Complete Ultrasound Examination of the Front and Hind Suspensory Ligaments.

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Suspensory ligament (SL) injury is an important source of lameness in performance horses. Injury to the SL not only affects the ligament, the third metacarpal or metatarsal bones may also be affected. Multiple modalities are available to aid in the diagnosis of SL injury. All modalities can make a contribution to diagnosing and characterizing SL injury. However, ultrasound is commonly used to diagnose suspensory ligament injury and can be used in the field. Although MRI will be required to diagnose certain injuries, ultrasound can be used to diagnose many types of suspensory ligament injury. The purpose of this article is to describe the techniques required for complete examination of the suspensory ligament.

Standard Approach in the Forelimb

Longitudinal and transverse images of the suspensory ligament should be acquired from the palmar aspect of the limb. A linear probe is most commonly used for examination of the metacarpal region. The frequency, focal zones, depth and gain should be adjusted to maximize image quality at the level of the suspensory ligament. Although all structures at this level should be assessed during the ultrasound examination, the depth should be set such that the hyperechoic line representing the palmar margin of the third metacarpal bone is clearly visible. Comparison to the opposite limb is imperative in almost all cases. Even in cases with obvious SL injury, additional findings become apparent when compared to the opposite leg. A measurement system (zones or centimetres distal to the accessory carpal bone) to record the level at which the images were acquired should be consistently used. The palmar approach with a linear probe creates a rectangular appearance to the suspensory ligament. This appearance occurs because the width of the suspensory ligament is greater than the flexor tendons. Therefore, the contact area of the ultrasound probe with the palmar margin of the leg creates this rectangular appearance. The ultrasound beam can only penetrate the suspensory ligament at the same width as the contact area when a linear probe is used. It is important to recognize that the suspensory ligament extends beyond these margins and additional techniques are required to fully image the ligament. A technique to address this shortcoming of the standard technique is described in the non-weight bearing section below. However, the probe can be angled toward the second and fourth metacarpal bones while positioned on the palmar aspect of the weight bearing limb to obtain images of the SL periphery.

The suspensory ligament has a mottled appearance due to regions of fat and muscle within the ligament. This mottled appearance will create regions of decreased echogenicity in the ligament on transverse images and regions without linear fibres when evaluating the ligament longitudinally. With the increase in image resolution and detection of tissue planes now available with portable ultrasound machines, the interfaces between fibres and regions of fat and muscle are more apparent. Due to the differences in technology and resultant image appearance, converting from an analog to digital ultrasound machine requires adjustments in the evaluation and interpretation of the suspensory ligament.

The entire SL body should be evaluated in transverse and longitudinal planes with images obtained at regular measurement intervals. The size, shape, margins and echogenicity should be evaluated.

Standard Technique in the Hindlimb

The standard technique for evaluation of the SL in the hindlimb typically involves using a medial standing approach. In certain cases, the mid to distal aspects of the suspensory ligament body must be imaged from the plantar aspect of the limb because at this level the medial aspect of the limb does not provide an adequate contact surface to allow
visualization of the ligament. A large portion of the proximal suspensory ligament is lateral of midline. In addition, the axial margin of the fourth metatarsal bone, which is curved, wraps around the lateral margin of the suspensory ligament. These anatomic features make the standing plantar approach unideal as it obscures the lateral aspect of the suspensory ligament. When performing the medial approach, the deep digital flexor tendon can be used as a contact surface and directing the ultrasound beam dorsolaterally, almost the entire suspensory ligament can be visualized. The normal hind suspensory ligament changes shape from proximal to distal more dramatically than the front suspensory ligament. In addition, subtle changes in shape are often visible before ligamentous abnormalities are detected. Therefore, comparison to the opposite limb is imperative. In addition, the size and shape of the fourth metatarsal bone changes in similar and dramatic fashion. The size and shape of the fourth metatarsal bone and its relationship to the third metatarsal bone can be used to ensure comparisons between the right and left hind limbs are being made at the same level. As previously discussed in the standard technique of the forelimb, standard measurement techniques as well as ultrasound machine settings that maximize image quality for imaging of the SL should be utilized. Evaluation of the SL margins for peri-ligamentous tissue proliferation should be performed. The non-weight bearing technique can be applied in the hind limb. In certain cases it is easier to see the fiber versus fat-muscle regions with the limb in a non-weight bearing position. Placing the limb resting on the toe provides enough laxity of the flexor tendons improve visualization of the SL and facilitate identification of different tissue types using variations in beam angle.

Non-weight Bearing Technique in the Fore and Hind Limb

In addition to the standard technique, the suspensory ligament should be examined with the limb mildly flexed at the carpus or tarsus. This examination is primarily performed in transverse plane, although abnormalities can be documented in both planes. Flexion of the carpus or tarsus creates flexor tendon laxity. The flexor tendons can then be manipulated, which will increase the contact area for the ultrasound probe. The entire SL is now visible in one image in contrast to the standard technique. The manipulation of the flexor tendons decreases the depth between the ultrasound probe and the suspensory ligament, thereby increasing image detail by allowing the use of a higher frequency. In addition to manipulation of the flexor tendons, the vasculature can be more easily manipulated decreasing the associated artefact. This method allows visualization of the relationship between the second and fourth metacarpal/tarsal bones and the suspensory ligament. Axial margin proliferation on the margins of the second and fourth metacarpal/tarsal bones along with syndesmoses can be more easily identified. In addition, increased detail achieved with this method allows careful assessment of potential contact areas between axial second and fourth metacarpal bone proliferation and the margins of the suspensory ligament. It is important to note that this method can falsely give the appearance of contact between axial metacarpal bone proliferation and the suspensory ligament. The laxity of the flexor tendons and pressure of the ultrasound probe can push the suspensory ligament into the bony margins of the metacarpal bones. This relationship may not exist in a similar fashion when the horse is in a weight-bearing position. Contact between the axial margins of the metacarpal bones and the suspensory ligament should be interpreted with caution in using this examination method.

The minimal amount of carpal flexion that can be maintained with the limb in a steady position will allow the best visualization of the suspensory ligament origin. If the horse is resistant in maintaining this position, the carpus can be maintained at a more flexed position once the proximal 4 cm of the SL body has been examined. The increased carpal flexion will still allow examination of the remaining suspensory ligament body. Examining the suspensory ligament with the carpus flexed allows improved visualization of the suspensory ligament when compared to the standard technique.

In the hind limb, standing with the tarsus flexed resting on the toe creates enough flexor tendon laxity to obtain the appropriate images using this technique. However, in cases with
poor patience compliance the limb can be held of the ground. This technique is often
superior to the medial approach because the ultrasound beam is now perpendicular to the
bone-suspensory ligament interface, thereby creating higher quality images of the area that
is most typically affected.

On and off beam angle techniques should be used during the non-weight bearing
examination and can be used during the weight bearing examination as well. In all cases,
comparison to the opposite leg is imperative. In many cases bilateral disease is present.
However, one limb is often more affected than the other so comparison of limbs can still be
beneficial. When possible the SL should be re-examined 2-4 weeks following the initial
diagnosis. In certain cases the injury will be worse in this time frame despite treatment.
Additional rechecks and treatment plan can be made by visualizing full extent of injury
which should be evident with the combination of these two US examinations. In conclusion,
the standard technique and flexed technique should be used to perform a complete
ultrasound examination of the suspensory ligament