How to Radiographically Assess the Hoof Capsule and Related Lameness Problems

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1. Introduction
Radiography of the horse in most clinical settings or on the farms presents multiple problems both in obtaining the image and processing it quickly. Digital radiography (DR) and computerized radiography (CR) provide “instant” films for on the spot interpretation (Fig. 1). This paper will explain how to achieve maximal diagnostic quality in field conditions.

This is now our standard, and techniques must be adjusted to the situation, equipment available, and patient. Working with farriers is also facilitated by making progressive assessments during work and not after the fact. The equipment available has changed markedly over the years with smaller, faster machines replacing the older, higher-powered units that used to be the norm.

Viewing the foot presents special problems. With traditional methods, bony structures were emphasized at the expense of the soft tissue or capsule. It is often difficult to assess the health of the laminae for the presence of abscesses, hematomas, or other space-occupying lesions. With the availability of CR/DR technology, more images are shown than can easily be identified. The most common use of radiology with regard to foot/capsule problems is in monitoring the status of posterior third (P3). Digital machines expand diagnosis to bruises, abscesses, or other soft-tissue problems.

Most of the views taken are for evaluation before purchase or for lameness examination. The equine foot and digits are remarkable in that they are symmetrical and difficult to differentiate medial from lateral in the dorsoplantar (DP) view. A purpose-built cassette holder should be used to ensure that every view will be symmetrical each time. Much lameness is also the result of hoof instability. Thus, the structures must be viewed from a level and firm perspective. The horse must always be standing on a flat, firm surface, and the film/focal distance must be appropriate (Fig. 2).

This must be determined for each unit in advance and adjusted accordingly to size, age, and depth of the structures to be examined with a standard five-view series of the average foot. The other joints of the lower leg must also be examined carefully. Anteroposterior, lateral, oblique, and special views such as flexed, skyline, and contrast films will be discussed. The importance of encouraging a “team” approach to cases involving complex foot problems will also be discussed (Fig. 3).

2. Capsular Conditions
The health status of the hoof capsule is often hidden under layers of dressings, paints, and equipment.

NOTES
Viewing the hoof from the bottom with the shoe in place sometimes obscures vital structures and penetrating wounds. Tracts also limit examination. In many instances, especially in a horse presented for a mild or minimal lameness where shoes have been recently applied, there is a lot of resistance to pulling the shoe for radiographs. Many cases of subtle lameness can be revealed using radiographs with the shoes in place to show capsular problems such as hematomas and abscesses. Quarter cracks in all types of horses are problematic, but they are especially so in “heavy-shod” horses like gaited horses or Park Morgans.

In this case, submural hematomas are visible beneath an early quarter crack (Fig. 4). Soft-tissue structures are highlighted at the expense of bony detail, but tendons are easily seen.

In many cases, finding a change in consistency in the lamina is consistent with pathology. To do that, the radiograph must be manipulated at the expense of bone contrast (Fig. 4). It is usually not productive or even necessary to remove the heavy shoes as part of the exam, but radiographs that show laminar hematomas, hoof-wall imbalance, or other pathology are helpful in explaining the causes. They also aid in the resolution of both the short-term problem (bleeding, infection, close nails, etc.) and the long-term problem (the need and implementation of corrective shoeing). In cases of quarter cracks, it is important to understand whether the cause is direct injury from the contralateral foot, improper loading of an imbalanced hoof during work, or prior pathology like white line.

3. Disease

In Figure 5, white-line disease has been obscured by the epoxy. This 9-yr-old Thoroughbred (TB) gelding was presented for pre-purchase examination. Initial assessments were good, but one freshly shod foot was seen to have considerable plastic filler over the lateral wall, reportedly because of a recently lost shoe. He was also grade 2 of 5 lame when trotted on a firm stone-dust surface. Digital views showed normal bony anatomy. When “softened” to show soft tissue, distortions in the laminar relationships were seen, indicative of possible separation or white-line disease. Follow-up oblique views revealed very extensive laminar loss and the full depth of the erosions and distortions that encompassed almost two-thirds of the lateral hoof capsule. The examination was halted, and the horse was returned to the seller and his farrier, who requested that the films be emailed to him for follow-up correction. Al-
though the sale did not occur, the horse was treated and shod correctly and began to recover.

The common presence of white-line disease in showhorses of all types is alarming, and ultimately, it is a problem of management where both farrier and veterinarian must be involved in resolution. With the digital imaging available, lesions are seen that extend farther and wider than the sometimes small areas seen at ground level during trimming. It is important to obtain a full impression of the extent of the disease before performing a resection. There are many cases where one quickly gets too far up the hoof wall without being prepared for the amount of support that will be required to allow a currently sound and competing horse to continue working while being treated. It is hard for an owner to hear that his currently sound and winning horse will get the next 6 mo off because of something found at a regular shoeing that was just being “chased down” until half the wall was gone. Images like these can allow access to specific areas without resection of the entire foot. In cases where a sound horse is presented for pre-purchase examination with obvious areas of hoof rebuilding, epoxy, or any other patch present, such radiographs can provide insight into the present condition and the potential management issues ahead. The digital views are also useful for delineating usually radiolucent foreign bodies in the hoof usually only seen grossly or with contrast media.

