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Examination of the Equine Foot

William Moyer, DVM and G. Kent Carter, DVM, Diplomate ACVIM

Authors’ address: Texas A&M University, Department of Large Animal Medicine and Surgery, College Station, TX 77843-4475; e-mail: wmoyer@cvm.tamu.edu.

Introduction

This paper is intended to deal with the most basic and important aspect of veterinary practice and that is conducting a “hands-on” examination. The physical examination is the beginning point; it is the one aspect of veterinary medical practice that is expected, affordable to the consumer, and remains the single most useful overall determinant in arriving at a diagnosis or diagnoses; treatment without an accurate diagnosis is problematic. How veterinarians examine a given horse is based on how they were initially taught, their experience, and methodologies borrowed from a myriad of past and present equine practitioners. The procedure to be described is purposely long and detailed; however, the actual performance of such an examination takes minutes to perform. The intent is to be complete, consistent, and ultimately it will become habit. It is apparent that an unknown percentage of cases occur in which an absolute diagnosis at the time of examination is not possible as there is simply insufficient information available other than having proven that the pain and thus lameness originates in the foot or feet. The past few years has increased our knowledge of anatomy,1,2 technological advances in imaging,3,4 and the use of diagnostic anesthesia.5 Such information has provided “new” diagnoses and questions concerning “older” diagnoses (navicular disease/syndrome being the prime example). A consistent and thorough physical examination in combination with an accurate history is often the only entity to ‘point the way’ in the absence of access to more advanced forms of imaging or to interpret findings utilizing imaging technologies.

The success of any physical examination is dependent upon a working knowledge of anatomy, the ability to control the animal, experience and a willingness to be thorough and consistent. The past few decades have been blessed with wonderful advances in imaging and computer technology, but many cases do not require such interventions and, as is often the case, cannot be afforded by the client. Such advances, however, also have limited value without an accurate history and thorough examination. The old platitude, “more diagnoses are missed from not looking rather than from not knowing” persists. This paper is about the “Looking” part.

Foot problems, considered as a group, are generally thought to be amongst the most common cause of lameness in horses. The list of conceivable insults and problems is extensive. Foot and shoeing problems are also thought to influence or act as initiators of problems elsewhere on the muscular-skeletal system such as the use of toe grabs in Thoroughbred racing and relationship to the incidence of suspensory ligament injuries. An individual horse’s foot, regardless of age or breed of the horse, is a reasonably small object that is easily viewed, handled, and manipulated (assuming the examiner is physically able and the horse willing) yet as an anatomic unit accounts for a myriad of frequently occurring and recurring problems.
Unfortunately, interpreting what may be seen or discovered upon examining a horse’s foot can be confusing. Any given foot may demonstrate several co-existing abnormal findings or be found concurrent with problems elsewhere on the musculo-skeletal system. Abnormal findings must be interpreted with the whole horse and in light of the clinical history. We believe it to be philosophically important to approach such an examination with the consistent goal of being complete and open-minded. A practiced and consistent examination procedure is likely to provide accurate results.

The examiner must develop a meticulous, "hands on" appreciation of foot anatomy. The construction of the majority of the foot is such that one does not have the ability to visualize or palpate structures within the hoof capsule, thus, the skilled examiner “sees and manipulates” the foot as if he or she had “x-ray vision” by trying to visualize the deep structures as if examining a radiograph of the structure. Such vision only comes with more than a casual appreciation of internal anatomy, a consistent ‘practiced’ approach, and constant correlation of radiographic or other imaging modalities findings to what is seen/palpated or determined with hoof testers and/or nerve blocks. It is very helpful for the examiner to have a thorough appreciation of the wide variety of possible disorders. The following list represents possibilities by their location:

**Coronet** - direct trauma/bruising, foreign body penetration and infection, laceration, avulsion, displacement, dermatopathies (fungal, chemical, allergic, parasitic, neoplastic, and idiopathic) also termed “coronitis,” cracks and scars.

**Hoof wall** - cracks at any location (to include the bars), wall separations, wall loss or avulsions, hoof wall growth abnormalities (focal absence of growth and shape changes such as flares, dishing, bulging, and ring formation), excessive or inadequate length, and poor hoof quality (flaky, brittle, excessively soft/weak).

**Sole** - solar bruising; external solar penetration and infection; solar laceration or loss/avulsion; internal solar penetration following solar prolapse via the 3rd phalanx (severe laminitis); excessively thin, weak, and/or flat.

**Laminar wall tissues** - laminitis, keratoma, infection, hematoma and tearing, invasion via canker/sarcomoid/squamous cell carcinoma, abnormally cornified as the result of chronic wall separation, so-called “white line disease”, disorientation of laminar pattern from known and unknown sources, and toxic insults (e.g., selenium toxicity).

**Frog** - thrush, canker, penetration and infection, loss via avulsion, bruising, and atrophy.

**Heel bulbs** - direct trauma and bruising, laceration, avulsion, dermatopathies (fungal, chemical [often iatrogenic from foot remedies or “soring” practices], allergic, parasitic, neoplastic), abscessation and infection, and cracks.

**Navicular bone** - absence (agenesis), navicular disease and “syndrome”, fracture, ligamentous damage (impar and suspensory ligaments), infection (osteomyelitis), proximal displacement (impar ligament disruption), and incomplete ossification.
**Navicular bursa** - non-infectious and infectious (penetrating wounds) bursitis and partial or complete obliteration via adhesion formation.

**Deep digital flexor tendon and sheath** - tendinitis, severance or detachment at the 3rd phalanx, degenerative and adhesive tendonitis (often the result of navicular disease or bursal infection), tenosynovitis (infectious [penetrating wounds] and non-infectious), and flexor tendon contracture.

**Ligaments** – desmitis, calcification, and disruption of the medial and lateral collateral ligaments of the coffin joint, impar and suspensory ligaments of the navicular bone.

**Digital cushion** - atrophy, absence, penetration and infection, extension of canker or thrush.

**Third phalanx** - fractures (types 1-V); infection (septic osteitis); rotation and/or displacement within the hoof capsule: absence (agenesis) and incomplete ossification; pedal osteitis (this is a radiographic description of solar margin bony loss and widening of vascular channels and perhaps should not be considered a diagnosis); focal loss of bone as a result of space occupying lesions (keratoma), bone infection, or avascular necrosis; extensor process damage (fractures, common/long digital extensor tendonitis [soft tissue calcification can be mistaken for an extensor process fracture]).

**Coffin joint** - arthropathies (infectious, traumatic, iatrogenic, subluxation, luxation), ligamentous damage [collateral ligaments], osteochondrosis, and intra-articular fractures of 2nd or 3rd phalanges); extensor process damage (fractures, common/long digital extensor tendinitis at attachment, focal calcification of common/long digital extensor tendons (can be mistaken for an extensor process fracture).

**Collateral cartilages (medial and lateral)** - ossification (sidebone), infection or aseptic necrosis (quittor), and fracture.

