**Imaging of the Stifle and Tarsus**

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**Stifle**

Although many stifle injuries will not be evident radiographically, radiology remains a commonly used modality due to convenience and accessibility for assessment of the stifle joint. A technique for radiographic imaging of the stifle has been described. Small osseous lesions may not be evident on radiographs due to superimposition of bone. Although digital radiography systems have offered technological advances as well as convenience, there are additional challenges with radiographic imaging of the stifle. Digital radiography systems tend to be more sensitive to scatter than plain-film screen systems. The musculature of the stifle creates a large degree of scatter in comparison to other joints which can translate into noise on digital images. It is important to compare the background noise on an image which is often overlying the soft tissues on the images relative to the trabecular pattern. If they are similar, the trabecular pattern of the bone may have been overcome by the noise and may not be reliable. Evaluation of the osseous structures and soft tissue attachments on radiographs is required for complete assessment of the joint. A negative radiographic study does not rule out osseous abnormalities.

Nuclear scintigraphy is commonly used in combination with other imaging modalities for evaluation of the stifle. Increased radiopharmaceutical uptake is not always evident in the stifle even with osseous lesions which have been determined to be clinically significant. In addition, increased radiopharmaceutical uptake can occur in the stifle due to increased or abnormal weight-bearing resulting from lameness elsewhere. Nuclear scintigraphy is helpful for precise localization of lesions such as non-displaced or incomplete fractures, detecting injury at soft tissue attachments such as enthesophytes and the evaluation of the physiology of osseous lesion identified on other imaging modalities. Nuclear scintigraphy provides valuable information, whether the findings are positive or negative, information must be carefully evaluated and correlated with clinical assessment and other imaging findings.

In most cases MRI examination cannot be performed on the stifle due to the configuration of the magnet bore. The systems designed with a short bore provide the most opportunity for MR imaging of the stifle. These units are not readily available and cannot accommodate all adult horses. Ultrasound remains the most common method for imaging the soft tissues of the stifle and provides important information about the osseous structures of this joint. Ultrasound examination of the stifle has been well described in the literature. Patellar ligaments, joint surfaces, bone margins, collateral ligaments, menisci, cranial tibial meniscal ligaments, and joint capsules as well as other...
associated soft tissue and osseous structures can be evaluated with ultrasound. Ultrasound of the cruciate ligaments has been described. This process is technically challenging and a limited window to these structures is provided. In addition it requires flexion of the limb, which can be difficult in cases with injury to these ligaments. In certain cases, the flexion of the limb cannot be sustained or is severely resented due to pain making the examination difficult. Complete evaluation of the stifle requires imaging from the cranial, caudal, medial and lateral aspects.

Evaluation of the stifle joint with the limb in a weight bearing and non-weight bearing position is required for complete evaluation of the stifle. The limb must be flexed to allow examination of the cranial horn of the meniscus and cranial tibial meniscal ligament in medial and lateral aspects of the limb (Fig 1). Fissures or tears of a meniscus may not be visible with the limb in a weight-bearing position, due to compression of the tear under the weight of the femur. With the limb in a non-weight bearing position, synovial fluid can enter the tear creating a larger separation between the edges of the tear making it more apparent. A small tear or fissure can be difficult to differentiate from focal areas of linear decreased echogenecity. The linear areas of decreased echogenecity or striated pattern in the meniscus can be found in many sound horses and the clinical significance of this finding is poorly understood. Digital ultrasound systems tend to enhance margins. Therefore this pattern is more evident on digital ultrasound systems. The striations and the meniscus should maintain the same size, shape and echogenecity with the limb weight bearing and non-weight bearing positions. If focal areas of decreased echogenecity within the meniscus increase in size and/or change shape with the limb in a non-weight bearing position compared to a weight-bearing position then fiber degeneration or intrasubstance tearing should be considered. Examination of the meniscus while taking the limb through a range of motion can provide further information about abnormal echogenecity as well as changes in position of the meniscus. Injury to the cranial tibial meniscal ligament as well as other support structures of the meniscus will allow the meniscus to slide or protrude medially along the medial margin of the femur. A change in the position of the meniscus confirms injury to the soft tissue support structures of the meniscus or injury to the meniscus and should prompt a thorough investigation to determine the affected structures.

Flexion of the stifle allows visualization of the distal articular margin of the femoral condyles. Defects in the subchondral bone can be easily identified (Fig 2). This is an effective method for evaluating the subchondral bone surface if there are questionable findings on radiographic examination. In the case where a lesion is identified on radiographs the overlying articular cartilage can be evaluated.

