How Imaging Findings in Western Sport Horses Relate to Performance and Lameness

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1. Introduction
Imaging of horses falls into two broad categories: imaging performed to diagnose the cause of a lameness or performance issue, and imaging performed to try to predict or rule out lesions that could cause problems in the future, such as the pre-purchase exam. Each of these scenarios presents unique challenges but both require a combination of clinical experience, scientific review, and educated guesses to come up with the appropriate answer. There are two specific steps to take when reviewing images: 1) analysis—find and describe the lesions and identify what is normal; and 2) synthesis—applying all the other pertinent details of the horse’s history, signalment, and clinical exam, and integrating this information with the imaging findings to weigh risk and significance. Both of these steps are crucial and each must be performed in its own right. The analysis should be undertaken without bias based on clinical suspicion and be considered a fact-finding mission. The next step of synthesis is also essential—without pertinent clinical information, most imaging findings are of little value.

Many elements can influence the significance of imaging lesions. One of these elements is the horse’s discipline. The reason for this is multifactorial and includes demands of the sport, breed predisposition, client expectations, and culture, among other factors. Western performance encompasses a range of disciplines with different expectations in terms of speed, agility, and longevity. The intention is to review common imaging findings that affect horses in these disciplines, what is known and what is suspected in terms of the significance of these findings in relation to performance and lameness.

2. Foot
By far the most commonly imaged area and most frequently localized source of lameness, the foot is complex and often requires more than one imaging modality for complete assessment. However, as a first line, radiographs are not obsolete and still provide very valuable information.

The Quarter Horse dominates the Western disciplines and with that comes certain lesions to which these horses are prone. In particular, damage to the navicular apparatus is a primary concern. There are many radiographic changes that can be suggestive of navicular changes and have a range of significance.

Dilated Synovial Invaginations
The synovial invaginations of the navicular bone should be symmetric between limbs and ovoid or...
triangular in shape. Quarter Horses normally have smaller synovial invaginations than some other breeds such as Warmbloods and should be assessed as such. Even within the breed there is a range of normal and therefore comparison between limbs is helpful to identify some changes. The significance of dilated synovial invaginations remains a source of debate and depends on the degree of change. Recently it has been suggested that synovial invagination dilation may be associated with synovitis of the distal interphalangeal joint rather than primary navicular disease, although this concept needs further exploration. In the author's opinion, mild-to-moderate synovial invagination dilation in the absence of other abnormalities in the bone can be incidental and may not change over time. Dilation of the synovial invaginations becomes a concern when the enlargement results in cyst-like dilation or extends to the palmar endosteum of the flexor cortex. Enlarged synovial invaginations that extend to the palmar aspect can cause pressure resorption of the flexor cortex, resulting in a flexor cortical defect, which is a clinically relevant finding.

Distal Border Fragments
Quarter Horses are a small component of the population in the reported studies regarding the significance of distal border fragments. The literature is mixed on the significance of these findings; the study with the greatest number of Quarter Horses did not show a significant relationship between distal border fragments identified on magnetic resonance imaging (MRI) and lameness. On MRI, fragments can be seen on the distal border of otherwise completely normal navicular bones or can also be a component of other navicular apparatus changes. The significance is likely a continuum of severity with other changes, and in isolation, these fragments are not likely to be a primary source of lameness.

Proximal Vascular Channels
Dilation of the proximal vascular supply of the navicular bones can be difficult to identify radiographically until advanced changes are present, but observing the shape of the navicular bone on the lateral view is helpful to identify an increased concave margin to the proximal border of the navicular bone. This change is more readily identified with MRI. Dilation of the proximal vascular channels is rarely found incidentally, in sound limbs, or in isolation and is an indication of navicular disease that is clinically significant. Increased size and number of the proximal vascular channels has been shown to be associated with lesions of the flexor cortex and deep digital flexor tendon.

Sclerosis
Trabecular and endosteal sclerosis of the navicular bone are significant indicators of navicular disease and often accompany palmar fibrocartilage damage and/or flexor cortical bone loss (Fig. 1). This can be a challenge for image interpretation as positional artifacts can mimic sclerosis. As this is a clinically significant finding when real, it is important to distinguish artifact from true change. The finding should be repeatable on both the lateral and skyline radiograph; if seen on only one view, it is more likely an artifact.