**Palmar digital artery** - occlusion (thrombus) and transection

**Palmar digital nerve** - transection and neuroma

The above abnormalities may exist in combinations. That is, an individual foot and/or horse may have multiple problems or findings. For example, the same foot may demonstrate third phalanx rotation, septic osteitis and bone loss, penetration of the sole; deep flexor tendon contracture, and subsolar infection. Horses with quartercracks often show evidence of subsolar bruising, long toe/low heel conformation, and radiographic evidence of P3 marginal changes (so-called “pedal osteitis”). Failure to recognize the total situation could easily lead to inappropriate/incomplete therapy and/or inaccurate appreciation of the prognosis.

The clinical signs for each problem or combinations of problems of the horse’s foot may lead to a given diagnosis or diagnoses, but in most cases, foot problems often share similar clinical findings (lameness of varying degrees, shared similar responses to hoof testers, and response to diagnostic
local anesthesia). For instance, a mild case of laminitis and bilateral sub-solar bruising can present with a very similar set of clinical findings without further diagnostic work-up.

**History**

Obtaining a useful and accurate history is critical to performing a good examination. Hopefully, it is an ability that improves with experience and coaxing useful information from clients/owners/trainers. A history may provide an instant diagnosis (horse stepped on a sharp object) or a variety of clues which lead to the diagnosis. It is also very important to understand that the useful and critical information may not be forthcoming, that is, do not assume someone will automatically provide such – one has to ask for it and in a format that is both understandable and non-threatening. Unfortunately, clear and accepted terminology for the various conditions, trimming/balancing/shoeing practices is still elusive in veterinary medicine; thus familiarity with common vernacular is important as well as an appreciation of the shoeing practices that may be specific to a given sport such a gaited horses and Standardbred racehorses.

Hoof wall growth is a reasonably rapid process that does respond to both internal and external factors, thus historical information may lead to why a given abnormal hoof wall shape or condition exists. Thus, the examiner should attempt to discover those factors which may have affected the individual patient.

Many horses are affected, for better or worse, by horseshoeing. The art and science of horseshoeing is an ancient practice but unfortunately clear and universally accepted terminology exists and is not universally utilized. For example, the terminology (shoe types and trimming practices) can vary remarkably from one breed/sport type or farrier to the next. The language and terms used to describe how a given Standardbred trotter is trimmed, balanced, and shod may be totally different from the language and terms used to describe how a Thoroughbred racehorse is handled. For example, a Standardbred racehorse farrier may indicate that a given horse is “balanced” which in their parlance means the horse, at racing speeds, is not hitting or interfering. In the event of confusion it is best served to ask or be shown as opposed to pretending knowledge. It is also important to note that a given horse on the day he or she is examined may well have been shod differently prior to the examination. For example, a Thoroughbred racehorse with a hindleg lameness of three weeks duration may have been shod with outside heel caulks to handle a muddy track three weeks ago, and recently reshod with standard aluminum racing plates.

The questions asked in obtaining a good history will vary with the patient. Many answers are often obvious and assumed, while others must be pursued and based on the individual. The following represents some salient questions and their rationale:

1. What is the presenting problem and how long has it existed? Is there a pattern to the lameness and what does the owner/trainer suspect is the problem and the cause? It is prudent to never assume an owner or trainer will volunteer useful information - it is best always to ask.
2. The breed, or more importantly, the sport type, may provide information regarding the incidence (likelihood) of certain foot problems. There appears to be a predilection for certain problems based sport type and breed, such as the following list observed by the authors while noting that foot abscesses, bruising, laminitis, and thrush tend to be ubiquitous.

**Thoroughbred and Quarter Horseracing** - foot bruising, “pedal osteitis,” P3 fractures, heel bulb damage (from overreaching), quarter cracks, nail problems, sheared heels, and long toe-low heel related problems such as heel pain.

**Standardbred harness racing** - heel and quarter cracks, foot bruising, P3 fractures, “pedal osteitis,” heel bulb damage from cross firing. It should be noted that Standardbred racehorses are the most frequently shod of all sport types and they tend to train and race on less forgiving and more abrasive surfaces (this has significance when attempting to determine the presence or absence of abnormal shoe wear as well as interpretation of its meaning).

**Rodeo sports and polo** - pulled shoes and subsequent hoof wall loss, navicular disease and related problems, 3rd phalanx fractures.

**Show jumpers, 3-day event horses** - foot bruising, pulled shoes and hoof wall loss, navicular disease and heel pain, quarter cracks, and a high incidence of weak walls resulting from constant exposure to excessive bathing and detergents (a common practice in the show horse world).

**Gaited horses** (Morgans, American Saddlebreds, Tennessee Walking horses and Arabians) - hoof wall loss, hoof wall cracks at any location, and thrush. These are perhaps the most difficult horses to shoe properly as a result of the shoe-affected movement that the gaited show horse community desires.

**Endurance and trail horses** - foot bruising, hoof wall loss as the result of pulled shoes, heel bulb damage from overreaching, and fatigue but often have some of the strongest feet in the equine athletic world (possibly a function of both horse selection to ‘do the job’ and constant athletic exercise).

**Turned out horses** (all breeds) - hoof wall loss and breakage, superficial hoof cracks, abscesses, and laminitis as this group of horses is susceptible to environmental/weather/pasture growth conditions and neglect.

**Morgan horses, ponies (of all breeds), older broodmares and stallions, heavily campaigned show horses** - high incidence of laminitis, which is perhaps related to body type (tendency towards obesity), lack of physical activity, and drug administration in show horses.
Draft horses - heel bulb damage from overreaching, hoof wall loss and cracks, cannon, thrush, and lateral hind foot wall flares and wall separations.

3. Establish when the horse was last shod or trimmed. Foot problems (acutely lame) that follow shoeing within a few days may imply that a poorly placed nail or nails exist, that the nails were over clinched, or that the feet were excessively trimmed. It is also important to ascertain if the farrier discovered any problems or has had to deal with ongoing shoeing problems. This might include horses that are difficult to shoe because of behavioral problems, thin walls and poor quality feet, continual evidence of bruising, thrush, etc. Irregular trimming/shoeing patterns may well prove to be either a cause or contributor to the problems at hand.

4. Evaluate the environment that the horse lives in, trains on, and competes on; and the management scheme the horse is subjected to. In the authors’ experience, the environment plays a major role in the condition of the hoof capsule and the genesis of foot damage. The time of the year and the surface conditions can dramatically change the feet and the condition of the hoof walls, frog, and sole. For instance, a horse training on a stone dust track may show very rapid wear of the shoes; whereas the same horse and shoes training on a deep, soft sand track may show very little evidence of shoe wear in 6 to 8 weeks. Foot bruising, “pedal osteitis,” and third phalanx fractures are more likely on hard "fast" surfaces than on grass or deeper surfaces. Horses that are subjected to wet grass in the morning and hot dry conditions later in the day will often develop weak hoof wall material, separated walls, “white line disease”, and are more prone to losing shoes. Knowledge of the environment and management can influence the treatment and prognosis. Some foot problems are more likely to do poorly or well simply by changing the surface that the horse has to live, train or compete on.

5. Ask how the horse has been shod in the past (with what type of shoe and at what intervals). A change in shoe types may be the problem as well as the solution. The use of traction devices on the shoes (toe grabs, block heels, screw-in calks, borium, etc.) can act as impact concentrators and can be, in the authors’ experience, the cause of foot problems, especially foot bruising. The examiner must have an appreciation of shoe types and the nomenclature used by the farrier profession.

