

The Role of Select Imaging Studies in the Lameness Examination

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The physical examination and gait analysis are the most important aspects of a lameness examination. However, interpreting and integrating images from different modalities can significantly enhance both diagnosis and prognosis. Authors' address: San Luis Rey Equine Hospital, 4211 Holly Lane, Bonsall, CA 92003. © 2002 AAEP.

1. Introduction

Lameness is one of the most common problems facing equine veterinarians. The sore or lame horse, incapacitated and unable to perform, permeates every aspect of the equine profession from racing and showing to backyard trail riding. Properly and effectively diagnosing and treating these musculoskeletal ailments can be a real challenge, even to the most experienced clinicians. Part of the difficulty is that both effective palpation and gait observation require certain skills. More importantly, these skills vary greatly between individuals. Even regional anesthesia interpretation can be somewhat subjective and prone to differences of opinion.¹

Although interpreting the significance of the imaging modality information relative to the lameness can be fraught with inconsistencies, it can often provide concrete observations about the disease or injury. This is particularly true with radiology, nuclear scintigraphy, and ultrasound.

2. Radiology

Radiology is an imaging modality important in determining bone quality. Typically, this has meant identifying fractures and osteoarthritis. In the

case of the latter, radiology has been described as a historical account of where the joint has been and not necessarily where it is currently. More meticulous and vigorous interpretation, however, can lead to earlier detection of disease processes in certain regions. Subtle differences in bone density, trabecular detail, and cortical thickness can be identified. Like any imaging modality, proper positioning and technique are essential for success.

3. Nuclear Scintigraphy

Nuclear scintigraphy is classified as a metabolic imaging modality because it requires inherent living tissue to produce a positive image. A bone-seeking agent, usually methylene diphosphonate (MDP), is labeled with a radioactive compound (technetium 99m) to produce a radiopharmaceutical. This is injected intravenously, and then imaging commences. The vascular phase images are acquired immediately after injection and highlight the radiopharmaceutical as it courses through the blood vessels. The soft tissue or pool phase images are acquired within the first 20–30 min post-injection when the radiopharmaceutical is present primarily in the soft tissues. The bone-phase images are acquired 2–3 h after injection, allowing the radiopharmaceutical to

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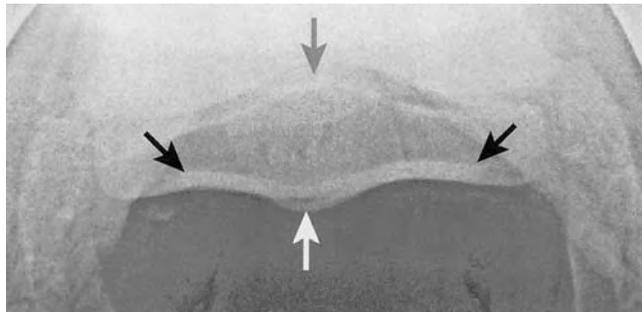


Fig. 1. This is a properly positioned flexor tangential view of the navicular bone. The gray arrow points to the cranial navicular bone border, indicating proper positioning. The black arrows show the well-defined corticomedullary junction. The white arrow points to a flexor surface radiolucency that is caused by a normal flexor surface concavity often implicated as a disease process.

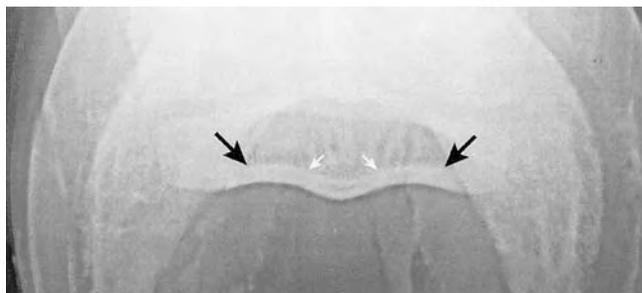


Fig. 2. On this radiograph, the corticomedullary junction between the black and white arrows on either side of midline is just beginning to lose definition, indicating very early changes.

clear from the soft tissues and incorporate into the bone. Nuclear scintigraphy has classically been used to identify abnormalities in bone remodeling, such as stress fractures or osteoarthritis, but it also identifies tendon and ligament enthesopathies. While it is technically easier to produce an image with nuclear scintigraphy than it is with either radiology or ultrasound, image quality is more dependent on the equipment quality. Furthermore, the interpretation is such that it must be done in relation to the clinical examination, and it takes some degree of experience to determine the significance of each region of increased radiopharmaceutical uptake (IRU).²

4. Ultrasound

Ultrasound is the imaging modality of choice to diagnose soft tissue injury. Doppler (and color-flow Doppler) provides qualitative and quantitative blood flow information, but it will not be discussed in this manuscript. Conventional ultrasonography can identify changes in soft tissue size, shape, position, and density. For instance, subtle tendon and ligament fiber abnormalities can be detected where palpation is negative. Deeper structures, difficult to

