, Steiger R, Schumacher J, de Graves F, Schramme M, Smith R, Coker M. Effects of analgesia of the distal interphalangeal joint or palmar digital nerves on lameness caused by solar pain in horses. Vet Surg 2000, 29(1):54-58.
2. Schumacher J, Schumacher J, de Graves F, Steiger R, Schramme M, Smith R, Coker M. A comparison of the effects of two volumes of local analgesic solution in the distal interphalangeal joint of horses with lameness caused by solar toe or solar heel pain. Equine Vet J. 2001, 33(3):265-268.
3. Sardari K, Kazemi H, Mohri M. Effects of analgesia of the distal interphalangeal joint and navicular bursa on experimental lameness caused by solar pain in horses. J Vet Med A Physiol Pathol Clin Med 2002, 49(9):478-481.
4. Schumacher J, Schumacher J, Gillette R, DeGraves F, Schramme M, Smith R, Perkins J, Coker M. The effects of local anaesthetic solution in the navicular bursa of horses with lameness caused by distal interphalangeal joint pain. Equine Vet J. 2003, 35(5):502-505.
5. Schumacher J, Livesey L, DeGraves FJ, Schumacher J, Schramme MC, Hathcock J, Taintor J, Gomez J. Effect of anaesthesia of the palmar digital nerves on proximal interphalangeal joint pain in the horse. Equine Vet J 2004, 36(5):409-414.
6. Harper J, Schumacher J, Degraves F, Schramme M, Schumacher J. Effects of analgesia of the digital flexor tendon sheath on pain originating in the sole, distal interphalangeal joint or navicular bursa of horses. Equine Vet J 2007, 39(6):535-539.
7. Kuemmerle JM1, Auer JA, Rademacher N, Lischer CJ, Bettschart-Wolfensberger R, Fürst AE. Short incomplete sagittal fractures of the proximal phalanx in ten horses not used for racing. Vet Surg 2008, 37(2):193-200.
8. Nagy A, Bodo G, Dyson SJ, Szabo F, Barr AR. Diffusion of contrast medium after perineural injection of the palmar nerves: an in vivo and in vitro study. Equine Vet J 2009, 41(4):379-383.
9. Dyson S, Brown V, Collins S, Murray R. Is there an association between ossification of the cartilages of the foot and collateral desmopathy of the distal interphalangeal joint or distal phalanx injury? Equine Vet J. 2010, 42(6):504-511.
10. Selberg K, Werpy N. Fractures of the distal phalanx and associated soft tissue and osseous abnormalities in 22 horses with ossified sclerotic ungual cartilages diagnosed with magnetic resonance imaging. Vet Radiol Ultrasound. 2011, 52(4):394-401.
11. Dyson S, Nagy A, Murray R. Clinical and diagnostic imaging findings in horses with subchondral bone trauma of the sagittal groove of the proximal phalanx. Vet Radiol Ultrasound 2011, 52(6):596-604.
12. Werpy NM, Denoix JM, Mcllwraith CW, Frisbie DD. Comparison between standard ultrasonography, angle contrast ultrasonography, and magnetic resonance imaging characteristics of the normal equine proximal suspensory ligament. Vet Radiol Ultrasound 2013, 54(5):536-547.
13. Jordana M, Martens A, Duchateau L, Vanderperren K, Saunders J, Oosterlinck M, Pille F. Distal limb desensitisation following analgesia of the digital flexor tendon sheath in horses using four different techniques. Equine Vet J 2014, 46(4):488-493.
14. Claunch KM, Eggleston RB, Baxter GM. Effects of approach and injection volume on diffusion of mepivacaine hydrochloride during local analgesia of the deep branch of the lateral plantar nerve in horses. J Am Vet Med Assoc 2014, 245(10):1153-1159.

15. Brünisholz HP, Hagen R, Fürst AE, Kuemmerle JM. Radiographic and computed tomographic configuration of incomplete proximal fractures of the proximal phalanx in horses not used for racing. Vet Surg 2015, 44(7):809-815.

16. Paz CF, Magalhães JF, Mendes HM, Rocha Junior S, Belknap JK, Alves GE, Faleiros RR. Mechanical nociceptive thresholds of dorsal laminae in horses after local anaesthesia of the palmar digital nerves or dorsal branches of the digital nerve. Vet J 2016, 214:102-108.

17. Gold SJ, Werpy NM, Gutierrez-Nibeyro SD. Injuries of the sagittal groove of the proximal phalanx in warmblood horses detected with low-field magnetic resonance imaging: 19 cases (2007-2016). Vet Radiol Ultrasound 2017, 58(3):344-353.

18. Smith MRW, Corletto FC, Wright IM. Parasagittal fractures of the proximal phalanx in Thoroughbred racehorses in the UK: Outcome of repaired fractures in 113 cases (2007-2011). Equine Vet J 2017, 49(6):784-788.