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Ultrasound of the Equine Stifle: Basic and Advanced Techniques

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Introduction

Ultrasonographic evaluation of the equine stifle has dramatically increased our knowledge of stifle soft tissue injuries over the past 10-15 years, including patellar ligament, meniscal and cranial meniscal ligament injuries.¹⁻⁷ Indications for ultrasound include lameness localized to the stifle joint, effusion and radiographic findings of osteoarthritis that may indicate joint instability. Ultrasound is also indicated in horses with wounds to rule out concurrent soft tissue injury or to detect evidence of sepsis. Ultrasound can be useful to detect osteochondrosis lesions of the trochlear ridges in juvenile horses that are normal radiographically.⁸ Ultrasound may be indicated in horses with radiographically visible OCD lesions when lameness is more severe than would be expected with an OCD lesion.

The middle patellar ligament is the most commonly injured patellar ligament,⁴ and the medial meniscus is more often injured than the lateral meniscus.⁵ Fortunately, these are also the easiest structures to evaluate. The medial and lateral patellar ligaments are not difficult to image, but may pose some problems for beginners due to their relatively small size. Evaluation of the collateral ligaments and lateral meniscus is somewhat challenging and requires experience and some practice. The most difficult structures to examine are the cranial meniscal ligaments which are imaged with the limb held in the flexed position.^{3,6,7} This technique is considered advanced and generally should only be attempted once imaging of stifle structures is mastered. Although described in the literature, in the author's opinion, a diagnostic evaluation of the cruciate ligaments cannot reliably be obtained using ultrasound and has not been validated. Diagnostic arthroscopy remains the method of choice for detection of cruciate injuries.⁹

Ultrasonographic Technique

Clipping the hair of the stifle is important to obtain a diagnostic exam in most horses. Alcohol saturation can be difficult in this region, and some horses resent alcohol application. Light sedation with detomidine is necessary for most horses. The addition of butorphanol is advised if the horse is sensitive to stifle palpation or is a known kicker. The use of stocks is advantageous when available.

Stifle ultrasound is most comfortably performed while seated in a chair of an appropriate height and facing the rear of the horse. A standoff pad is not necessary, especially if using a transducer with a frequency ≥ 10 MHz. Scanning depth should be set at 3-6 cm for most structures. A high frequency 7-14 MHz tendon transducer is ideal for evaluating the patellar ligaments, collateral ligaments and medial meniscus. A microconvex (small curvilinear) transducer is best suited to evaluate the lateral meniscus due to its small footprint, divergent beam and mid-range frequency

(5-7.5 MHz). It can also be useful to evaluate the medial meniscus and cranial meniscal ligaments (flexed views). Appropriate program selection is important, and a program designed for superficial, tendon or small parts imaging should be used.

The stifle exam is best performed in a systematic manner, beginning with the middle patellar ligament and then scanning each medial structure sequentially in the following order: medial patellar ligament, medial femorotibial joint capsule, medial meniscus and finally the medial collateral ligament. Upon returning to the middle patellar ligament, each lateral structure is then scanned sequentially beginning with the lateral patellar ligament, common origin of the peroneus tertius/long digital extensor tendon, lateral meniscus and lateral collateral ligament.

Patellar Ligaments

The middle patellar ligament is the most commonly injured patellar ligament (PL).⁴ It is helpful to remember that the middle PL has a slightly oblique orientation and is not perpendicular to the ground, as is often suspected by many stifle imagers. The ligament has a flattened oval shape at its origin and a rounded triangular shape in the mid and distal ligament region. Small hypoechoic striations at the tibial insertions of all patellar ligaments are common and should not be mistaken for injury (Fig. 1).⁴ Acute tears are most often found in the mid to distal ligament region and appear as discrete anechoic to hypoechoic areas with fiber disruption on long axis views. This appearance may also result from previous intraligamentous injections for upward fixation of the patella (Fig. 2).¹⁰ Therefore, it is important to obtain a detailed history to help differentiate between clinically significant injury and residual hypoechoic areas from previous injection. Desmitis of the middle PL may appear similar to tearing, but lesions may be less discrete and more echogenic. In the author's experience, ultrasonographic evidence of healing seems to be prolonged in most horses with middle patellar ligament tearing or desmitis.

