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Ultrasonography of Equine Musculoskeletal Soft Tissues Containing Striations

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Review Article

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ABSTRACT

Ultrasonography is commonly used for equine musculoskeletal imaging. Several musculoskeletal soft tissues in the horse contain hypoechoic linear striations that can be mistaken for pathological change. This review summarizes the relevant literature describing striations, as well as how to distinguish these striations from pathological change on ultrasound evaluation.

INTRODUCTION

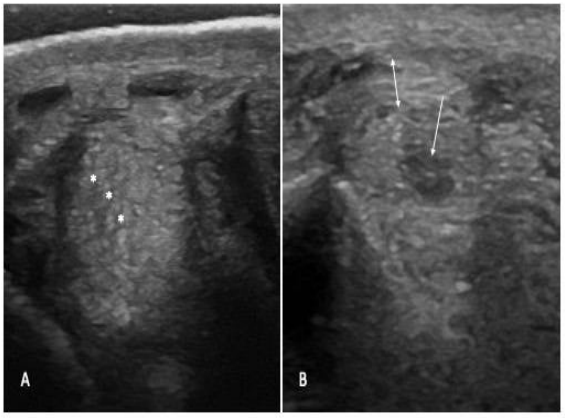
Ultrasonography is frequently performed for first-line equine musculoskeletal imaging due to its ease of use, convenience, and cost. Knowledge of detailed anatomic features is necessary for accurate interpretation during musculoskeletal ultrasound examinations. One anatomic feature that can easily be mistaken for pathology is presence of striations within soft tissues. Striations containing fat appear as hypoechoic linear regions within the tissue and can be confused with tearing within the soft tissue. This review will highlight common musculoskeletal structures that contain striations seen on ultrasound exam, as well as how to distinguish these striations from pathology.

Oblique sesamoidean ligaments

The Oblique Sesamoidean Ligaments (OSLs) originate at the base of the lateral and medial proximal sesamoid bones and course axially in a V-shape where they insert on the palmar/plantar aspect of the proximal phalanx [1]. The oblique sesamoidean ligaments contain striations, most easily seen at the origin. This is also the location at which pathology is most common [2].

In a study of 232 horses with lameness localized to the metacarpo (tarso) phalangeal region, desmopathy of the OSLs was diagnosed in 31% of horses using MRI, indicating that injury to the OSLs is not uncommon [3]. The striations present within the OSLs are highly variable between horses with some horses having easily discernible striations and others having no obvious striations [4]. No study has been performed evaluating striation pattern, striation number, or variation between breed, forelimbs/hindlimbs. The striations present within the OSLs appear as linear, hypoechogenic regions. Some striations appear to completely transect the ligament at the origin as shown in Figure 1.

Figure 1. Striations *versus* pathologic change in the Oblique Sesamoidean Ligament (OSL) on ultrasound.



Note: A. Transverse ultrasound images a normal OSL at the origin. Hypoechoic striations are denoted by the white asterisks.

B. Transverse ultrasound image of an injured OSL at the origin. Note the hypoechoic core lesion (white arrow), as well as periligamentous thickening (double-headed white arrow).

Striations were present in histologically normal OSLs, while histologically abnormal OSLs had significantly fewer striations present (less interfascicular fat content) [4]. This is similarly seen in the proximal suspensory ligament in which enlargement of the ligament compresses the central fat/muscle bundles [5]. A moderate correlation was present between interfascicular fat content and presence of proteoglycan on histopathology, with a reduction in fat occurring as proteoglycan content increased. Normal ligament contains very little proteoglycan, and presence of this compound indicates pathological change [4]. This finding supports the conclusion that pathologic change within the OSLs results in compression and loss of the normal striations.

Because of the variable nature of presence of striation, it is challenging to recognize lack of striations present on ultrasonography. Therefore, other signs of pathology should be evaluated. These signs on ultrasound may include presence of a heterogenous fiber pattern, a more focal hypoechoic region, enlargement of the ligament, and presence of periligamentous thickening [2]. If a linear tear is suspected within the OSL, the non-weightbearing exam should be performed. This exam will be described later in this review. In the aforementioned study in which unusual striation patterns were present on MRI in histologically normal OSLs, when comparing forelimbs and hindlimb pairs,

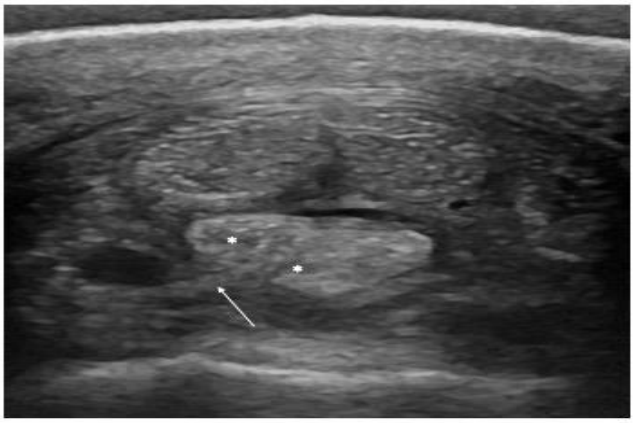
these striation patterns were present bilaterally [4]. This indicates that comparison to the contralateral limb can be performed if a tear is suspected without other pathological changes as shown in Figure 1.

Evaluation of ligament enlargement should be performed cautiously. In the Ellis et al. study, the lateral OSL had a larger cross-sectional area at the origin than the medial OSL in 97% of histologically normal ligaments on MRI [4]. This finding suggests that comparison to the contralateral limb (i.e. comparing left forelimb lateral OSL to the right forelimb lateral OSL) may be more accurate when comparing cross-sectional area than comparing lateral and medial OSLs on the same limb.