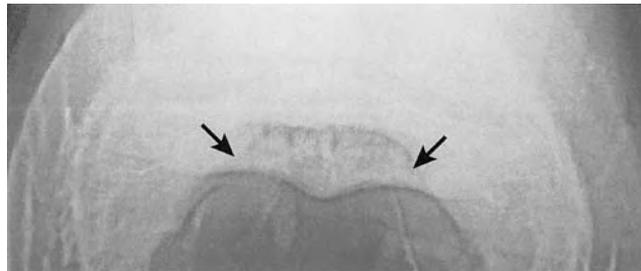


Fig. 3. In this radiograph, the corticomedullary junction, as delineated by the black arrows, is completely lost because of sclerosis and remodeling. This finding is common in advanced navicular disease.

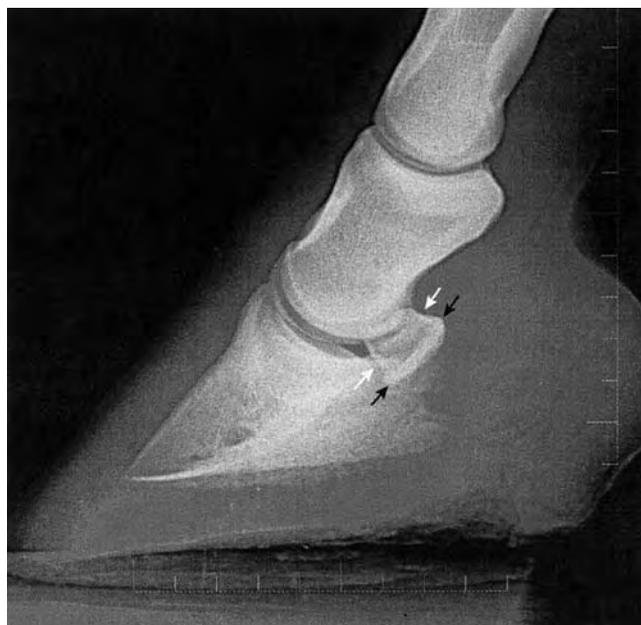


Fig. 4. The navicular bone should also be evaluated on the lateral view. Whereas obvious changes can be seen along the cortical borders (black arrows), more subtle alterations can be seen in the trabecular bone (between the white arrows). Any thickening or loss of trabecular definition should be considered a significant navicular bone change.

palpate for sensitivity, can be evaluated for structural abnormality. Unlike radiology and nuclear scintigraphy, however, ultrasound examination is more heavily reliant on the sonographer's skill level. Diagnostic images must be obtained and properly interpreted.³

5. Anatomical Regions Requiring Rigorous Imaging Techniques

Foot

Foot injury is one of the most common pain sources encountered in equine practice. Many horses exhibit lameness that is easily abolished or improved by palmar digital (PD) nerve block and then further improved by an abaxial sesamoid block. Conven-

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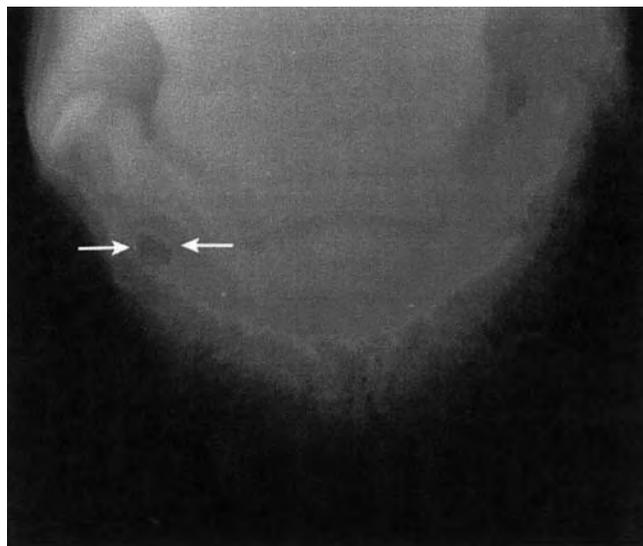


Fig. 5. On this dorsopalmar view, the ovoid P3 wing radiolucency is the collateral ligament of the coffin insertion (white arrows). This can indicate an injury to the entheses.

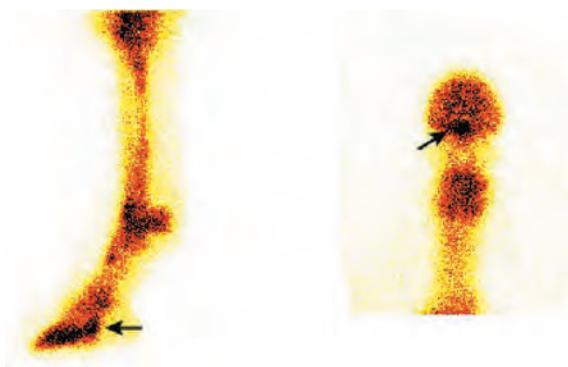


Fig. 6. This nuclear scan of a foot demonstrates IRU associated with the navicular bone (black arrows). The scan on the left is a straight lateral view and the scan on the right is a solar view taken with the horse's foot extended over the horizontal camera surface.

tional foot radiographs often do not allow a definitive diagnosis to be made. Historically, horses were diagnosed as having a so-called "navicular syndrome."