Examination of the medial aspect of the stifle allows visualization of the medial meniscus, medial collateral ligament and the medial femorotibial joint (Fig 3). The caudal horns of the menisci can be evaluated from the caudal aspect of the limb. The probe is angled toward to joint to identify the margins of the femur and tibia and locate the meniscus (Fig 4). The increased depth and necessary adjustments in probe frequency required to visualize the caudal horn may obscure subtle abnormalities. Examination of the lateral aspect of the joint allows visualization of the lateral meniscus, the lateral
collateral ligament, and the popliteus tendon. In addition to abnormalities in the meniscus, ultrasound of the stifle allows identification of joint arthrosis characterized by peri-articular osteophyte formation, enthesophytes, synovitis, and injury to the collateral ligaments or other associated soft tissue structures.

Fig. 1. Flexion of the stifle allows visualization of the cranial horn of the meniscus and the cranial tibial meniscal ligament (A) using ultrasound. The transition between the meniscus and the ligament is well delineated by a change in fiber pattern and echogenicity. This ultrasound appearance correlates well with the gross image (B). Abnormalities in the cranial horn of the meniscus and the cranial tibial meniscal ligament can be identified using this approach.

Fig. 2. Flexion of the stifle allows visualization of the distal margin of the femoral condyles. Subchondral bone defects can be easily identified by a depression or region of cortical discontinuity in the normally smooth and continuously echogenic line created by the bone margin. By changing the orientation of the probe relative to the curvature of the condyle, the articular cartilage margin can be identified and evaluated.
Fig. 3. Examination of the medial aspect of the stifle joint allows visualization of the medial meniscus, medial femorotibial joint, medial collateral ligament and margins of the femur and tibia. The bone margins should be smooth and continuously echogenic. The medial meniscus should be uniformly echogenic with well defined margins. The medial collateral ligament should have a linear echogenic fiber pattern.

Tarsus

Radiography in the tarsus can be used for detection of joint arthrosis, developmental orthopedic disease, trauma or infection. Joint arthrosis is characterized by peri-articular osteophyte production, subchondral bone sclerosis or lysis and joint space narrowing. In addition, enthesophyte formation can be detected at soft tissue attachments. Technique for radiographic study of the tarsus has been described.6

Fig. 4. A MRI image demonstrating the probe angle required to visualize the caudal aspect of the stifle joint (A). The corresponding ultrasound image shows the caudal horn of the medial meniscus which can be identified in the joint space between the femur and the tibia (B). The increased depth required a lower frequency probe to be used to image the caudal aspect of the stifle compared to the other regions of the stifle. The resulting loss of detail may obscure subtle abnormalities in the meniscus.
Fig. 5. Abnormal fluid in bone can be easily detected on MR images. This sagittal STIR image of a tarsus has increased signal intensity in the calcaneus indicating the presence of fluid. This finding would not be evident on radiographs or computed tomography. In this case, increased radiopharmaceutical uptake in the calcaneus would have been present on examination using nuclear scintigraphy. Increased radiopharmaceutical uptake may not always occur with the presence of abnormal fluid in bone, it is likely dependent on the cause of the fluid. In addition, nuclear scintigraphy would not provide a thorough assessment of the soft tissues of the joint. The MR image also demonstrates evidence of synovitis of tarsocrural joint. The abnormalities on this image were the result of infection of the joint and osteomyelitis.

The scintigraphic pattern of the distal tarsal region, which is a common site of investigation, has been described. Scintigraphic examination of the tarsus can be used as an adjunct to radiographs to evaluate the physiologic state of osseous abnormalities. Scintigraphic examination can be used for detection of incomplete or non-displaced fractures. Enthesopathy at soft tissue attachments and osteoarthritis can be evaluated using scintigraphy. Reassessment of osseous lesions that may not change on radiographs can provide useful clinical information. A lack of radiographic abnormalities or certain scintigraphic findings which may indicate soft tissue injury of the tarsus can be further investigated with ultrasound and/or MR imaging.

Ultrasound examination of the tarsus can be challenging due to the complex anatomy. The process for a standardized comprehensive and thorough examination of the structures of the tarsus has been described and illustrated. The interosseous ligaments of the tarsus cannot be visualized with ultrasound and are best evaluated with MR imaging. In addition, MR images best demonstrate fluid in the bones of the tarsus compared with other imaging modalities (Fig 5). Ultrasound of the proximal suspensory ligament can demonstrate certain abnormalities. However, a normal ultrasound examination does not rule out injury to the suspensory ligament. Suspensory ligament injury is best characterized with MR imaging (Fig 6).
Fig. 6. Proton density images of an abnormal suspensory ligament (A) and the unaffected opposite limb for comparison (B). The pattern in the unaffected limb is normal and is the result of the muscle and adipose tissue present in the suspensory ligament. The affected limb was first examined using ultrasound. The enlargement of the suspensory ligament was easily identified during the ultrasound exam. The increased signal intensity in the dorsal aspect of the ligament (arrow) indicating injury was not detected using ultrasound even with a retrospective exam. Injury to the suspensory ligament is most accurately characterized on MR images compared to other imaging modalities.

References