6. Information about the previous history of foot problems and other lameness problems is essential. The horse being examined may have previously experienced episodes of foot abscessation or laminitis. In the authors’ experience the likelihood of recurrence is high. Farms and ranches with a consistent pattern of foot problems realistically should be examined from a total management perspective (pasture, housing and environmental exposure, farrier regimen/expertise, etc.)

7. Obtain reasonable detail about the previous treatments if you are examining the same ongoing problem but for the first time. This will help to prevent the use of similar, but previously utilized, unsuccessful treatments.

8. Discussing the horse and problem or problems with the horse’s farrier can be rewarding but it is very important to show common sense and discretion. For example if you believe the problem to be the fault of the farrier, discuss this with the farrier rather than the client. The farrier may know or suspect what the problem is
and will feel more ownership in solving the problem as opposed to being perceived as being the problem.

**Equipment**

Specific equipment is necessary to completely examine the foot. The use of some equipment requires expertise and experience to be used properly, or at least to prevent being used improperly. The following is a suggested list:

1. **hoof testers**
2. **shoe pullers**
3. single nail ("crease") pullers
4. **hoof knives and sharpening tools** (a dull knife can be useless as well as dangerous)
5. **rasp**
6. clinch cutters and a clinching tool
7. hoof nippers (standard as well as half-round nippers which are very useful removing large sections of abnormal hoof wall material)
8. **shoeing apron**
9. shoeing hammer
10. flexible probes (exploring abscesses, tracts, and defects)
11. portable motorized tools (variable speed)
12. wire foot brushes (significantly improve the ability to thoroughly examine the weight bearing structures as well as enhance radiographic quality)
13. Hoof gage (hoof protractor)

Most of this equipment has obvious application and requires very little explanation or discussion; however, others require careful selection by the individual examiner.

It is **prudent to use a shoeing apron**. Shoeing apron provides protection to the examiner and also helps to grip the limb being examined. The protection factor cannot be overemphasized whether one is examining a young foal, a racehorse, or a large draft horse. It is also a means of keeping reasonably clean and professionally appearing while working with dirty feet and legs.

**Hoof testers** come in a variety of shapes and designs. They are an **absolutely necessary** piece of equipment and should therefore be selected for the individual examiner and his or her practice. Hoof testers are more useful if they are light and small enough to be able to operate comfortably with one or both hands as well as strong enough to endure the years and circumstances of equine practice. The most commonly encountered failings of hoof testers are: too large to accommodate a small foot; too small and of insufficient strength to handle the large foot; poorly hinged (too loose, too tight, or bent); and insufficient grip at the contact points allowing for slippage. It is also worthwhile to have varying sizes to accommodate all variation in foot size, particularly if you work on a variety of horse sizes.

**Hoof knives** are also best individually selected by the examiner. This author prefers a handmade, looped, double-bladed type for most work. It is imperative to have and carry spare knives (they will
break, wear out, get lost, etc.), as well as a sharpening stone or "stick" that is designed to also sharpen the curl at the end of the knife. Take the time to learn how to properly put and keep an edge on hoof knives from a farrier. Less conventional tools exist for all types of specific jobs such as grooving the hoof wall, exploring abscesses, etc. They are helpful and practical if the examiner does a great deal of foot work.

**Flexible probes** are cheap and very useful. The author prefers the plastic applicators used for culturing tissues. The flexibility is a safety factor not shared by rigid or breakable probes.

**Shoe pullers** are a necessity. They are utilized to carefully elevate and remove the shoe. The procedure should consist of straightening/rasping or cutting the nail clinches and then elevating the shoe. Inappropriate elevation and/or failing to remove or file the clinches can result in hoof wall loss. The **individual nail puller** (crease puller) is, by its design, able to elevate an individual nail head (after the clinch has been rasped and cut) so it can be removed without loosening the rest of the shoe and nails. This is a useful tool when dealing with a single nail problem or removing shoes from shelly footed horses to prevent hoof wall breakage which may occur using standard shoe pullers. It is a must when dealing with racehorses as one often can help individual horses by removing a single nail (usually the medial heel nail) without having to have the shoe reset or the individual horse that has a particularly painful foot problem and thus the shoe can be removed with considerably less pain.

**Portable motorized tools** are made by several manufacturers. They are primarily useful for removal of hoof wall material. The ideal, in the author's opinion, is that which is capable of at least 25,000 rpm, is small enough to be operated with one hand, is reasonably quiet, and that can be fitted with several size cutting burrs, drum sanders, and drill bits. The authors prefer equipment that features variable speeds. Examiners that do a great deal of foot work are well advised to have a "back up" set because they will wear out, break, malfunction, etc. Those units with re-chargeable batteries are, in the authors’ opinion, presently incapable of sufficient speed and torque, and the batteries are often dead when most inconvenient.

**Hoof nippers** are available from a wide variety of manufacturers and can be purchased in different sizes (lengths) and nipper head shapes (straight and half-round). We suspect most practitioners would prefer the standard 12” – 14” length nipper. The half-round nipper provides the clinician with the ability to remove reasonably large and specific sections of the hoof wall and thus reduces the work if one were so do so with a hoof knife and/or rasp.

A **shoeing hammer** is useful diagnostically and occasionally helpful to reset a shoe or replace a loose nail. Focal percussion of the hoof wall, sole, and frog help facilitate locating focal pain. Hammers can also facilitate testing of the foot. For example, the hammer head can also be used as a foot wedge (laid on its side with the foot bearing weight at the toe, heel or individual quarter), or the handle can be used to place focal pressure on the middle of the frog with the horse bearing weight on it (the handle bottom is placed in the direction the horse is facing, the foot being examined is placed on the end of the handle so that the frog is bearing weight while the opposite limb is held up). The **hoof gage** (protractor), in the authors’ experience, has limited value unless it is utilized consistently by the same operator and thus can potentially provide repeatable information. They are
very useful to point out to an owner or trainer obvious discrepancies in hoof angle. Its true value lies with the farrier. Its use in harness racing is much greater than that in other sports.

A shoeing rasp is a necessary tool to help remove clinches and thus shoes, improve visualization of the white line, and to help to remove excessive or separated hoof wall material, which if left in place is likely to break off or act as a trap for foreign material.

**Examination Procedure**

The feet are best examined initially at a distance of approximately twenty feet on a flat surface. This allows for comparison of all four feet. One is assessing the size, shape, toe and heel length, approximate angles (toe, heels, quarters), and the position of each foot relative to each limb (limb conformation) and to each other. Subtle differences in foot shape and angle are best appreciated at a distance. Overall conformation should also be assessed as it clearly affects foot shape and wear.

**Examination in the Weight Bearing Position**

Each foot is examined with the leg in the weight bearing position. Palpate and carefully examine the following areas:

1. Palpate the palmar digital vein, artery and nerve bundle. Check for neurectomy scars (clipping the hair and/or wetting the skin may assist in their detection if necessary or suspected). Lightly palpate the character of the arterial pulse and compare with other limbs if in doubt as to whether it is normal or abnormal. In many foot-related abnormalities, such as abscess, laminitis, or bruising, the character of the pulse in the affected foot is stronger than in the other feet, especially after exercise. A very useful test, especially when examining horses without clear evidence of where on the limb or limbs the lameness (or performance related problem) is originating from is to subjectively evaluate the digital pulse intensity prior to exercise – followed by an immediate (as the horse pulls up) evaluation. It has been the authors’ experience that pulse intensity will increase (often for a brief period of time) following exercise. Lack of such a finding does not preclude, however, the presence of a foot problem.