In our practice, the most important view for determining subtle changes in the navicular bone is the navicular skyline or flexor tangential view. This view is taken from the palmar aspect of the foot with the horse "standing" on the cassette (a tunnel is used to protect the cassette). Care must be taken to prevent palmar fetlock soft tissue overlap, which will artifactually increase the navicular bone density. With a properly positioned view, however, subtle changes in navicular bone medullary trabecular density (sclerosis) and flexor cortex irregularities can be readily identified.⁴ Increased trabecular thickness and density indicate a bone

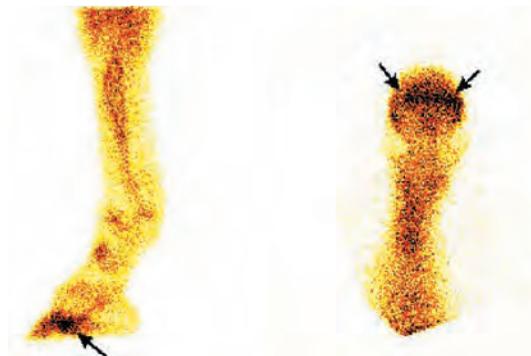


Fig. 7. On this foot scan, the IRU is associated with the insertion of the deep digital flexor (DDF) tendon. On the lateral view, the IRU is more cranial than the navicular uptake as seen on the previous scan. The solar view shows a line of IRU along the attachment of the DDF to P3.

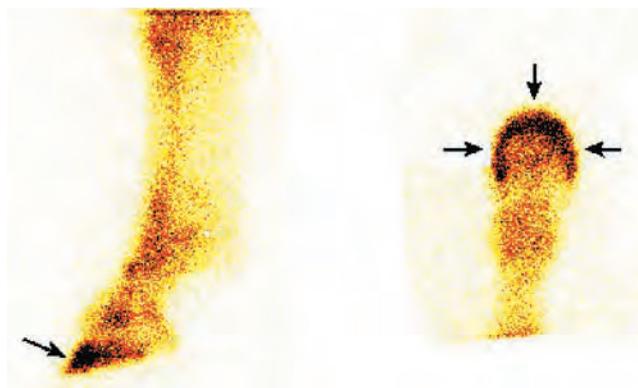


Fig. 8. On this foot scan, the IRU is seen in P3. On the lateral view, it is along the tip of P3 and on the solar view, the IRU is seen extending all the way to the edge of the foot.

response to trauma. Flexor cortex radiolucencies and erosions are degenerative findings indicating a more severe involvement. A well-positioned lateral-medial radiograph is also taken, which also allows evaluation of the trabecular density, flexor cortex, and the bone shape. The interface between the spongiosa and the inner flexor cortical surface should be well defined in both projections (Figs. 1-4).

Oval-shaped radiolucencies, often with sclerotic borders, can be found in the lateral and medial aspects of the P3 wings near the joint margin. These are the coffin joint collateral ligament insertion sites. Remodeling of these entheses can be incidental findings, but they can be present in lame horses that improve with PD, abaxial, or coffin joint anesthesia. Foot radiographic interpretation is more accurate when it is done in conjunction with nuclear scintigraphy (Fig. 5).

Nuclear scintigraphy has greatly improved our ability to determine the cause of foot lameness. Three distinct patterns of IRU have been found in

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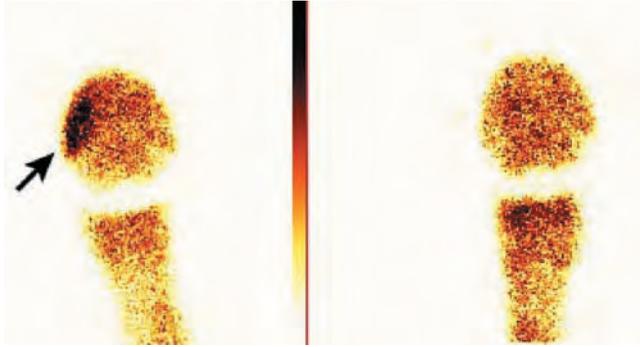


Fig. 9. In this fore feet nuclear scan, the area of increased radiopharmaceutical uptake (IRU) along the P3 lateral wing (black arrow) corresponds to the collateral ligament insertion of the coffin joint. This indicates an enthesopathy, or injury to the ligament insertion. This pattern can also be seen with other injuries, such as a wing fracture of P3.