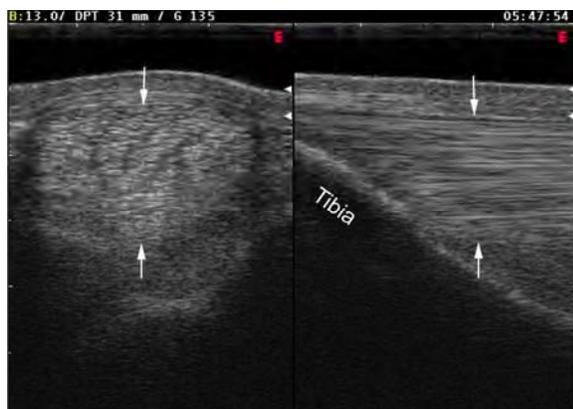


Fig. 1. Normal middle patellar ligament insertion onto the proximal tibia. Note the somewhat linear striations on the transverse view that are typically seen at the insertions of all three patellar ligaments.



Fig. 2. Ultrasound image of the middle patellar ligament in a horse that recently underwent intraligamentous injections for upward fixation of the patella. An irregularly shaped, hypoechoic area is visible within the ligament on the transverse view with corresponding irregular fiber pattern seen on the longitudinal image. This appearance may also be found in horses with primary middle patellar ligament injury.

The medial patellar ligament is located by sliding the transducer medially from a longitudinal image of the middle PL until its linear fibers are seen. The ligament is then followed distally to its tibial insertion. On transverse views, the medial PL is smaller than the middle PL but has a more triangular shape. The medial PL becomes thicker in its proximal portion as it curves towards its patellar origin. The medial PL origin cannot be visualized due to its location proximal to the patella and the transducer's inability to be placed in this location. Injuries to the medial PL are rare, although hypoechoic areas consistent with desmitis in the mid/distal portion can be seen.

The lateral patellar ligament is found by sliding the transducer laterally from a longitudinal image of the middle PL until its linear fibers are seen (Fig. 3). The lateral PL is a thin and flattened ligament located close to the skin surface, especially as it courses over the lateral trochlear ridge (LTR) of the distal femur. It can be evaluated from origin to insertion, but due to the contribution of fibers from proximal muscle bellies (quadriceps), some fibers can be seen to extend proximal to the patella. The lateral PL is infrequently injured,⁴ but injuries are not uncommon in horses with stifle trauma such as kicks, wounds or lacerations. Radiographic evidence of proximal tibial avulsion fractures should prompt ultrasonographic investigation to detect concurrent lateral PL injury. Affected horses often show large, irregularly shaped, anechoic areas with a severely disrupted fiber pattern and marked thickening of the ligament (Fig. 4). It is interesting that the location of LPL injury can be located at some distance from the external wound site in many horses.

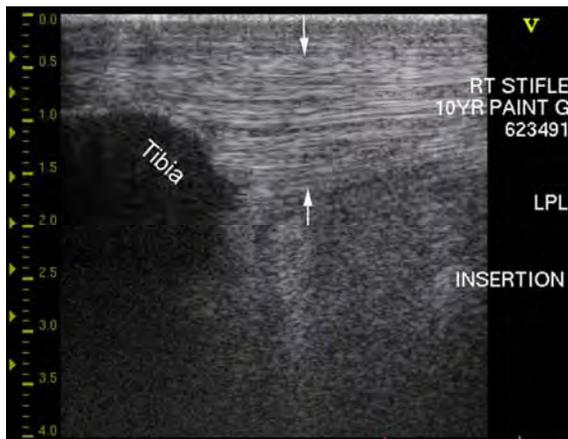


Fig. 3. Longitudinal ultrasound image of a normal lateral patellar ligament (arrows) at its insertion onto the proximal tibia.

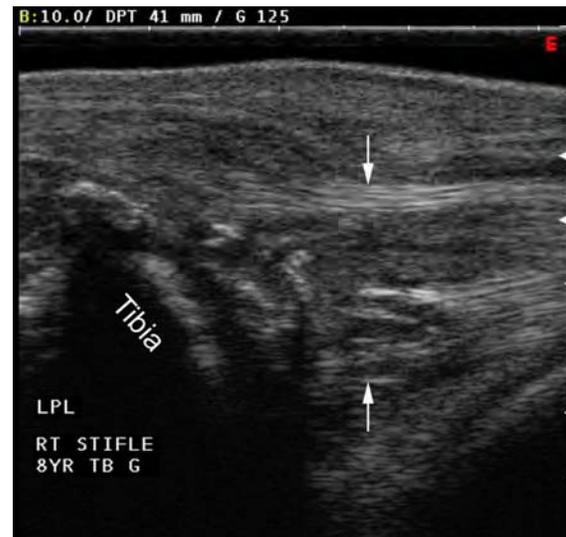


Fig. 4. Longitudinal ultrasound image of a severe injury of the lateral patellar ligament (arrows) with associated avulsion fragments of the proximal tibia in a horse with recent kick trauma.