Flexor Cortical Lysis
Flexor cortical erosions are a clinically significant finding that are routinely associated with lameness. While small flexor cortex lesions can be found in the contralateral non or less lame leg on a bilateral MRI or computed tomography (CT) foot study, it is rare to find these lesions incidentally in horses that are in full work and completely sound. While some horses with these lesions can be serviceably sound and manageable for a period of time, generally these lesions progress and often have other comorbidities such as damage to the deep digital flexor tendon and navicular bursitis.

Deep Digital Flexor Tendinopathy
Damage to the deep digital flexor tendon can occur in conjunction with navicular disease or in isolation. While horses can manage for a while with some degree of tendon damage, lesions often progress or worsen with continued work. Dorsal border fraying is most frequently found at the level of the proximal recess of the navicular bursa and has been reported to have improved likelihood for return to work than other lesions types. Deep digital flexor tendon damage is much more likely to be found in lame horses than sound horses, indicating that it is rarely an incidental finding. An important practice note is that deep digital flexor tendon core le-

Fig. 1. Navicular skyline view of an 8-year-old Quarter Horse used for roping. Radiographic changes include marked sclerosis of the spongiosa, decreased corticomedullary distinction and lucencies consistent with flexor cortical lysis medial and lateral of the sagittal ridge.
sions or splits at the level of the pastern often extend distally into the foot; therefore, if a deep digital flexor tendon tear is found on pastern ultrasound, an MRI is warranted to further investigate the extent of disease.

3. Pastern
Osteoarthritis of the pastern joint is of variable clinical significance and moderate changes can be found in the absence of lameness. Subchondral bone lysis, subchondral cystic lesions, and joint space narrowing are more likely to be significant.

4. Fetlock
The fetlock generally does not receive the same attention in Western horses as in racehorses and English sport horses. While a less common area of injury, there are still lesions of significance that pertain to Western performance horses. Evidence of osteoarthritis of the metatarsophalangeal joint may be of greater significance in team roping heeling horses, which are more prone to changes in this joint and to hind-limb lameness than heading horses.7 Fetlock osteoarthritis is of variable clinical significance. Fetlock radiographs often do not adequately depict the degree of pathology in the joint, so horses that block to the fetlock and do not have sufficient radiographic changes to explain the lameness often benefit from MRI. Subchondral bone damage of the fetlock joint presents a management challenge and can result in long-term lameness. Western pleasure and competitive trail horses are more prone to repetitive stress injuries, including of the fetlock joint6; therefore, changes in this joint should be examined more critically in this population.

5. Forelimb Suspensory Apparatus
Reining and cutting horses have a propensity to develop forelimb suspensory ligament injuries. In cutting horses, the degree of lameness and severity of the suspensory ligament injury has not been shown to affect likelihood of return to work or earnings in limited age events, with 22 of 30 in the study returning to work.8 However, it was not determined by the study whether these horses still had some degree of lameness despite the positive performance outcome.

The most common manifestation of suspensory ligament desmopathy is ligamentous enlargement (Fig. 2). This enlargement persists even after the resolution of the clinical signs; therefore, suspensory ligament changes found on ultrasound have to be correlated with lameness evaluation to assess significance. Bone marrow lesions (often called bone bruises) of the third metacarpal bone at the suspensory ligament origin are almost always of clinical significance. These require MRI for identification. Some horses that block to the proximal suspensory region can have almost no ligament change and almost all of the pathology is related to the bone.

6. Superficial Digital Flexor Tendon
Older Quarter Horses have been reported to suffer more from damage to the proximal aspect of the forelimb superficial digital flexor tendon with a low rate of return to work.9 Western performance horses are less likely to develop a classic core lesion and more frequently have peripheral tendon tears. This pattern has been reported in cutting horses in the mid metacarpus with good rate of return to work (82%) and low recurrence rate (18%).10 In the author’s experience, the reinjury rate seems to be higher in reining horses, who tend to get lesions that “zipper” or extend up or down from the original injury site. It is crucial when performing the ultrasound scan to extend the range of the ultrasound into the carpal canal to avoid missing lesions that are clinically significant. Therefore, the significance of superficial digital flexor tendon injuries should be weighed more heavily when they are in the proximal metacarpus and/or carpal canal and when reining horses are affected.

