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# Shoeing Strategies of Foot Pathology Identified With Magnetic Resonance Imaging

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***Take Home Message*—MRI has changed the way veterinarians treat injuries of the distal limb. The identification of specific lesions allows the veterinarian and farrier to develop a shoeing protocol to better aid in the recovery of the horse.**

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## I. INTRODUCTION

THE equine veterinary field is ever growing and changing. The use of magnetic resonance imaging (MRI) in equine practice has been shown to be a valuable diagnostic tool in recent years.[1-2] There have been great advances in the understanding of distal limb lameness as a result of this diagnostic tool, primarily concerning navicular syndrome or palmar foot pain.[3] Prior to MRI, clinicians relied only on radiography and ultrasound techniques for diagnostic imaging. Radiographs are limited to osseous changes[4] and ultrasonography of the foot is limited due to the keratinized structures of the hoof capsule.[5] As a result of identifying pathology through MRI diagnostics, specific treatment plans can be made for the patient.[3] The purpose of this article is to describe shoeing strategies that may provide adjunctive therapy for injuries of the distal limb following localization of a lesion/lesions via MRI.

Therapeutic farriery accompanies most treatment plans outlined in the literature for distal limb injuries. However, many of these techniques are shrouded in traditional means and lack scientific evidence. This is due to the relatively small amount of research that has been performed regarding specific farrier techniques.[6] When formulating a shoeing protocol for a specific injury one must understand and distinguish between the terms conformation and balance which are frequently used in reference to the size, shape and special arrangement of anatomical structures of the distal limb.[7,8] Conformation relates to the general shape, size, and static arrangement of the distal limb.[7] Balance encompasses the function and shape of the foot as it relates to the ground and proximal structures of the limb during static and dynamic phases.[9] A foot is said to be balanced when it has been trimmed to reach its maximum mechanical efficiency.[8] The first step to developing a shoeing protocol is to evaluate the horse at rest and in motion, making note of any conformation abnormities or gait faults. Quality radiographs of the digit are necessary to assess imbalance issues. Personal experience shows the importance of a balanced trim to the hoof accompanied by the proper diagnosis to facilitate a successful shoeing prescription. The shoeing protocol used is determined by the location of the lesion and the biomechanical stress placed on the injured structure. Application of a specific shoe may help to reduce the stress or forces placed on an anatomic structure.[6] The goals of developing a shoeing protocol are as follows: 1. Reduce biomechanical forces on the primarily injured structure; 2. Restore foot balance; 3. Improve on existing hoof morphology problems; 4. Provide protection to injured areas of the foot.

## II. NAVICULAR SYNDROME

Navicular disease/syndrome is a commonly used term that can encompass multiple structures within the caudle/palmar aspect of the equine foot.[3] Cases showing navicular bone edema or sclerosis are often sensitive to concussion or vibratory forces from impact. In these cases, direct pressure over the central frog has been shown to cause pain.[10] Additionally, compression of the navicular bone by the deep digital flexor tendon may attribute to progression of lameness.[11] The author's experience has shown that a soft composite pad between the shoe and the foot to dampen the concussion has been helpful in these cases. Protection of the palmar aspect of the foot with a bar or heelplate can be beneficial. However, it is important not to apply pressure to the frog with the bar or heelplate as this will most likely make the lameness worse. The purpose of the bar or heelplate is to prevent trauma to the caudle aspect of the foot. The shoe should have caudal extension to a point perpendicular to a vertical plumb line dropped from the heel bulbs. Egg-bar shoes have traditionally been used for the treatment of navicular disease.[6] Although the egg-bar shoe does not affect the stress placed on the navicular bone by the deep digital flexor tendon in normal horses, it has been shown to decrease that stress in horses with navicular disease having a low angle hoof.[12] Possible reasons for this are the redistribution of weight across the heels and added length of the shoe

preventing overextension and further compression of the navicular bone. Wedging the heels and rockering/rolling the toe may help to decrease the force of compression of the navicular bone by the deep digital flexor tendon.[13] However, the heel structures are placed under more loading force when wedged and may be further compromised in a horse with an already low angle hoof or crushed heel.[14]

Injuries of the impar ligament, suspensory ligament of the navicular bone and the distal portion of the deep digital flexor tendon are all shod in a similar fashion. Stress on the impar ligament of the navicular bone and distal portion of the deep digital flexor tendon have been shown to be the highest during dorsiflexion.[15] The theory of wedging the heel to decrease tension on these structures, in the author's opinion, has been helpful in treatment. Although studies have indicated rolled toe, rocker toe, and square toe shoes do not significantly change the duration of breakover from a flat steel shoe,[16] one study showed that a long toe created a longer breakover duration.[13] Furthermore, reduction in the moment arm of the distal interphalangeal joint through the use of rolled or rocker toe shoes[17] may not significantly change the duration of breakover but may have a reduction in stress placed on deep digital flexor tendon and supporting ligaments of the navicular bone during dorsiflexion and at the point of breakover. In the author's personal experience, trimming alone can radically change hoof angle and digital alignment. Therefore, radiographic evaluation of the digit is imperative to proper alignment through trimming. This further demonstrates the need to achieve a balanced trim especially before application of a shoe or appliance.