Trochlear Ridge OCD Lesions

The LTR can be evaluated for OCD lesions during lateral PL imaging. The medial trochlear ridge is visible between the middle and medial PLs. The anechoic cartilage layer and underlying hyperechoic subchondral bony surface should be smooth and uniform. OCD lesions can appear

as subchondral defects which may be small and subtle to large and very irregular.⁸ Cartilage thickening or flaps can also be seen (Fig. 5). Cartilage defects without subchondral changes are more difficult to detect and require careful and systematic evaluation.

Medial Structures

The medial structures of the stifle are most easily imaged in this order: medial patellar ligament, medial femorotibial (FT) joint capsule, medial meniscus and medial collateral ligament (MCL). From a longitudinal image of the medial patellar ligament, the medial FT joint capsule is found by sliding the transducer medially until an anechoic, fluid-filled, oval shaped structure is seen adjacent to the distal femur (Fig. 6). Some fluid in this joint capsule is visible in nearly all horses;¹¹ however, the amount of visible fluid can be significantly affected by transducer pressure and position as well as weight bearing status. Mild synovial thickening is also common and is considered a nonspecific finding. Marked distention can create a more circular shape to the joint capsule.

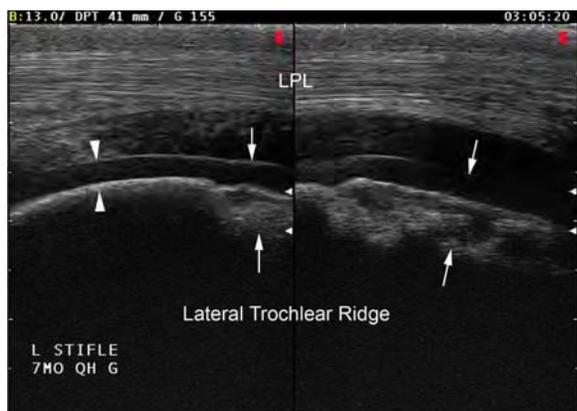


Fig. 5. Large OCD lesion (arrows) of the lateral trochlear ridge of the distal femur. Normal subchondral bone & cartilage is visible on the left of the image (arrowheads). Proximal is to the right.

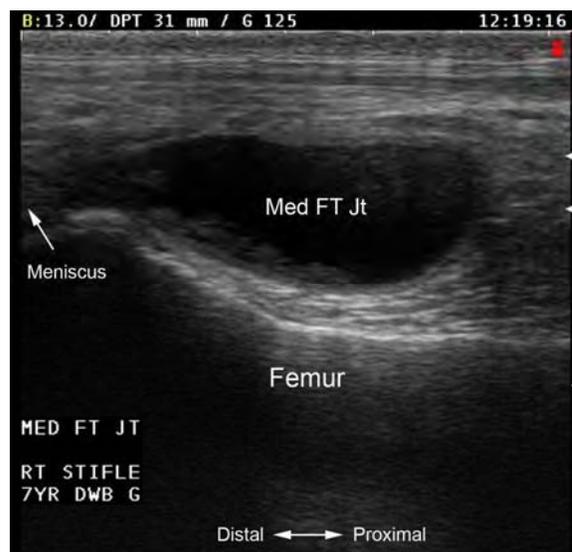


Fig. 6. Normal amount of synovial fluid within the medial femorotibial joint. Proximal is to the right.