2. Examine the heel bulb area. This is a common site of various dermatopathies, damage from trauma, as a point of exit for underlying focal and generalized infections. The position of one heel bulb to its mate provides information regarding heel/foot conformation and foot balance.

3. Palpate the deep digital flexor tendon and the digital sheath at the level of the pastern and continue the palpation as the structures disappear into the heel bulb region. We suspect with the continued introduction and refinement of imaging modalities the importance of these structures as they relate to the diagnosis of foot-related lameness will increase.

4. Palpate and manipulate the collateral cartilages (medial and lateral). One should be able to define the palmar proximal edges of these cartilages. Assess the structures for their degree of pliability and the presence or absence of pain or swelling or drainage.
5. View and palpate the coronet from the medial and lateral heel bulbs to the central toe region. On the normal foot the coronet should sweep evenly towards the heel bulbs and one should appreciate a spongy feel at the margin of the hoof wall (the underlying coronary cushion). Any deviation from this normal sweep/contour (proximal displacement, for example, or feel (swelling, discharge, focal pain and/or heat, absence of tissue, sinking and/or cleft formation, etc.) should be examined more closely and noted as being abnormal. The approximate location of the dorsal aspect of the coffin joint is just proximal to the palpable coronary cushion and thus should be palpated to appreciate the presence or absence of joint effusion. This is best appreciated by applying pressure in the area of the joint along the edge of the digital extensor tendon.  

6. Palpate and examine the entire hoof wall carefully for the presence of fissures, cracks, bulges, growth abnormalities, local heat, wall loss or breakage, etc. Often quarter and heel cracks begin as very fine fissure defects at the coronet that extend less than 1 inch distally. These fissures can be easily missed but may be a cause of foot pain and lameness. Further information can be attained on white-footed horses by applying water to the walls as it makes the horn material more translucent (in some instances evidence of discoloration, usually hemorrhage, can be detected in underlying laminar tissues). Note the quality of the horn and the presence of variation away from the normal parallel horn tubular arrangement. 

6. Examine the exit position relative to the bearing surface of the foot, exit hole, and clinch of all shoeing nails if the horse is shod. The higher the exit point, the more likely that the individual nail is in or next to sensitive tissue. Over clinched nails and/or loose nails are worth noting. 

7. Gently tap the hoof wall with a closed pair of hoof testers or a shoeing hammer as one may detect evidence of pain or wall separation. 

8. Reminder – hind feet deserve the same degree of consistent evaluation as do the front feet. 

**Examination with the Foot in the Non-Weight Bearing Position**

Each foot is then examined in the non-weight bearing position. Again, it is good practice to wear a shoeing apron to protect yourself and to facilitate the exam. Learn how to assume the stance and posture that an experienced farrier uses as this will provide greater comfort for both the examiner and the horse as well as place the examiner in a better mechanical position. The suggested procedure is as follows with the unshod foot.

1. Begin by cleaning the bottom of the hoof using the dull side of a hoof knife, steel brush, hoof pick or the handle of the hoof testers. Greater visualization is often acquired with a wire brush and is highly recommended. Lightly pare away any debris that obscures an accurate visualization of the frog, sulci of the frog, sole, and white line if the horse is unshod. **Do not use a hoof knife as an exploratory instrument** without an accurate appreciation of sole depth which can be estimated with digital pressure and hoof testers. Examine the following:
a) The frog (size, shape, consistency, position it exists in relative to the foot (centered, directed medially or laterally, etc), whether it is securely attached to the underlying tissue) and its sulci (medial, lateral, and central). The depth of the central sulci can be determined and explored atraumatically with the dull side of a hoof knife blade or hoof pick.

b) Medial and lateral bars of the foot usually require light paring or brushing to appreciate problems such as bar cracks. Keep in mind that some horses have had the bars pared out. This has been a standard practice for some farriers and may represent a problem with regard to total support of the sole and deeper structures.

c) The entire sole of the foot should be carefully examined for fissures, punctures, consistency, discoloration (bruising) and the degree of concavity. The consistency (relative degree of stiffness) is easily determined with digital pressure, as well as with hoof testers. Focal or general areas of sensitivity are often significant.

d) The white line is examined to determine its width and character. The white line is usually wider at the toe and gradually tapers to a thinner structure as it approaches the heels. It is best visualized either with a wire brush, light paring with the hoof knife, or lightly rasping the area (key word being lightly).

e) Determine the symmetry or lack thereof of the bearing surface of the foot.

2. The bulbs of the heels are examined to determine their relative position (height) to one another. The strength of the caudal foot is assessed manually by attempting to distract the two bulbs from one another in a vertical direction as well as determining caudal foot mass. Digitally explore the heel bulbs for the presence of swelling, heat, pain or separation at the coronet. Re-palpate and manipulate the deep flexor tendon and sheath specifically for differences in width, the presence of effusion, or evidence of pain with digital pressure.

3. Lightly support the leg at the cannon bone and allow the foot to drop naturally. Position your line of vision so as to appreciate foot balance and levelness of the walls. Admittedly, determination of foot balance is difficult as the so-called ‘ideal’ foot balance has not yet been defined.

4. Examine the entire bottom of the foot to determine the relative proportion that the divisions of the foot (toe, quarters, heels, and frog) occupy. Imagine a line drawn through the center of the axial skeleton of the limb, transecting the bottom of the foot and then determine the relative proportion of the medial and lateral foot to this imaginary line. For example, a given foot may demonstrate a unilateral medial heel contraction in combination with a flared lateral quarter.

5. The foot is next examined with hoof testers. It is prudent to always begin hoof tester application with light pressure to make a subjective evaluation regarding the individual horse’s response. Some horses are more sensitive to manipulation than others regardless of the presence or absence of pain while others simply have thin
walls and soles in which case a response is likely. Abnormal responses should be compared to the other feet and repeated to be sure they are consistent. A suggested sequence is:

a) Begin with the medial bar to the medial heel wall.

b) Place the testers on the medial sole to medial heel wall and continue at approximately 1” intervals to the lateral wall and lateral bar. Be sure to include each exit point of the shoeing nails. At each interval look carefully at the junction of the wall and sole (white line) as pressure is applied – one may detect separation, presence of fluid/exudates, or significant movement of the sole suggesting underlying cavitation. One is not just attempting to determine the presence or absence of pain but also is characterizing the strength and character of the hoof capsule.

c) Place the testers at the medial quarter wall, midway between the bearing surface of the foot and the coronet, to the lateral middle aspect of the frog. Repeat this procedure on the opposite side of the foot. Place the testers in the middle bearing surface of the frog to midway between the coronet and the bearing surface at the toe. Finally, place the testers across the medial and lateral quarters in an attempt to isolate the length of the navicular bone. Keep in mind that hoof testers are essential, but not foolproof. Hoof testers do not apply pressure to the foot in the same direction and manner that the foot experiences with contact with the ground and the depth and strength of wall and sole material have a protective influence. It is not rare to ultimately discover a significant foot problem (3rd phalanx fracture, laminitis, navicular disease, etc) in the absence of a meaningful response to hoof testers. In the event of a “positive” hoof tester finding (evidence of pain via reaction) it is prudent to complete the examination and re-test the area of discovery, i.e., to be sure that the positive finding is repeatable.

d) Gently tap the structures on the bearing surface of the sole and frog with the rounded end of either closed hoof testers or a shoeing hammer.