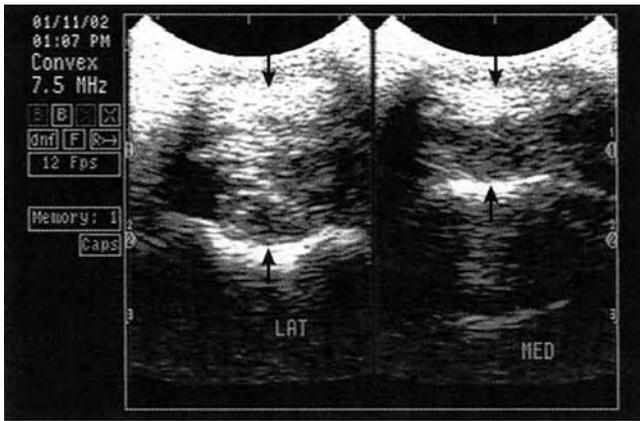


Fig. 10. Ultrasound images of the coffin joint collateral ligament origins on P2. The lateral ligament (left image between black arrows) is almost twice as large as the medial (right image). Ultrasound provides significant additional information that correlates with the radiograph and nuclear scintigraphy images above.

horses that improve or are sound after PD and/or abaxial sesamoid anesthesia. The first is focal navicular bone IRU. Second, there can be IRU associated with the attachment of the deep digital flexor (DDF) tendon to P3. The third common pattern is diffuse P3 IRU. In many horses, however, more than one site may be present. The value of foot scintigraphy is the prognostic information it provides. Focal and intense navicular bone IRU is an unfavorable finding, whereas IRU associated with the DDF attachment usually resolves with time. Third phalanx IRU is more difficult to interpret and must be done in light of breed and foot conformation. Two other areas of focal IRU along one or both wings of P3 are occasionally found. One is the collateral ligament insertion and the other is the P3 cartilage of the foot. The latter can be located both medial and lateral in the foot. It must not be mistaken for



Fig. 11. This dorsopalmar (DP) tarsal radiograph is the best view to evaluate the suspensory ligament origin (OSL). There is bone sclerosis and trabecular detail loss, indicating chronic change (white arrows).

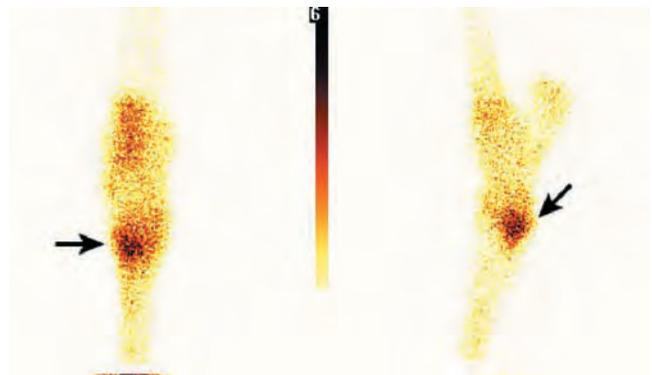


Fig. 12. Nuclear scintigraphy is very sensitive in confirming OSL injuries in both fore- and hindlimbs. The IRU pattern is located on the proximal palmar or plantar aspect of the metacarpus or metatarsus, extending distally in a “V”-shape. In the hindlimb, the IRU is more lateral, whereas in the forelimb, the IRU is more centrally located because of anatomical differences.

navicular bone IRU on the lateral view (Figs. 6–9).^{5,6}

Foot ultrasound has been discussed more recently as a method to image the navicular bursa and DDF insertion.⁷ In our clinic, we have found that this is possible only in horses that do not have a thick frog