The medial meniscus is imaged next by sliding the transducer distally 1-2 cm and slightly medially from an image of the medial FT joint capsule. The longitudinal orientation of the transducer relative to the joint (perpendicular to the ground) produces a transverse image of the meniscus. The normal meniscus has a nearly equilateral triangular shape, a homogeneous echogenicity and is well-seated in the joint space with no evidence of abaxial bulging. Vertical hypoechoic striations are commonly seen in normal menisci and should not be misinterpreted as injury (Fig. 7). The meniscus should be evaluated as far caudally as possible, but imaging beyond the caudal border of the MCL is not easily performed. Abnormal menisci take many forms, the most subtle of which is meniscal flattening. Severely affected menisci typically show a markedly distorted shape with irregular hypoechoic areas and portions of the meniscus extending beyond the abaxial margins of the joint (Fig. 8). Horses with chronic meniscal tearing

typically exhibit prominent osteoarthritis on the affected side of the joint on stifle radiographs.⁵ It is important to remember that ultrasonography and arthroscopy are complimentary imaging modalities for meniscal injury. The midbody region of the meniscus is not visible arthroscopically, but is well visualized ultrasonographically.¹² As such, negative findings on arthroscopy do not rule out meniscal injury. Arthroscopy is better suited to visualize small tears of the cranial and caudal horns of the menisci that may be challenging or impossible to visualize ultrasonographically.

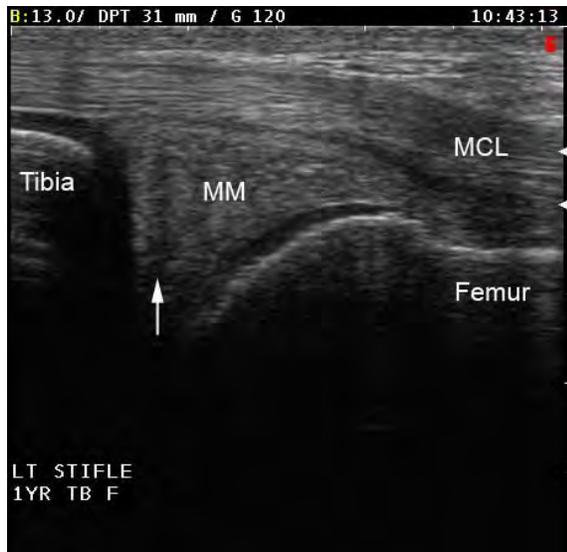


Fig. 7. Normal transverse image of the medial meniscus (MM). The vertical striation (arrow) present within the meniscus is within normal limits and should not be mistaken for injury. The MCL is visible overlying the MM.

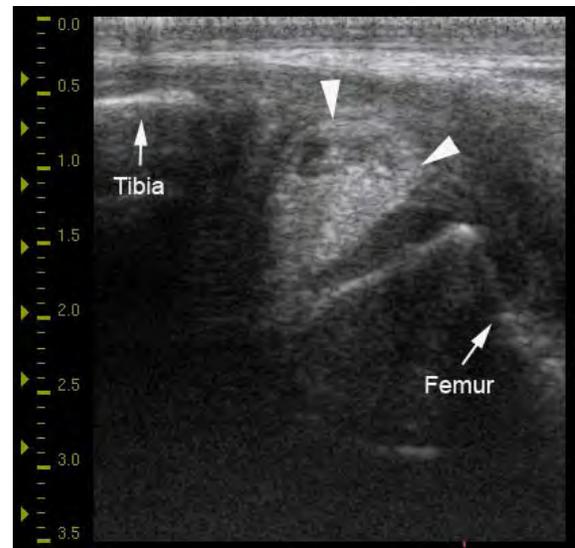


Fig. 8. Abnormal medial meniscus (arrowheads) with a flattened shape and hypoechoic areas present along the abaxial border of the meniscus in a horse with chronic lameness.

The medial collateral ligament is next imaged by sliding the transducer slightly caudally from the initial image of the medial meniscus until its linear fibers are seen overlying the meniscus. Similar to all CLs, the MCL is best imaged longitudinally first and then transversely. The MCL can be readily followed to its tibial insertion. Visualization of the MCL origin is very challenging unless the horse can be prompted to rest the limb in partial weight bearing in which case, visibility is excellent. The resting limb position creates more space for the transducer in the inguinal region and allows the transducer to be positioned to parallel to the fibers of the CL origin. The origin should have a fairly linear fiber pattern as it inserts onto the femur (Fig. 9); however, mild irregularities in fiber pattern can be seen in normal horses. Similar to longitudinal views, transverse views are more easily obtained in the mid to insertional region and are difficult to obtain at the origin. MCL injuries are relatively uncommon in the horse, although partial tearing and complete ruptures have been seen by the author. The MCL is more often injured than the LCL, in the author's experience.