6. Repeat the palpation of the collateral cartilages and the coronet. Palpation of the extensor process of the third phalanx region and the associated coffin joint can be facilitated by bringing the leg forward and flexing the toe caudally.

7. Palmar flexion of the lower limb is performed with the fetlock in somewhat of a fixed position. One is manipulating both the pastern and coffin joints to determine range of motion and presence or absence of a painful reaction. Rotate (twist) the foot medially and laterally around the vertical axis of the pastern. This manipulative test, as with any joint manipulation, is quite subjective, and is also subject to much inter-examiner variation and individual horse response. In the event of a positive reaction, it is prudent to repeat this portion of the examination after the horse has been jogged to determine if this either creates or enhances lameness.

The procedure and technique is the same if the horse is shod, but the following is added:
1. The examination begins by tapping the shoe with closed hoof testers or a shoeing hammer at one inch intervals as this greatly facilitates cleaning the bottom of the foot as well as alert the examiner to the presence of pain (often associated with a poorly placed nail or nails) or a loose shoe.

2. Make note of the shoe type and the presence or absence of additions such as toe grabs, block heels, trailers, etc.

3. Determine the security of the shoe to the foot.

4. Carefully examine the shoe for abnormal wear.

5. Position the hoof testers and utilize the same procedure described above. The presence of full or partial pads may influence the findings.

- **Caution** - it is best not to remove the shoes, or shoes and pads, until the horse has been examined in motion and/or subjected to diagnostic local anesthesia demonstrating convincing evidence of the presence of foot pain/problems. Consider that removed shoes are not only costly to the client but often are protective for weak footed shoes. It is not unusual following the removal of shoes on horses who are both with or without foot problems to become tender/painful as they may not be used to being without shoes. If a given horse is to go without shoes for a period of time it is useful and thoughtful to protect the foot with a few layers of duct tape, perhaps padding, and suggest that the horse remain confined until shod.

Carefully **record your findings** as it is easy to forget subtle discoveries which may ultimately determine how the horse is going to be treated or shod.

**Examination with the Horse in Motion**

This aspect of the examination of the foot is best accomplished with the horse being led, ridden-driven, or lunged on a flat, hard surface, if available. The question of what surface or surfaces are best (in a hospital or clinical setting) is best answered by considering the sport type that a given practice is most likely to work on. For example, the authors find the assessment of particularly subtle lameness/performance problems in Standardbred racehorses is best determined at a suitable training or racetrack. Ideally for most horses (pleasure, hunter/jumper and Western performance) a well drained asphalt or concrete surface that is of sufficient size to safely jog and/or lunge a horse works nicely. In those instances, particularly the very subtle problems are best served by viewing the horse under the circumstances in which they train and compete. This may include: training/race track, arena suited for dressage and jumping, rodeo arena to watch roping events and barrel racing, etc. Realistically most lame horses are viewed where they live which at times can be less than ideal. The authors also prefer, when possible, to have the horse ridden if the lameness is subtle or intermittent simply because, assuming a reasonably experienced rider/driver, the individual on the horse can relate changes in motion following manipulative tests and diagnostic anesthesia (but surely not a situation if one is dealing with a patient demonstrating significant lameness or the possibility of further injury). The authors routinely utilize flexion tests, use of hoof testers, and other means of enhancing the information base with a rider up. Initially a given horse under these circumstances is walked away from and back toward the visual plane.
The examination of the horse in motion begins by having the horse walked away from and back toward the examiner’s visual plane. The visualization is enhanced if the examiner lowers his or her view by crouching. Examine the foot strike for each foot. Try to determine if the foot (and thus feet) lands flat, heel or toe first, medial or lateral hoof first. Appreciate the landing position of the individual foot relative to the vertical axis of the respective limb (does it land under or medial or lateral to this axis). Evaluate the flight path the individual foot takes from foot break over to foot strike. Always include examination at the walk because it is the one gait that is sufficiently slow to detect fine movement and foot landing abnormalities. Repeat the same process when viewing the horse from the left and right sides.

The horse is then trotted (or paced) and visualized in the same manner as at the walk. Circling the horse at a trot or pace will often intensify foot lameness (this is true of most lamenesses regardless of the source of pain), but do not fall into the trap of thinking that the painful foot (or limb) will always show greater lameness when it is on the inside of the circle. For instance if a given patient is being lunged/ridden in a circle with the right front limb on the outside and is suffering from (for example) a medial heel or quartercrack on the right front – he or she may be more lame with the limb on the outside of the circle. In most instances, but not all, horses with high suspensory desmitis will show increased lameness with the involved limb on the outside of a circle. The point being that preconceived notions about the circles/limbs/lameness can be wrong. Be also aware that lameness, regardless of the source, will not always be attended with a discernible head nod (head ‘bob’), a good example being a patient with bilateral problems. Clues that a horse may have a sore foot that does not result in obvious lameness may be decreased performance or an inability to perform a particular task (for example, occasional or consistent refusals to jump, poor performance on a hard race track, a loss of fluid motion in a dressage test, inability to “stop” properly, etc.). Palpation and appreciation of the pulse pressure of the digital arteries can be useful immediately following exercise. Horses clinically free from problems will experience no change in pulse pressures following exercise, in my experience, while those with painful and inflammatory lesion often will. This feature when present can be very helpful in attempting to determine if a given horse with a subtle performance problem is experiencing foot related disorders. Further examination of the horse in motion will be dependent upon the clinical signs seen and often require a rider or driver and further may require that the horse work for a period of time or undertake specific exercises (side passes, sliding stops, jump safe obstacles, training mile, etc.) or in changes in terrain (up and down inclines, variation in ground quality and type of surface, etc.).

Localization of the problem, at this point in the examination, may be obvious and very little further work-up required. However, other cases will require more extensive examination in order to get an accurate appreciation of the location of the problem (or even to identify the limb). In those situations the localization of the problem is usually attained by either increasing (making the problem/lameness more apparent by performing specific tasks or examiner manipulations) or decreasing the clinical signs with local anesthesia. The method or methods of choice are dependent upon the individual examiner, the problem at hand, the individual horse, and the wishes of the owner/trainer. There is no single technique that will always provide accurate results; this unfortunately includes local anesthesia.
Each method or technique has both advantages and disadvantages. Some are easier to accomplish than others and some may depend on the horse and his or her environment as well as the wishes of the owner or trainer. The following additional examination may be performed:

1. Lower limb sustained flexion and/or rotation of the foot may help isolate joint pain. This is easily accomplished and often quite helpful. The authors generally hold the flexion for approximately one minute (unless significant pain exists) and the rotation for 15-20 seconds (as separate events). In the event of a positive reaction (increased lameness) it is prudent to perform the same manipulation on the opposing limb as well as repeating the manipulation to assure consistency of reaction. One cannot isolate a given joint (coffin, pastern, or fetlock) with these manipulations. Positive reaction, particularly when dealing with “experienced” equine athletes, are not unusual. A marked response and increase in lameness, however, is a notable finding. **Caution** – if a given patient is showing significant pain and reaction to the manipulations, simply let the foot down and allow the horse to walk off rather than trot, etc to lessen the likelihood of an accident or a horrified owner/trainer!