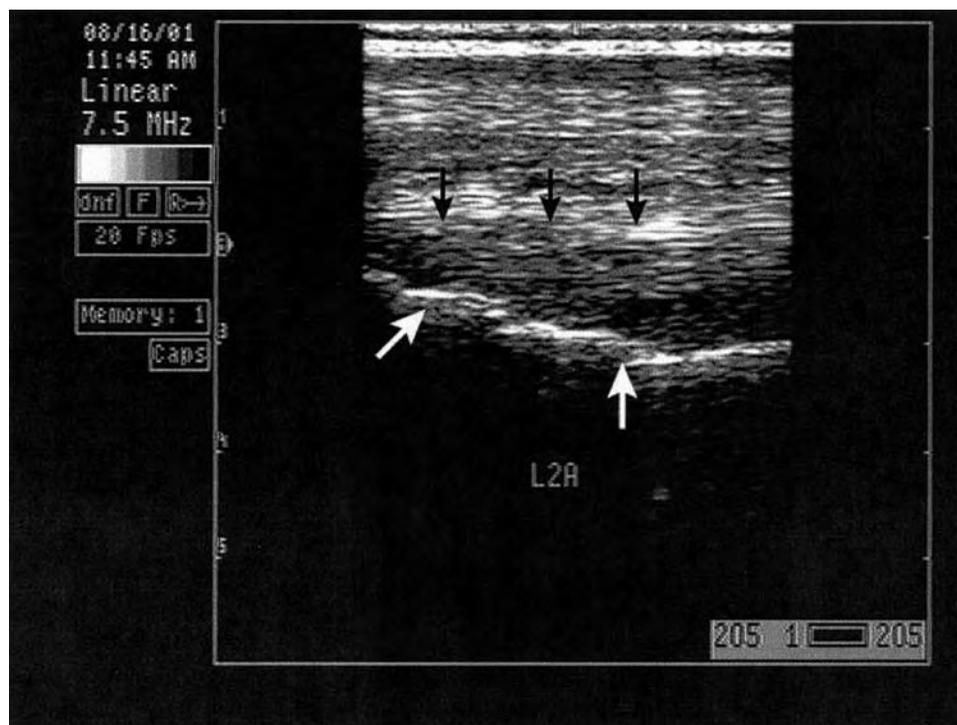


Fig. 13. Ultrasound is the most common imaging modality used to evaluate the OSL soft tissue. In this hindlimb longitudinal view, the white arrows point to the roughened proximal plantar MT3 surface, indicating chronic injury. The black arrows outline OSL haphazard fibers consistent with a serious injury.

or sole. Most of the Warmblood foot ultrasound examinations we attempt are suboptimal because of lack of penetration. It may also be caused by drying of the frog tissues in the hot weather. Ultrasound examination of suspected collateral ligament damage is practical if scintigraphy is positive or the ovoid radiolucency on the P3 wing is present (Fig. 10).

Suspensory Ligament Origins

The fore- and hindlimb suspensory ligament origins (OSL) are challenging areas to diagnose clinical lameness and to support with images. Clinically, our practice is presented with a relatively high number of horses with OSL injury. While some are primary sources of the lameness, others are apparently secondary to other problems. Forelimb OSL strains, for instance, are often associated with foot lameness, whereas hindlimb strains can be secondary to underlying neurological conditions. In our experience, forelimb OSL palpation will often elicit a painful response, whereas the anatomical hindlimb location makes it more difficult and negative responses are common. There is a shortened cranial stride phase of the affected limbs, especially when on the outside of the circle. Regional infiltration anesthesia or blocking the nerves supplying the origins may be successful. In the forelimb, the lateral palmar nerve at the accessory carpal bone base can be anesthetized. In the hindlimb, the lateral plantar nerve can be anesthetized at the level of the chestnut.⁸

Radiographs should be taken to evaluate the trabecular patterns of the origins. In horses with chronic strain, there can be trabecular thickening and sclerosis of the proximal metacarpus or metatarsus. This can be seen most readily on dorsopalmar (plantar) (DP) views (Fig. 11).

Nuclear scintigraphy is used to confirm fore- and hindlimb OSL injury. The uptake is usually seen as a triangular pattern with the apex extending distally on the palmar (plantar) proximal metacarpus (metatarsus). On the dorsal or palmar (plantar) views, the region of IRU tends to be centrally located but may slightly favor the lateral aspect in the hindlimb. Lateral or medial IRU may indicate a proximal splint bone involvement instead. IRU at the OSL usually indicates a more serious problem, although it does not always correlate with radiographic changes (Fig. 12).

Ultrasound remains the most sensitive method to image the OSL.^{3,8} Skill is necessary to produce quality images, especially in the hindlimb where a medial oblique window is often more effective. Bone surface irregularity, avulsion fracture fragments, and varying degrees of fiber disruption can be found. A degree of fiber malalignment is expected at the origins, which is caused by “wear and tear” remodeling with age and training. Because of this, correlation with clinical signs is necessary (Fig. 13).

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Fig. 14. This radiograph is a horse with clinical stifle lameness signs confirmed with intra-articular anesthesia. The radiograph confirmed a medial femoral condylar subchondral bone cyst and a large medial tibial plateau osteophyte.

Stifle

The diagnosis of stifle injury often requires correlation of multiple imaging modality findings with the clinical examination. The physical examination may reveal effusion, although many cases have no palpable abnormalities. There will usually be a noticeable gait deficit when trotting in hand that may become more apparent when lunging, and especially under saddle. Stifle joint anesthesia is the preferred method to confirm the lameness source.

In our experience, when the lameness is subtle to moderate, we prefer to block the horse under saddle.