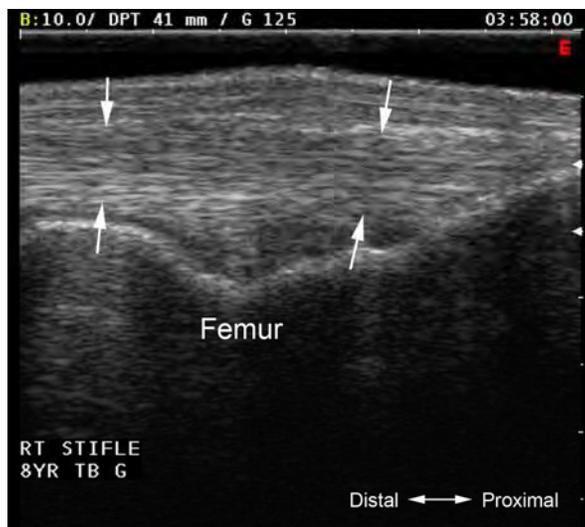


Fig. 9. Normal longitudinal image of the MCL origin (arrows) at the distal femur. This image was obtained with the horse resting the right hind limb.

Lateral Structures

Techniques for imaging the lateral structures of the stifle joint (lateral PL, peroneus tertius, lateral FT joint, lateral meniscus, lateral collateral ligament [LCL]) are similar to that described for the medial structures. All lateral structures are most easily imaged with the transducer oriented longitudinal to the joint, beginning from a longitudinal view of the lateral PL. The common tendon of origin of the peroneus tertius and long digital extensor is first encountered as the transducer is slid laterally from the lateral PL. This large tendon can be followed throughout the length of the tibia to its tarsal/metatarsal insertions and should not be mistaken for the more laterally located LCL. Although peroneus tertius injuries are infrequent at this level, the PT should be evaluated to detect distention of the lateral FT joint capsule that is located deep to and partially surrounds the PT in the proximal tibia region. Effusion of this joint capsule is an uncommon finding in normal horses. Moderate to severe effusion (Fig. 10) should raise the suspicion for lateral meniscal or cranial meniscal ligament injury.

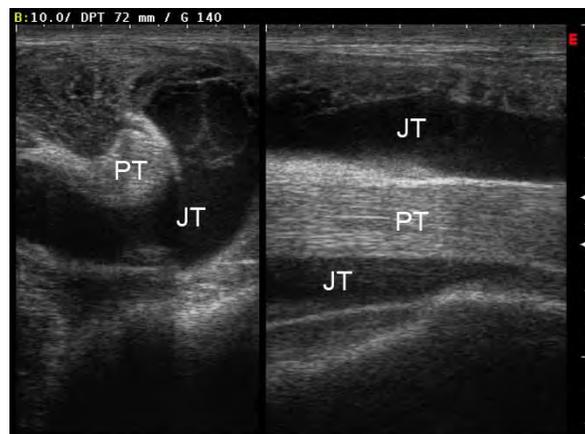


Fig. 10. Severe lateral femorotibial joint effusion (JT) visible deep to and nearly surrounding the peroneus tertius (PT) tendon at the level of the proximal tibia in a horse with synovial sepsis.

The lateral meniscus is imaged by sliding the transducer laterally and aiming slightly caudally from a longitudinal image of the PT tendon at the level of the joint. Similar to the MM, the cranial horn and midbody region of the LM can be evaluated to the caudal border of the LCL. The lateral meniscus is more difficult to image with a standard linear tendon format transducer. If available, a microconvex transducer can be used to obtain a better image, as this transducer better conforms to the contours of the lateral stifle joint and offers improved penetration. The normal lateral meniscus often shows slight abaxial bulging compared to the MM (Fig. 11). Lateral meniscal injuries are less common but do occur with some regularity.⁵ When present, injuries appear similar to MM injuries. Affected horses tend to have distention +/- synovitis of the lateral FT joint and may also show evidence of degenerative joint disease in chronic cases.



Fig. 11. Normal appearance of the lateral meniscus (LM) at the level of the lateral collateral ligament (LCL).