7. Carpus
Similar to the fetlock, the carpus receives less attention in Western horses. Carpal arthritis has been reported as a low percentage as a cause of lameness in barrel horses.11 While it is certainly a less common cause of forelimb lameness than foot-related pain, barrel horses are prone to more severe osteoarthritis of the carpus compared to other Western performance disciplines (Fig. 3). Often these horses are able to manage mild-to-moderate osteoarthritis of the carpus and may not present for carpal-related lameness until the changes are more advanced. This is important in relation to longevity and client expectations for career length; a barrel horse with...
milder carpal osteoarthritis may be able to run for many years before it becomes performance limiting. Although not proven in the literature, it seems that off the track Quarter Horses that have raced longer and are then used as second career barrel horses may be more prone to carpal disease.\(^b\)

Reining horses can have repetitive osseous stress and sclerosis of the third carpal bone, similar to that of racehorses, and therefore including a skyline view of the carpus is warranted in these horses with lameness localized to the carpus.

**8. Elbow and Shoulder**

While not specific to the Western performance horse, subchondral bone injury, osteochondrosis, and osteoarthritis of the elbow and shoulder do not tend to be well tolerated and findings of disease in these joints is usually clinically significant.

**9. Hind Suspensory Apparatus**

Hind-limb suspensory ligament disease affects all disciplines but is particularly problematic in cutting\(^c\) and reining horses. In rope horses, more suspensory injuries have been reported in heading horses than heeling horses.\(^d\) Lameness due to suspensory ligament damage can be challenging to definitively diagnose because of the overlap in blocking patterns and propensity for Western performance horses to have concurrent distal tarsal disease. A retrospective review of tarsal/metatarsal MRIs predominantly of Western performance horses found that almost 47% of the horses that had lameness resolve with diagnostic analgesia of the proximal suspensory ligament (PSL) actually had more distal tarsal changes than changes to the PSL.\(^e\)

Ultrasound of the PSL is the most common diagnostic imaging modality. It is the author’s firm opinion that an ultrasound of the PSL must include assessment of the ligament with the limb nonweight bearing. Similar to the forelimb, the most common manifestation of PSL desmopathy is enlargement and this will persist even when clinical signs resolve; therefore, it must be correlated with the results of the lameness exam. Similar bone resorption and proliferation of the plantar cortex will also persist even when lameness resolves. The severity of ligament and metatarsal (MT3) changes have not been found to significantly correlate with the degree of lameness.\(^f\) In a retrospective review of tarsal and metatarsal MRIs in cutting horses, 9 of 17 horses diagnosed with PSL disease on MRI did not return to work. There was no association between severity of lesions and the likelihood to return to work or the degree of lameness. The surprise being that one cannot predict outcome based on the severity of the injury.

**10. Tarsus**

Distal tarsal osteoarthritis is a major contributor to hind-limb lameness in Western horses across all disciplines. However, there is a fairly large range of clinical significance of tarsal changes, which can make them a challenge to interpret. In the juvenile horse, dorsal wedging or malformation of the tarsal bones indicates an increased likelihood of developing osteoarthritis and should be noted as a risk. The distal intertarsal joint is more prone to ankylosis than the tarsometatarsal joint. The earlier phases of ankylosis, particularly when accompanied with subchondral bone lysis, are more likely to result in lameness, in the author’s opinion. Once physiologically fused, the distal intertarsal joint will have marked radiographic changes but may not be clinically significant. The author is also of the opinion that lysis that extends to the plantar aspect of the joint and involves the second and/or fourth tarsal bone tends to cause more severe or difficult-to-manage lameness than changes confined to the dorsal aspect of the joint.