If the horse blocks to the stifle joint, radiographs are usually obtained. Osteolytic lesions are usually present on the lateral femoral ridge in horses with developmental bone disease (OCD). Calcified fragments may be present adjacent to the defects. Cystic medial femoral subchondral defects may be present. Subchondral cystic lesions are more frequently diagnosed in adult performance horses and

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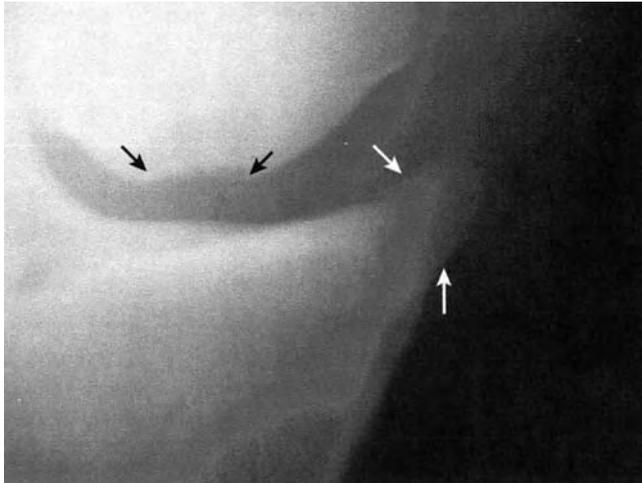


Fig. 15. In this enlarged stifle radiograph view, the black arrows highlight the subchondral radiolucency, and the white arrows point to the medial tibial plateau osteophyte.

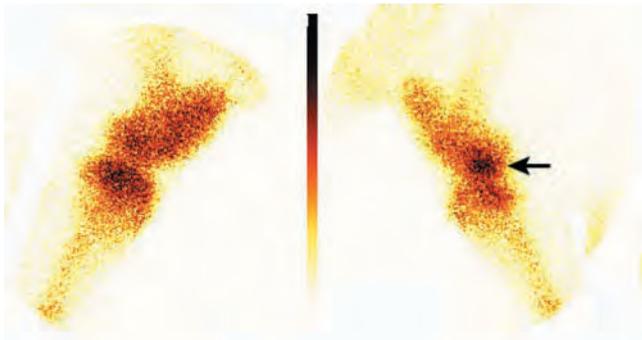


Fig. 16. In these images, nuclear scintigraphy has highlighted a focal intense the left femoral IRU (black arrow), corresponding with the cyst seen on the previous radiograph.

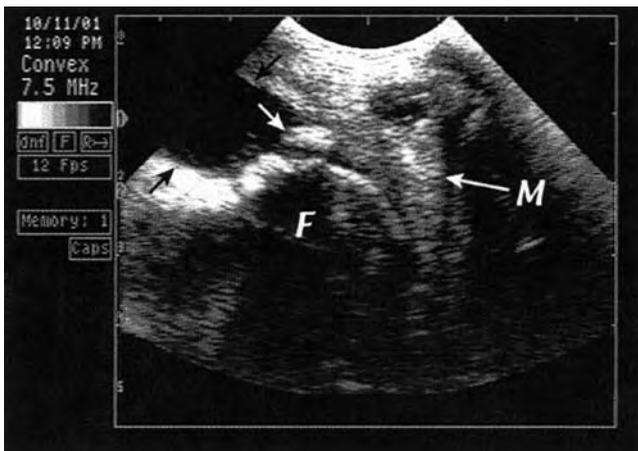


Fig. 17. In this stifle sonogram, the femur (F) and medial meniscus (M) are easily identified. There is an osteophyte (white arrow) present on the distal femur. These osteophytes are not always seen radiographically but are readily apparent on ultrasound. The black arrows show proximal medial femorotibial joint effusion.

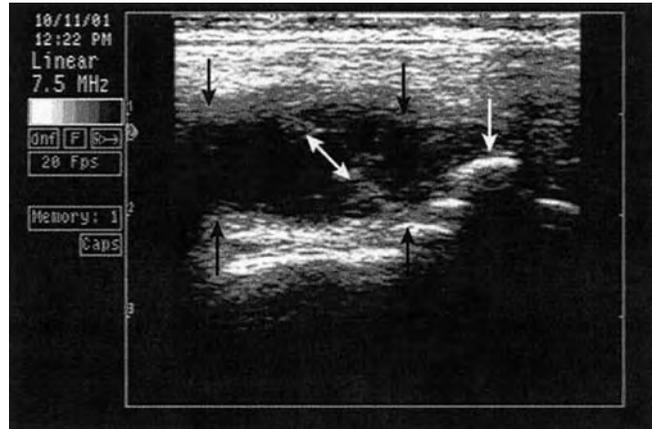


Fig. 18. In this stifle sonogram, the white arrow shows the medial osteophyte and the black arrows outline the proximal medial femorotibial joint effusion. The two-headed white arrow points to synovial plica consistent with synovitis.

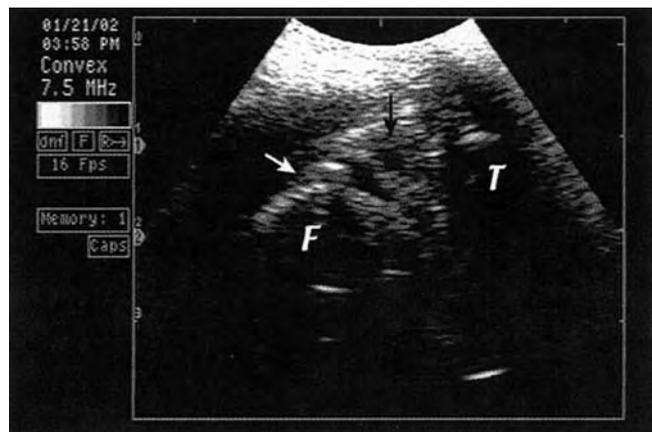


Fig. 19. In this stifle sonogram, the femur (F) and tibia (T) can be seen. There is an osteophyte present on the distal medial femur (white arrow). Between the femur and tibia lies the meniscus, which should be homogeneous in appearance. The black arrow points to a complete meniscal tear (echoluency).