The lateral collateral ligament is imaged by sliding the transducer caudolaterally along the meniscus until the linear fibers of the LCL are seen. The LCL generally appears thicker than the MCL. In contrast to the MCL, the LCL origin is readily visualized, but its insertion is not clearly visible. Discrete fibers inserting onto the bony surface of the tibia/fibula are typically not seen as some fibers continue distally to merge with the lateral digital extensor muscle and tendon. The most common error during LCL imaging occurs when the transducer is not placed far enough caudally on the limb. It is also important to remember that the LCL has a slightly oblique orientation, with the origin located more cranially than its insertion. Injuries to the LCL are not common.

Flexed Views: Cranial Stifle Structures

Ultrasound of the stifle joint with the limb held in the flexed position provides excellent visualization of the cranial horns of both menisci and the cranial meniscal ligaments (aka meniscotibial ligaments).^{3,6,7} These structures are not able to be visualized in the weight bearing horse. As stated earlier, a diagnostic exam of the cruciate ligaments is unreliable. Examination of the cruciate ligaments requires a scanning depth of 7-8 cm. As such, resolution is significantly impeded, and the likelihood of accurately detecting injury to these small structures is poor. In addition, the presence of overlying synovial thickening is extremely difficult to differentiate from cruciate injury.

The cranial meniscal ligaments (CML) are located relatively close to the skin surface and can be readily evaluated with practice utilizing a linear “tendon” format transducer. A microconvex transducer is often useful in larger or other difficult-to-image horses. Each CML extends from the cranial horn of each meniscus to its insertion near the tibial tuberosity. The CML of the medial meniscus is located by holding the limb flexed with the transducer held in the hand closest to the horse. The medial meniscus is first identified and then followed cranially to its cranial horn, at which point the transducer is rotated in a clockwise (left stifle) or counterclockwise (right stifle) direction until the transducer is oriented transverse to the joint. The linear fibers of the CML are seen by aiming the transducer slightly distally and then followed axially to their insertion onto the tibia. The medial CML is best visualized using longitudinal images and should have a linear fiber pattern (Fig. 12). The medial CML may be difficult to assess in horses with chronic stifle effusion and synovitis due to multiple refractive edge artifacts. Disruption of its linear fiber pattern with or without bony change is consistent with injury (Fig. 13). Affected horses may benefit from stifle arthroscopy.



Fig. 12. Normal cranial meniscal ligament (arrows) of the medial meniscus at its tibial insertion. This image was obtained with the limb held in the flexed position.

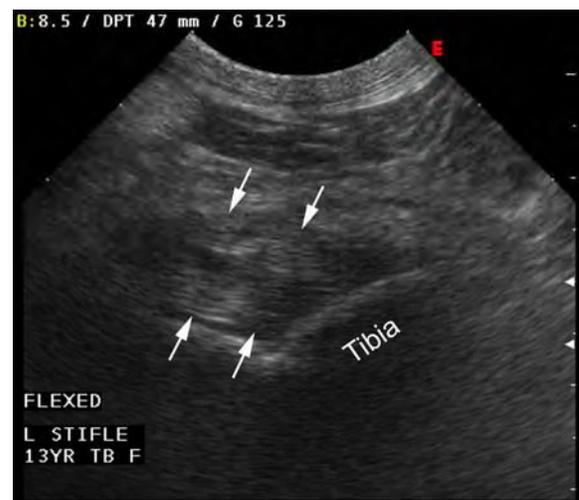


Fig. 13. Central area of irregular fiber pattern consistent with injury of the cranial meniscal ligament (arrows) of the medial meniscus. This image was obtained with the limb held in the flexed position.

In contrast to the medial CML, the CML of the lateral meniscus is best evaluated using transverse views. The horse’s limb should now be held with the examiner’s hand closest to the horse and the transducer held in the hand away from the horse. Similar to the medial CML, visualization is obtained by first locating a transverse image of the lateral meniscus and then sliding the transducer cranially while aiming caudomedially. Visualization of the linear fibers of the peroneus tertius serves as a reliable landmark. The lateral CML is visible deep to the PT tendon as a half circle to crescent shaped structure adjacent to the tibial surface (Fig. 14). Echogenicity should be homogeneous. Longitudinal views of the lateral CML are not typically diagnostic due to prominent refractive edge artifacts from the overlying peroneus tertius tendon. Abnormalities range from small hypoechoic areas to complete disruption where the ligament is nearly unrecognizable.