2. Sustained or intermittent pressure applied to various parts of the hoof with hoof testers followed by jogging is a very useful addition to the examination. The application consists of intermittent pressure for 15-20 seconds assuming the patient tolerates it. If the patient does not tolerate it, that may also provide a clue to the origin of the lameness.

3. Having the horse ridden (or driven) at various gaits, patterns, and exercises, may help identify the involved limb or limbs.

4. Moving the horses in hand or under tack over varying terrain (hard, soft, inclines, etc.), if it exists, may help to localize and characterize the problem.

5. Foot wedges or items placed under the foot to put pressure on selected area such as the frog are used by some examiners. Their use requires experience to provide an accurate assessment of the results, as well as requiring a manageable horse.

5. **Local anesthesia is the most useful entity in identifying the approximate location of the source of pain.**

**Local Diagnostic Anesthesia**

Local anesthesia remains the most useful clinical tool in establishing the source(s) of pain; however, it has known disadvantages such as:

1. Local anesthesia will only improve lameness that results from pain; that is, it will not improve lameness that results from mechanical problems.

2. Normal variation of the location of nerves/branches can exist and thus confuse results and interpretation.

3. Injectable materials do not necessarily remain where they are deposited; that is, with time (following injection) and motion, their distribution could vary.
4. It is not clear if adjoining synovial structures communicate with one another and how often. For example, does an injection into the coffin joint, digital sheath, or navicular bursa remain in the intended synovial structure on all horses? More recent information indicates that injection of a local anesthetic, for instance, into the coffin joint is capable to desensitizing the navicular region and subsolar pain and thus it is not specific to the joint only. Recent work by Schumachers, Schramme, et al indicates that local anesthetics injected in the area of the palmar digital nerve, at the mid-pastern level, are capable of negating pain in the pastern joint as well. There is no accurate indication that the timing (time of injection to time of improvement) in coffin joint anesthesia has no predictable relevance with regard to determining the source of pain. In summary there is considerable overlap amongst the commonly used techniques and thus an examiner can only guess as to the actually source of pain when dealing with foot problems requiring diagnostic anesthesia.

5. A recent paper indicates the complete anesthesia requires at least 15 minutes and thus it is important that time is allowed for such anesthesia to take place.

6. The authors suspect that some horses who have experienced chronic pain and lameness (months, years) may well have adopted an habitual way of moving even though the pain is negated with local anesthesia.

The examiner with a horse with a sore foot cannot be absolutely sure which or what portion of the structures have been successfully anesthetized. It does, however, help to localize the region that a problem(s) exists in assuming a given horse improves following the procedure or procedures.

The sequence of diagnostic anesthetic injections preferred by the authors is as follows: medial and lateral palmar digital nerves (below the level of the collateral cartilages to prevent possible pastern joint anesthesia) blocks either one at a time or at the same time followed by the abaxial sesamoid block. This will, in the author's opinion, desensitize all conceivable painful foot problems given that the injections are accurately placed and that sufficient time is taken to allow the local anesthetics to work. In the event of and following the use of imaging modalities of choice (or availability) one can (usually not on the same day) utilize the navicular bursal block as it is more “focal” with regard to navicular bone/bursal pain. The usefulness of coffin joint anesthesia to differentiate specific sources of pain is of questionable value based on the most recent research information. If one chooses to utilize the navicular bursal block we recommend practicing the technique on cadaver specimens as well as verifying the location of the needle radiographically or with fluoroscopy – the accuracy of a “blind stick” is such that one cannot be sure of where and thus what structures (tendon sheath or coffin joint) have been injected. The authors recommend allowing at least 15 minutes from the time of injection to the time of evaluation regardless of the technique. The authors further believe it is useful for a “blocked” individual to be walked for a few minutes before further evaluation. The authors fully admit that the order of this process and the selected time periods are arbitrary and based solely on experience. It is important to note and thus warn owners/trainers that some horses following diagnostic anesthesia techniques may be considerably lamer in subsequent days. If the examiner suspects that will be the case, he or she may wish to provide anti-inflammatory medications as well as the warning. If intra-thecal anesthesia is used, the examining clinician should be alert to the possibility of post-injection reactions or infections and thus warn the owner if the
horse is not in the overnight care of the examiner. If multiple diagnostic and/or therapeutic injections are utilized it is wise to consider lower limb bandaging and non-steroidal anti-inflammatory medications.

Therapy as a Diagnostic Tool

The presence or absence of response to chosen therapeutic regimens is with careful evaluation a diagnostic tool. For instance, in the face of dealing with a lame patient who in spite of one’s best efforts has a diagnosis of “I do not know what is wrong” one may attempt a specific therapy and thus gage the success or failure. Examples would be the use of intra-articular corticosteroids in the coffin joint or navicular bursa (done with owner consent). Assuming the horse improves or is sound one can then indicate that one of these two structures is likely involved without positive evidence via imaging. An additional example is the use of pads on suspected, but unproven, subsolar bruising (“sore footed” individuals). The use of more generalized or so-called “shotgun” approaches are difficult to interpret.

Interpretation of Findings

Using a record system that is not only retrievable but more importantly put together in such a way that it is useful months or years later when examining the same horse, is critical. Lameness and performance problems have “a way of getting complicated” especially over a period of time as most equine patients are athletes and acquire problems training, competing, and often with age. A readable and consistent record system is more than useful in attempting to solve problems through a given horse’s career. The authors’ prefer a medical record that denotes the limbs (LF, RF, LH, RH) and the major anatomical sites (foot, pastern, fetlock, etc.). Further it is useful, if not critical in the event of litigation, to get in the habit of using consistent language (including abbreviations) to describe findings and actions. The authors utilize the system of grading the degree of lameness that is consistent with what has become a standard in the literature and initially described by the AAEP (0-5 with 0 meaning no lameness and gradations up to and including 5 denoting a state of being non-weight bearing). One author (Moyer) uses the same gradations (to simply remain consistent) to denote degrees of severity with regards to findings (2/5 pain with hoof testers, for example). The following, by way of example, is the technique utilized by one of the authors (Moyer) with regard to recording information about lame horses in a medical record:

“LF foot – excessively flat sole, low/underslung heel, 2/5 pain with testers @ medial quarter/heel. 2/5 lame in straight line; 3/5 lame circling to the left; 3/5 with testers. Sound with PDN; and RADS – NSF”

“Treatment – ¾” X ¼” flat Al shoes, concaved – solar surface, Bute @ 1gram BID for 5 days, back to work on the 6th day following shoeing. Owner told to call on 7th or 8th day.”