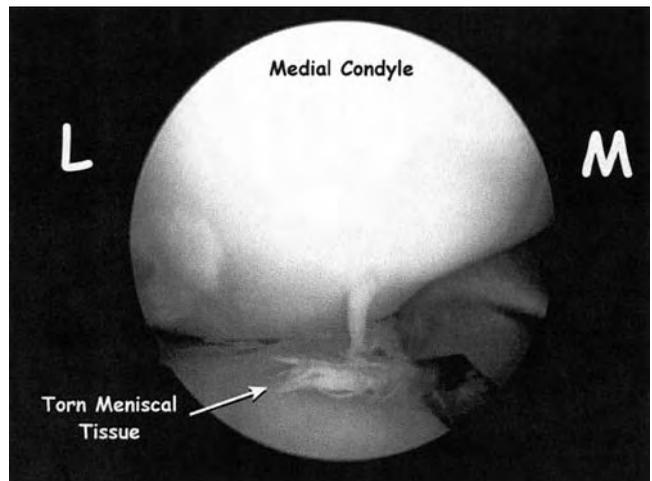


Fig. 20. This photograph was taken at the time of arthroscopic stifle surgery. A rongeur is being used to debride torn fibers from a sagittal medial meniscal tear. This injury was not seen sonographically because of its orientation within the meniscus.

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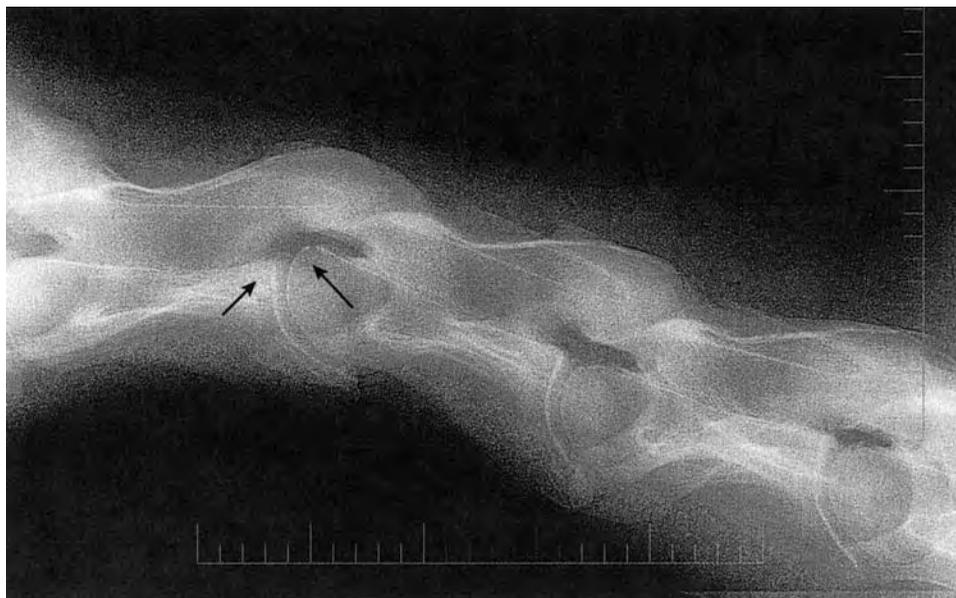


Fig. 21. In this standing cervical vertebral radiograph, the black arrows point to a misalignment of the C3–C4 vertebrae (kyphosis). Such misalignment can cause spinal cord compression and neurological deficits.

can range from medial femoral subchondral bone flattening to variable size cystic lesions. In the adult horse, however, the etiology is thought to be traumatic instead of developmental. Other radiographic changes in horses with stifle lameness include medial tibial plateau and proximal medial femoral condylar osteophytes. Less commonly, there is an ovoid radiolucency on the proximal mid-dorsal tibia, just medial to the intercondylar eminence below the articular surface. This radiolucency can be evidence of injury to the medial meniscal ligament (Figs. 14 and 15).

Stifle nuclear scintigraphy has historically been less rewarding than other anatomical sites. Recently, however, our diagnostic yield during stifle scintigraphy has improved because of increased awareness and more aggressive imaging techniques. In horses with stifle cysts, whether developmental or traumatic, there may be focal medial condylar IRU. Medial meniscal ligament injury may produce a small, focal, proximal dorsal tibial IRU. Opposing or oblique views may help localize suspicious areas. Although focal IRU patterns do occur, it is more common to find a diffuse uptake involving the entire stifle joint (Fig. 16).