Sclerosis of the central and third tarsal bones is a normal physiologic adaptive response—to a point. Once the bones become moderately to severely sclerotic, the risk of fracture increases. In particular, barrel horses and rope horses seem more prone to central tarsal bone fractures than some of the other disciplines, perhaps related to speed work and turn-

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\(^a\) Fig. 3. Flexed lateral view of the carpus in a 7-year-old barrel horse. There are multiple osteochondral fragments of the radiocarpal joint, including in the palmar aspect of the joint (circle).
These horses have a common presentation of coming up acutely, moderately to severely lame while working and often have no soft tissue swelling or other localizing signs. The most common orientation of the central tarsal bone slab fracture precludes its identification on a standard four-view tarsal series, risking missing the significant diagnosis. A dorsal 20–30° medial-plantarolateral oblique view is the optimal view for identifying this particular type of fracture and should always be included when the history suggests this type of injury.

Bone marrow lesions (“bone bruises”) of the distal tarsal bones will have uptake on a bone scan but require MRI to accurately localize and characterize the lesion. Horses with tarsal bone marrow lesions have variable lameness and may improve to diagnostic analgesia of the PSL, distal tarsus, or may require a peroneal tibial nerve block. These lesions can be seen along with other tarsal changes but also can be found in horses with otherwise completely normal tarsi, likely as a result of trauma.

11. Stifle

Stifle injuries are found among all disciplines but cutting horses in particular suffer from stifle disease, primarily affecting the medial femoral tibial joint. Subchondral bone defects and cysts of the medial femoral condyle found on screening radiographs of cutting horses have not been found to be associated with decreased performance outcome. However, this study had a limited number of horses with more severe condylar lesions and also lameness data were not known, therefore the long-term outcome of these changes still remains somewhat unknown and controversial.

Optimally if a subchondral bone defect is identified, the horse should undergo an ultrasound to assess for other changes in the joint. If the joint is otherwise relatively normal without synovitis and no more than mild-moderate effusion, the defect is of questionable significance, particularly if the horse is already in work. Many working cutting horses carry some effusion in the joint and if the joint capsule is not thick and there is not synovial proliferation, the fluid can be incidental.

Horses can have mild osteophytes of the medial tibial condyle incidentally found on radiographs. However, further osteoarthritic changes of the medial femoral tibial joint including osteophytes of the axial or abaxial margins of the medial femoral condyle and sharp elongation of the medial tibial intercondylar eminence are usually clinically significant findings and are uncommonly found on screening exams of sound, unmedicated horses (Fig. 4).

In the author’s opinion, tears of the medial meniscus and medial cranial meniscotibial ligament are also rarely incidental and are typically found in conjunction with other joint disease such as synovitis and osteoarthritis. When found with articular cartilage damage and other joint disease, the prognosis for return to work lessens. In studies that included all or the majority Western horses, reported rates of return to full work for horses with meniscal damage ranged from 38% to 29%. Mineralization of the medial meniscus is a poor prognostic indicator and when found radiographically should be further explored with ultrasound and/or arthroscopy.

Injuries to the lateral femoral tibial joint are relatively rare in comparison to the medial, but can occur either in isolation or in conjunction with medial femoral tibial joint pathology. Effusion of the lateral femoral tibial joint is typically not seen incidentally and is generally suggestive of stifle pathology, either diffusely due to communication of joint pouches or originating from the lateral femoral tibial joint.

12. Axial Skeleton

Overall, the axial skeleton receives less attention in Western than English sport horses. Interest in cervical lesions is increasing but there is a dearth of information about how this is manifested specifically in Western horses.

Barrel horses are more likely than other Western disciplines to be assessed and treated for back problems, particularly impinging spinous processes of the thoracolumbar spine. Impinging spinous processes are of variable clinical significance and even marked radiographic abnormalities can be clinically incidental. The combination of radiographic abnormalities, evidence of back pain and, when possible to acquire, increased uptake on a bone scan, improves the likelihood that the changes are significant.
13. Conclusion

It is important to understand the individual Western performance disciplines and the demands they place on the horses, which can affect the impact of radiographic abnormalities in terms of performance and outcome. Additionally, each discipline comes with its own culture and expectations, which can also affect how radiographic finding are weighed. Finally, utilize the two-part process of image interpretation—objective assessment followed by individual synthesis for the most accurate evaluation of the significance of the radiographic findings.

Acknowledgments

Declaration of Ethics

The Author has adhered to the Principles of Veterinary Medical Ethics of the AVMA.

Conflict of Interest

The Author has no conflicts of interest.

References and Footnotes

22. *Barrett MF. Personal observation.