The above notation in the record means that the hypothetical horse had excessively flat soles and an underslung heel; showed moderate pain on the inside heel region; was moderately lame and the lameness was increased with circling and focal hoof tester pressure. The horse was sound following a bilateral heel nerve block, was radiographed and “no significant findings’ were noted. The horse

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was shod with wide-web aluminum shoes that were deeply concaved on take weight bearing off the flat sole. The horse was placed on Bute 2X/day for five days put back into work on the sixth day and the owner/trainer was instructed to provide a progress (or lack thereof) report. We believe the above is very useful information months or years later assuming the horse returns or moves and a colleague is calling to find out what was discovered and performed.

The most challenging aspect of foot and lameness work is the interpretation of findings. A portion of the cases will be very straightforward and present little or no diagnostic challenge. Subtle, intermittent, and/or performance related problems can be very challenging. Particularly frustrating are horses whose clinical signs have changed or disappeared since the owner/trainer first observed the problem, in which case, it may be useful to have the horse worked before examination.

The interpretation of hoof tester examination is a reasonable objective, but it also can provide confusing or conflicting information. There are several reasons for this, such as: hoof testers do not necessarily direct pressure in the same direction as actual foot fall; each examiner applies pressure to greater or lesser extent, and for more or less time, than his or her colleagues; thin soled and walled feet are more likely to react to pressure than feet with a substantial hoof capsule; and some horses will act as though a positive response has been elicited simply because they do not care to be tested. Interpretation of findings, however, is often enhanced by examining an opposing foot and repetition of the manipulation. The use and interpretation of hoof testers is in many ways a learned art form that requires experience and practice. In addition, very useful information about the integrity of the horny capsule may be gained with hoof testers (the depth and resiliency of the sole and wall, defects and motion at wall separation and hoof crack sites, presence of fluids (pus, blood, or serum), and evidence of underlying separation that may not be readily visible.

The interpretation of shoe or bearing surface wear can be very useful but one should be careful to take in all the factors that influence shoe or foot wear. Abnormal wearing of these surfaces is dependent upon the manner in which the foot contacts the ground surface as well as the character of the surface itself. Thus a given horse can be landing in a less than ideal manner but that fact may not necessarily be evident when the shoes are examined if he or she is exposed to soft, forgiving, non-abrasive surfaces (grass, for instance). One way to help avoid missing abnormal shoe wear as a sign of abnormal foot landing is to use a steel brush to clean/semi-polish the shoe surface followed by jogging the horse on asphalt or concrete, followed by re-examination. Abnormal wear can occur from the following: a less than ideal foot flight pattern resulting from conformational problems, lameness and the avoidance of pain, or improper application of either trimming or shoeing practices. An example of foot flight pattern change which often effects shoe wear is that of active degeneration joint disease of the lower joints of the hock (bone spavin) - afflicted horses tend to carry the affected limb or limbs toward the mid-line of the horse and make initial contact with the ground surface on the inside toe and quarter region of the shoe. This is especially evident on Standardbred racehorses training and competing on abrasive surfaces. The interpretation and use of this portion of the examination is then best made by first examining the opposing foot for wear, an appreciation of the horse’s conformation, and the presence or absence of lameness. Abnormal toe wear has often been assigned in the literature to horses experiencing navicular disease, but that has not been a consistent finding in the experience of the authors.
The interpretation of abnormal hoof wall shape can be quite useful but, like abnormal wear, can vary with more than one factor (conformation, trimming and shoeing practices, environment, nutrition, and the presence or absence of problems within the hoof capsule). Generalized distortions may be the result of foot conformation, hoof imbalance problems, generalized white line disease, or laminitis. Focal distortions of the hoof wall may occur as a result of a space occupying lesion such as a keratoma or foreign body, underlying separation of the hoof wall (white line disease, laminitis, submural infections, or mechanical structural damage).

The evaluation and interpretation of “foot balance” (perhaps better thought of in terms of what can be most easily manipulated/changed as “hoof balance”) is, in the authors’ opinion, a difficult and subjective matter. Controversy continues to exist as to what constitutes normal and/or ideal balance. At present hoof balance is described in two broad categories: **morphologic hoof balance** and **dynamic hoof balance**; it is logical to assume that one can surely influence the other. Visual examination of the foot is conducted to appreciate the respective proportion of the foot (heels, quarter, and toe) to the total bearing surface. The “ideal” most frequently proposed is that of a symmetrical foot which consists of the frog dividing the foot into equal medial and lateral aspects and a level bearing surface when viewed from heel to toe. Absolute symmetry is virtually non-existent in nature; surely horses are not symmetrical, nor should their feet be. The relative proportion of the bearing surface of a given foot is determined by the position of the tissues responsible for hoof wall growth and their growth direction/shape, as well as the mechanics of the forces influencing both growth and the tissues (hoof wall material can be distorted), and wear. The examiner must be careful in making a determination of “improper balance” without considering normal and abnormal forces that influence growth, distortion, and wear lest erroneous interpretations be made. For instance, horses with less than ideal conformation are likely to have asymmetrical bearing surfaces. However, in some horses the weight bearing surface may be “in balance” with the crooked or distorted limb, allowing the limb to more efficiently accept the forces of impact for a given conformation and swing pattern. Front to back balance is another aspect of overall foot balance and is generally described in terms of toe length/angle and heel depth/angle. The long toe/low heel foot conformation is undoubtedly a significant contributor to foot and limb disorders. The basic factors in foot balance can be summarized as follows: toe length, hoof angle, mediolateral hoof orientation, wall contour and ground surface, and the symmetry (or lack thereof) of pairs (left and right limbs).9

The evaluation of the response to diagnostic local anesthesia is more objective, particularly if a given patient improves and/or returns to a normal gait after injection, but it also has limitations. The major limitation of diagnostic procedures performed in the vicinity of the foot is the lack of specificity due to the presence of anatomical variation amongst horses as well as the distribution of injected materials. **Diagnostic anesthetic techniques utilized to determine pain within the foot are not anatomically specific.** Positive results (improved or normal) should be interpreted by the examiner as indicating that the pain source is approximately in a region rather than specific anatomical parts.

**Additional Foot Examination**
Often physical examination procedures will not establish a firm diagnosis. In such cases, further examination of the horse's foot or feet will often be necessary to either diagnose or further characterize a given problem. The available techniques vary tremendously in cost, availability, usefulness and the experience required to perform them. The techniques which can be utilized include: synovial fluid analysis; imaging techniques (plain film radiography, contrast radiography, scintigraphy, ultrasonography, computed or digital radiography, thermography, computed tomography, and magnetic resonance imaging); high speed photography analysis; force plate and instrumented shoe studies; and the use of high speed treadmills to analyze motion.

**Synovial fluid analysis** (coffin joint or navicular bursa) may be the only premortem diagnostic test in assessing early joint or bursal infections resulting from puncture wounds, etc. Such information early in the course of the problem can be life saving. We suspect that in the future synovial fluid analysis will continue to evolve and provide accurate information with regard to early detection of joint dysfunction.