Ultrasound is frequently employed in our practice when stifle lameness is diagnosed. The medial joint pouch and medial meniscus are commonly examined. Ultrasonographic examination is used to document joint distension and synovial membrane thickening. Small osteophytes can be found on the distal medial femur before they are radiographically evident. Medial meniscus examination can detect tears or fiber disruptions, including meniscal protrusion from its “normal” position (Figs. 17–19).

In the stifle, it is important to incorporate arthroscopic inspection of the joint in the diagnostic regimen. In cases of stifle lameness where images are negative or equivocal, arthroscopy can provide diagnostic information and also treat the problem. Generalized synovitis, occult cartilage damage, cruciate ligament, and some meniscal injuries can be diagnosed arthroscopically. Often, arthroscopic inspection is needed to convey a prognosis (Fig. 20).⁹

Cervical Spine

The cervical spine is often overlooked as a cause of gait abnormality or decreased performance. Obvious neck stiffness during manipulation or regions of decreased sensitivity to stimulation are important findings. In horses with neurological deficits, the cervical spine should be considered the most likely source, but it may also be the cause of subtler hind-limb gait abnormalities.^a

Survey cervical radiography is usually done standing. With standard 14 × 17 in. cassettes, three views are usually needed to survey the vertebrae from the poll to C7. Left and right lateral caudal neck views are taken because of the high-facet arthrosis incidence in that region. Lack of symmetry of facet size is useful information. Common findings include kyphosis, fractures, and neural canal narrowing. The ratio of the neural canal height to cranial vertebral body thickness should be greater than 50%. Low ratios raise the suspicion index but are not definitive for significant neural canal narrowing (Figs. 21 and 22).¹⁰

Cervical scintigraphy is done from both sides to detect asymmetrical uptake in the facets. Most

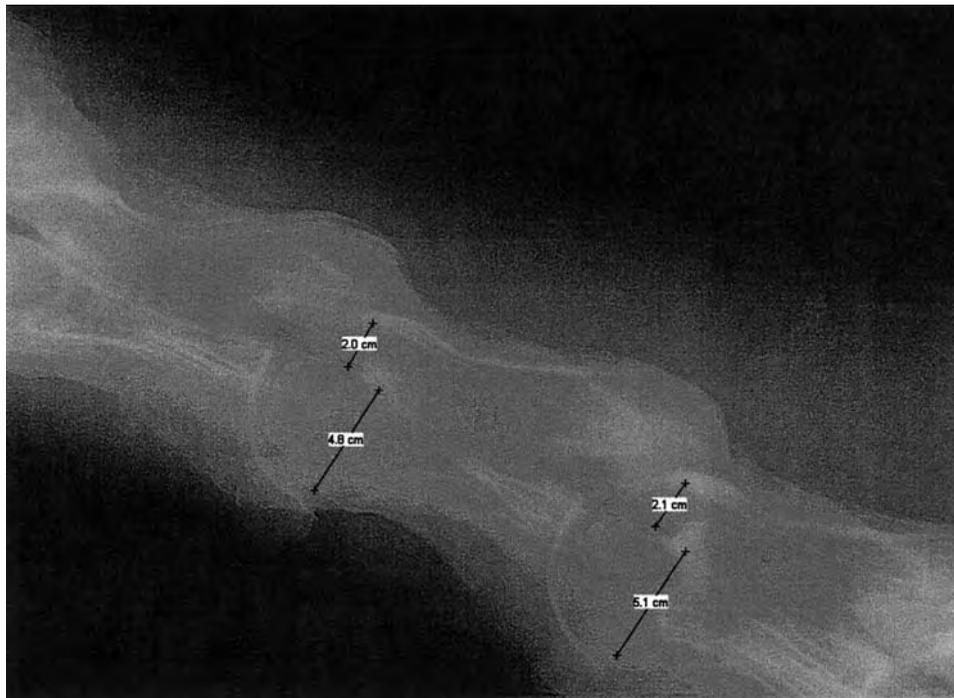


Fig. 22. In this standing cervical radiograph, the neural canal height is compared with the vertebral body height at its widest point. In this horse, the ratio was less than 50%, indicating possible compression at that site. A myelogram must be done to confirm significant compression.

facet lesions are found in the C5–C6 and C6–C7 level; however, they have been found at all levels.

Ultrasound-guided facet injection is usually performed after a diagnosis of facet arthrosis is made. Additional information about the degree of the arthropathy, such as joint margin irregularity, can also be made during the examination.

6. Conclusion

While lameness is one of the most common reasons for a consult in clinical practice, it remains a challenging aspect of equine veterinary medicine. The most effective way to diagnose musculoskeletal abnormalities is to integrate a thorough physical examination and gait analysis with the proper imaging modalities. Precise image acquisition and interpretation can enhance both diagnosis and prognosis.

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