4. Laterality and Hoof Distortions
Assessment of the flight/landing patterns of hooves is and will continue to be the source of much controversy and sometimes strained interprofessional relations between veterinarians and farriers. No matter what the cause or the outcome, radiographs often provide excellent fodder for good discussion in many cases. Radiographs taken on a flat surface with appropriate marking and measurement are very helpful to all parties in resolving questions regarding bony column/capsule relationships. The ability of an instant assessment of a particular change in bearing surface can be established, and
appropriate corrections can be made. Similarly, the presence of excess heel, toe, or wall can be shown, and therapy can then begin. The presence of external distortions of the hoof capsule is often reflected in the internal position of P3 and can sometimes be deduced without radiographs; however, this is not always accurate and can lead to false assumptions and faulty treatment. One of the most common problems is related to the long-toe low-heel syndrome. This is a common finding, but what is often underestimated is the actual relationship of the solar surfaces to the ground. Many horses with a healthy appearance to their foot are actually suffering from a negative palmar angle that distorts the load on the bony column as well as on the heel. This is a self-perpetuating situation with the heel tubules progressively migrating to a near horizontal position. Often, these horses will present with a report of “normal X-rays,” and indeed, no bony pathology exists. Measurement of the sole/ground relationship will often reveal an angle of ≤0°. It is important to realize that the most usual angle of the ground surface is 0–8°. The flattening of this angle compounds the ground forces along all of the solar structures and is often the source of pain as shown by local anesthesia. Further explorations of the sources of heel pain are ongoing, and the technologies exist to assess and categorize the specific injuries that cause it. Magnetic resonance imaging (MRI), digital images of all types, bone scans, and thermography have all been shown to elucidate these lesions not visible on standard X-rays. The simple fact is that early intervention in the form of correct shoeing and trimming practices will prevent many of these lesions from ever occurring in most animals. Incorporation of yearly foot radiographs into annual physical examinations has been recommended and has considerable merit. There also exists several software programs that help in the analysis of hoof angulations, but they are not necessary for an experienced clinician to make an assessment.

Figures 6–8 show the back feet of a 9-yr-old Warmblood mare presented for problems related to her lead changes and loss of impulsion while working at the Grand Prix level in dressage. She was freshly reshed a week before presentation, and her work had deteriorated since then; she also had a history of chronic swelling and tenosynovitis in both hindlimbs for the past year. Examination showed no lameness, but she was reluctant to hold her leads at work. Her right hind pastern was also chronically affected with a painful, non-responsive dermatitis. Both hind heels were crushed, and she exhibited a “broken” hoof-pastern angle. Radiographs confirmed this and also revealed a negative palmar angle to the third phalanx. Corrective shoeing was discussed with the farrier, and a CD with appropriate views was left for him. Serial radiographic examinations were done over the next 8 wk to help find the appropriate shoe/pad combi-

Fig. 6. Negative palmar angle on the hindlimb.

Fig. 7. Initial treatment with a 2” wedge shoe.

A 19-yr-old Arabian stallion was presented for chronic lameness after a possible laminitic episode. The acute phase had resolved well, but the horse had a chronic lameness in the club foot that was thought to be related to the laminitis. Over 6 mo,
the horse was treated with therapeutic shoeing and finally, a deep-flexor tenotomy to resolve the lameness completely. He was a difficult, self-mutilating individual but did respond to long-term therapy. His radiographs and history illustrate the complex interrelationship of farriery, veterinary medicine, radiography, surgery, and owner compliance (Fig. 9).

5. Discussion
There are many variables in the presentation, assessment, and final treatment protocols and outcomes of the various hoof-related cases we all see. Minimizing the complexity of the variables is one of the easiest ways to arrive at a successful treatment plan. Clear, on-the-spot radiographs coupled with a thorough knowledge of normal anatomy and pathology will add immeasurably to the discussion. These resources will help set us on a course that optimizes the chances for success or if need be, allow for difficult humane discussions to take place with all interested parties. There will always be exceptions to the rules, but bringing the most current information to the discussion will invariably work in the horses favor.

6. Procedures
A clean foot is placed on a level surface. For studies of the foot and P3, the beam should be centered on the foot at the level of the shoe. A marker is placed on the dorsal hoof wall and if possible, at the tip of the frog. Marking devices of many types and personal preference may be superimposed on the foot or incorporated into the foot block. There are many commercially available blocks, and the choice is personal. Stability of the foot and X-ray machine, repeatability of the angulations, and availability of support for oblique or special views are all desirable characteristics. Combining a machine that costs over $100,000 with a spare piece of 2 × 4 or random construction material is one of the most common reasons for poor field radiographs. Film-focal distance is critical and again, individually variable, but it is always an important factor. If using digital equipment, it is still recommended to take both a standard and a “hot” view using a grid or higher-exposure factors to maximize readability. The standard 65° DP of the navicular may be taken with weight on the plate or in an angled holder, which is much safer for the expensive plate. The unshod foot must be packed with a space-occupying substance to minimize shadowing artifacts. Obliques are taken as needed.

The most important “take-home” message here is that correct information, current knowledge, and thorough medical training and understanding of anatomy and pathology combined with competent farriery are the keys to achieving our ultimate goal: the restoration of health and the protection of the welfare of our mutual patient, the horse. The concept of teamwork must be introduced here with the owner/caregiver involved from the start.