Ultrasound of the cranial aspect of the flexed stifle can also produce excellent images of medial femoral condylar cysts. This can be useful if ultrasound-guided injection is desired as a therapeutic option in affected horses. Small to large subchondral defects (Fig. 15) can be seen by aiming the transducer slightly proximally while imaging throughout sequential slices of the medial aspect of the joint.

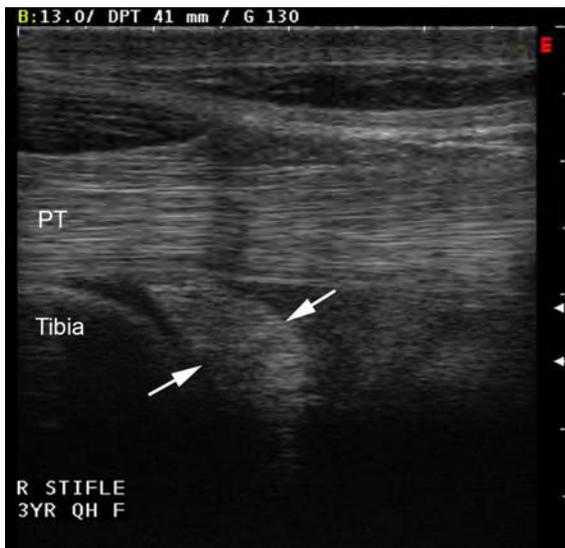


Fig. 14. Transverse image of the normal cranial meniscal ligament (arrows) of the lateral meniscus (PT=peroneus tertius), obtained with the limb held in the flexed position.

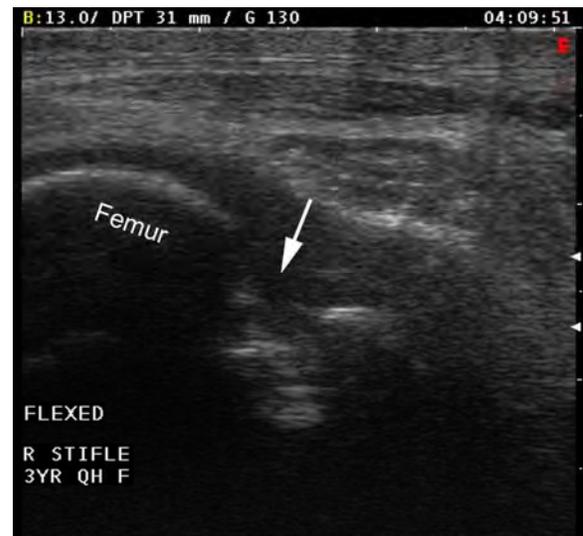


Fig. 15. Large medial femoral condylar cyst (arrow). Image was obtained with the limb held in the flexed position.

Summary

It is hoped that this proceedings will serve as a useful guide and resource for future stifle scans. Ultrasound of the stifle can be a challenging but rewarding experience, made easier by a strong knowledge of stifle anatomy. It is not a coincidence that some of the best imagers in the world are either anatomists or have an exceptional knowledge of anatomy. Stifle ultrasonography takes considerable practice and will not be mastered after a few cases. Some horses are more difficult to scan than others, especially those with chronic stifle problems and significant effusion/synovitis. Novice ultrasonographers should begin with the most straightforward structures to scan (patellar ligaments and medial meniscus) and then progress to the more difficult structures. A complete exam of all stifle structures should ultimately be the goal of stifle imagers. Because there are few localizing signs that would indicate a focused exam of a specific stifle structure, a complete exam will maximize diagnostic yield. That said, many veterinarians are eager to attempt flexed views before they have obtained adequate transducer control and manipulation skills. These should only be performed after imaging of standing views is mastered. For example, in the LA ultrasound fellowship program at UC Davis (a 1-2 year training program), flexed views are not performed by our fellows until month 6-8 of their training program.

Safety should always be a consideration with stifle imaging. A relatively light touch with the ultrasound transducer is very important to decrease the likelihood of getting kicked. At least one finger of the scanning hand should be in contact with the horse. This serves a dual function. It provides advanced notice of limb movement, weight shifting or leaning of the horse. It also stabilizes the scanning hand for improved image acquisition. Lastly, it is important to exercise care when wiping ultrasound gel from the limb. Surprisingly, even a quiet horse that has been completely cooperative throughout the exam can kick while having gel removed with a towel.

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