## III. Distal interphalangeal joint (DIPJ) Synovitis/Osteoarthritis

The goals of farriery for treating DIPJ synovitis/ osteoarthritis include eliminating or improving any imbalance issues of the foot by trimming, reducing the moment arm of the DIP, and protecting/supporting the foot. It is thought to be counterproductive to drastically increase the angle of the hoof when treating this disease process due to the resulting increase in pressure caused within the DIP joint from increasing the angle.[17] A shoe with an exaggerated roll or gradual rocker from quarter to quarter may be beneficial in reducing the moment arm of the DIP and allow the foot to roll out in a more fluid manner.[18] Consequently, horses that have pain stemming from the DIP are often painful to pressure over the central frog. Therefore, it may be beneficial to unload the frog with a shoeing modification. Simply cutting out a "V" shaped window directly over the frog in a thick leather pad with a steel shoe may be helpful to achieve this. Additionally, a urethane pour-in pad may be added to the sole excluding the frog as another means of unloading this region. In cases of severe DIP synovitis the author has had favorable results by restricting movement of the DIP through the use of a foot cast placed up to the base of the proximal sesamoids. The bottom of the cast is domed slightly with acrylic to reduce torsion and eliminate as much stress on the joint as possible. The cast would be in place 3-4 weeks depending on the clinical progression of the patient.

## IV. DIP Collateral Ligament Desmitis/Desmopothy

Injuries of the DIP collateral ligaments have been shown to be a significant source of foot lameness that may be difficult to diagnose.[19] The primary goal of the corrective farriery for collateral ligament injuries is to reduce tension of the injured structure.[20] Again, the need for radiographs of the digit is imperative to provide a balanced trim and eliminate medio-lateral imbalance issues. For an injury of the medial collateral ligament the corrective shoeing consists of providing more support (wider branch) on the medial side, with improved rolling effect on the lateral (opposite) side and vice versa if the lesion is of the lateral collateral ligament. The ground reaction force (GRF) is greater on the side of the shoe with the wider branch and therefore prevents the affected/injured ligament from being stretched and further traumatized. Additionally, the rolling effect of the opposite side of the shoe prevents excessive strain of the injured ligament when the horse is turning and breaking over in a medio-lateral direction.

## V. Pedal Osteitis

Pedal osteitis is primarily caused by trauma to some aspect of the solar surface of the foot. Historically, flat-footed horses have been prone to this type of lameness. In the author's opinion, horses with low palmar angles and horses with varus or valgus deformities of the distal limb are more commonly affected. This is most likely due to chronic overloading of a focal region of the foot due to the anatomical variation of the horse. The shoeing goals for cases with pedal osteitis are to protect and stabilize the hoof capsule, unload compromised areas, and provide support to areas of load transfer. Radiographic evaluation of the digit is always necessary to properly develop a shoeing protocol for these cases. Horses with pedal osteitis are often refractory to concussion. Therefore, adding a pad to the shoe to dampen vibratory forces is helpful. Unloading different regions of the foot using a bar shoe and heavy leather pad cut out in such a way as to "float" the affected area may also be beneficial.

## VI. Suspensory ligament injuries

Most authors agree that elevation of the heels causes more stress on the suspensory ligament (SL).[21-23] Therefore, elevating the heels of a horse with a suspensory ligament injury would be counterproductive. Shoeing goals for these injuries are to reduce tension of the suspensory ligament at rest and prevent further strain on the structure when the horse is loading the limb. Increased toe length increases the lever arm on the PIP and MCP joints, thereby increasing the strain in the SL and predisposing horses to injury.[24] Again, the foot must have a balanced trim with the aid of radiography to

assure adequate digital alignment is reached. JM Denoix recommends a shoe that is wider at the toe than the heels to prevent a wedging effect caused by GRF in soft footing. Egg-bar shoes have been used by veterinarians and farriers in the past in an attempt to treat injuries to the SL yet this shoeing protocol creates more stress on the SL[21] and in the author's opinion is not recommended.

## VII. Multiple injuries

When multiple injuries are identified on MRI imaging, often one lesion is more significant than the others and can be identified at the source of pain.[3] However, some situations arise when several lesions are dramatic. In those instances, the shoeing protocol should complement the healing of each structure and not create a situation in which further injury of a structure is induced by the shoeing. Additionally, the shoeing protocol should include advances to promote healthy hoof growth and improve on existing morphologic hoof capsular distortion.

## VIII. Summary

The current use of MRI for aiding in the imaging and diagnosing of distal limb lameness has been unsurpassed. Veterinarians are now able to develop treatment protocols specifically for injuries that were once treated by ancillary means. Included in this treatment regime is therapeutic farriery. The use of the strategies and theories discussed in this article will allow the veterinarian and farrier to further aid the equine patient.

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