**Ultrasonography** is useful to examine soft tissues (deep digital flexor tendon and sheath) as they enter the palmar aspect of the foot. The tissues of the caudal heel can be accessed with ultrasonography through a carefully prepared frog.10

**Plain film radiography** remains the most commonly utilized imaging system of the equine foot but with time will be replaced with digital radiography. Discussion continues to exist as to what constitutes a so-called "foot series". The following views are considered by most as “standard”:

1. Lateral-medial view to assess the dorsal and palmar/plantar surfaces of the phalanges and interphalangeal joints, the hoof wall thickness, position of the coffin bone within the hoof capsule, as well as the four surfaces of the navicular bone.
2. Two (2) and maybe three (3) views of the foot (two dorsal 65-degree-palmarodistal or -plantarodistal oblique views at different radiographic exposures, and possible a 45 degree oblique view). A 65 degree lighter radiographic exposure is used to examine the solar margin and body of the third phalanx, while darker exposures at 65 degrees and possibly at 45 degrees are used to evaluate the navicular bone and the coffin joint. In our experience the lighter 65 degree exposure is often overlooked and often quite useful.
3. Dorsopalmar/plantar view (D-P) to examine the medial and lateral surfaces of the third phalanx, the collateral cartilages, the borders and body of the navicular bone and the interphalangeal joints.
4. Palmaroproximal-palmarodistal oblique view (skyline or flexor surface view) is necessary to isolate the medullary cavity and flexor cortex of the navicular bone and the palmar/plantar (wings) of the third phalanx.

* Additional and ‘creative’ views as variations of the above are often very useful and may include oblique and other views intended to isolate a given portion of the bony and soft tissue structures of the foot.6 More than one exposure may be necessary to
‘capture’ specific regions and thus it is very important to consider the exposure as well as positioning of the horse, film, and machine to accommodate conformational differences.

Based on the results of initial plain film radiographic examinations, special techniques such as contrast radiography or the placement of radiopaque probes may also be required.

Regardless of the techniques employed, it is imperative to clean the surface of the body part being imaged, and, in the case of the hoof to remove the horse shoe whenever possible. Prior to taking the radiographs, the foot should be thoroughly cleaned and the frog crevices and sole packed with a radiolucent medium. It is important to note that foot films taken for the purpose of prepurchase examinations should be taken with the shoes removed or a remark in the record indicating why they were not removed. Proper radiographic exposure, labeling, and processing are very important. Proper radiation safety practices must be used for all persons who are around or are involved with the radiographic examination.

**Scintigraphy** requires the use of radiopharmaceuticals and a gamma camera to produce its image (often referred to as a “nuclear scan” or “bone scan”). Scintigraphy tends to be more sensitive in detecting early bony reaction but less specific than radiography for diagnosing bone abnormalities. The technique is expensive, but is becoming increasingly available.

**Computed radiography** and **digital radiography** are increasingly being used in place of traditional film-type radiography for radiographic examinations. Both computed and digital radiography are types of digital imaging utilizing filmless image detectors, and both allow for digital manipulation of the image to provide better and more uniform image quality. Digital images can be transmitted over computer networks to distant sites.

**Computed tomography (CT)** is an x-ray form of imaging that has been utilized at some academic institutions to produce high detail planar and possible 3-D reformatted images, and in particular for evaluation of bone and joints. “Interventional imaging” (guided injections, implants, and other applications) using computerized tomography and ultrasonography is also a very rapidly growing diagnostic and therapeutic tool.

**Magnetic resonance imaging (MRI)** utilizes the effects of relatively strong magnetic fields for planar evaluation of the equine foot, and in particular for its soft tissues. It is, however, very expensive for both the equipment and the regular maintenance that is required and technically requires significant training. However, units are being placed throughout North America. Currently, both CT and MRI equipment and their examinations are expensive, but they will become increasingly available and useful in the future. MRI has provided information with regard to lesions in the foot that cannot presently be diagnosed by other means.

**Thermography** is an imaging technique that measures infrared emissions and produces a graphic visualization of surface temperature of the object being examined. It appears to have useful application in that it is capable of localizing subtle (and obvious) inflammatory lesions in both soft and bony tissues. A thermogram may be capable of detecting pathology before being visible on a
radiograph. The equipment costs are moderate to high, experience is necessary to both produce quality thermograms and interpret the results, and the conditions of the examination require some control. Hand-held infrared thermometers are available and considerably cheaper, but their usefulness is limited.

**High speed cinematography** for the purpose of gait analysis has been used for the most part as a research tool. The use of high-speed filming and videotape techniques allows the examiner to appreciate motion which occurs too rapidly to be perceived by the naked eye. The usefulness of this technique with foot and shoeing problems is obvious, but the cost of equipment, film and analysis is high and thus a factor. A less expensive, but somewhat of a similar application, is the use of portable video equipment.

**Force plate and other equine kinetic technologies** offer for the most part unique research opportunities as well as clinical application. This includes individually designed horseshoes with strain gauges, floor mounted force plates, the KAEGI computerized equine gait analysis system, and angular motion detection equipment. Such systems are useful, but are expensive and not ‘yet’ a practical situation for other than university or similar large centers. The future may well produce more portable and affordable equipment.

**High speed treadmills** have been utilized for many years to both condition horses and investigate physiological parameters in the exercising horse. The use of such equipment to investigate limb motion and lameness problems appears to have limited value. The equipment is expensive, requires a reasonably large space (usually requiring sound proofing and air handling systems), and can be labor intensive depending on the system employed. The authors suspect that the amount of information from high speed treadmill technology will increase over the next several years but is still somewhat questionable with regards to utilization in lameness and foot/shoeing research because of the fact that the surface is moving and quite forgiving – i.e., a reasonably artificial means of evaluation.

**Developing an Accurate Diagnosis**

The prognosis for any limb problem is an important consideration. The prognosis in most all instances is an “educated guess.” However, statements made by the examiner often determine the decisions made of the owner or trainer. The prognosis of foot problems requires knowledge of a multitude of factors, some of which differ from those influencing problems elsewhere on the limb:

1. The diagnosis or diagnoses is of paramount importance.
2. Whether or not other limb problems coexist will influence the outcome.
3. The duration of the lameness is a very important aspect. The longer a problem or problems exist, generally the more difficult they are to solve.
4. The training and competing environment can be a limited factor. For example, foot bruising, hoof cracks, pedal osteitis*, and similar problems are easily and negatively influenced by concussion, which is in turn influenced by the training and competing surfaces. The time of the year can also influence the surfaces.
5. The sport may dictate the types of available shoe types and corrections possible. For example, Thoroughbred racing is limited in the variety of shoe designs, materials, and shoe weights, etc. The Standardbred racehorse, on the other hand, can often race successfully with a number of shoe designs and types.

6. The expertise of the involved farrier may be the sole reason for the success or failure of a given correction. This means that a solid and trusting relationship must exist between the veterinarian and the farrier.

7. The expectations of the owner or trainer are very important. Chronic laminitis, as an example, is obviously a serious problem, but it may be manageable and of limited significance for a broodmare; a sole bruise, on the other hand, is usually a minor problem but takes on great importance if a given horse is attempting to compete the next day.

The ability to provide an accurate prognosis is dependent upon knowing and understanding as many of these variables as is possible.

Summary

The foot is amongst the most common source of limb pain. The problems vary from being simple to very complex. An accurate diagnosis is dependent upon a thorough and detailed knowledge of anatomy, an appreciation of available examination techniques, and a significant dose of “common sense.”

References