Straight sesamoidean ligament

The Straight Sesamoidean Ligament (SSL) originates from the base of the proximal sesamoid bones on midline and inserts on the middle scutum [6]. The straight sesamoidean ligament is commonly injured with rates of 21% in horses with lameness localized to the metacarpo (tarso) phalangeal joint [3]. The normal SSL contain variable short, linear striations when imaged in the transverse plane, as well as hypo- to anechoic foci. Tissue strands extending from the OSL to the SSL are present in 57% of histologically normal limbs, as seen on MRI. These tissue strands should not be misinterpreted as torn ligament fibers as shown in Figure 2.

Figure 2. Striations present within the Straight Sesamoidean Ligament (SSL) on ultrasound.



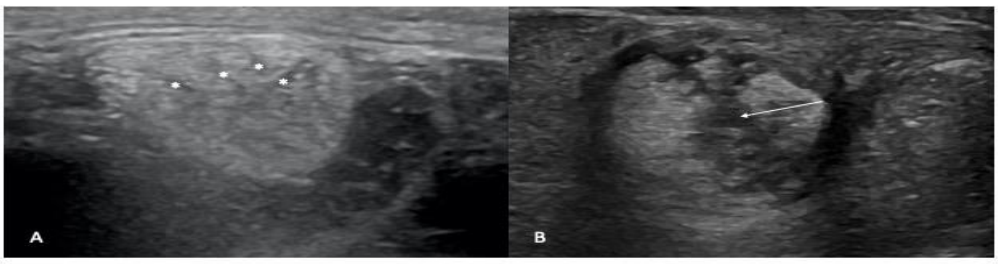
Note: Transverse ultrasound image a normal SSL within the mid-pastern. The short, linear hypoechoic striations are denoted by the white asterisks. A tissue strand is present which extends to the OSL (white arrow).

Comparison to the contralateral limb is recommended if a hypo- to anechoic regions are seen ultrasonographically. The SSL in the hindlimbs often has an unusual shape that can be mistaken for pathological change, making comparison to the contralateral limb important to avoid misdiagnosis of SSL desmopathy. In a recent study, injury to the SSL was more common in the forelimbs than the hindlimbs. Similar to the OSL, a non-weightbearing exam should be performed to help distinguish a tear from a striation. Core lesions within the SSL are common; therefore, presences of hypoechoic foci along with enlargement of the ligament when compared to the contralateral limb are supportive of desmopathy [2,7].

Intermediate patellar ligament

The intermediate patellar ligament courses from the cranial part of the apex of the patella through the trochlear groove to insert on the tibial tuberosity [8-10]. Of the three patellar ligaments in the horse, the intermediate patellar ligament is the most commonly injured [11,12]. Striations are apparent in the transverse plane and are highly variable between horses, with some horses having an abundance of striations and others having none. In a recent study by Cannon et al., the striation pattern within the intermediate patellar ligament was described [13]. These patterns were also compared between six quarter horses and six warm bloods. Striations were present in greatest number in both breeds within the distal aspect of the ligament, similar to previous studies [10,11,13,14]. The striation patterns within the distal aspect of the intermediate patellar ligament described included: Parallel: Two or more parallel striations present with no perpendicular striations; Grid: Two or more parallel striations and 1 or more perpendicular striations; Arborizing: Two or more diverging striations that are not parallel to each other; None: No distinct striation pattern present. Evaluation of the striation patterns within the distal portion of the intermediate patellar ligament determined that 58.3% of quarter horses had parallel striation patterns, 25.0% were arborizing, 8.3% had a grid, and 8.3% had no recognizable pattern. The striation patterns in the distal portion of the intermediate patellar ligament in Warmbloods were 33.3% parallel, 58.3% arborizing, 0% grid, and 8.3% had no recognizable pattern [13].

Figure 3. Striations *versus* pathologic change in the intermediate patellar ligament on ultrasound.



Note: A. Transverse ultrasound image of a normal intermediate patellar ligament within the distal aspect of the ligament. Hypoechoic striations are denoted by the white asterisks.

B. Transverse ultrasound image of an injured intermediate patellar ligament within the mid-portion of the ligament. Note the large, hypoechoic lesion that extends around the entire diameter of the ligament (white arrow).

In addition, this study evaluated if striation pattern was symmetric from left to right for each horse. When comparing striation patterns between the left and right limbs in each horse, 66.6% of the study population had bilaterally symmetrical striation patterns, while 33.3% were asymmetric [13]. This highlights that while comparison to the contralateral limb is often used to help distinguish between pathologic change and anatomic variation, in one-third of horses, this may result in mis-categorization of normal striations as pathologic change. Other signs of pathologic change should be utilized instead when evaluating the intermediate patellar ligament.

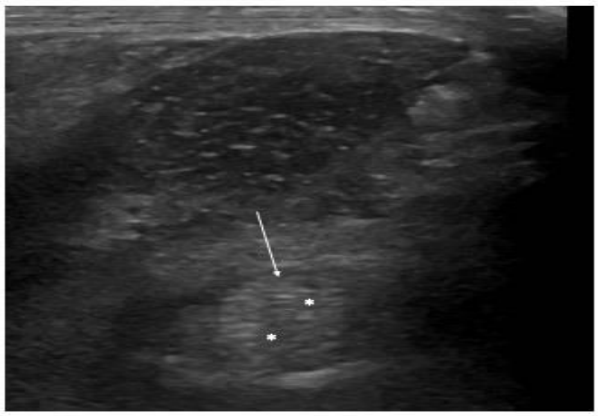
According to Hoaglund et al., intermediate patellar ligament desmopathy usually occurs in the midbody to distal aspect of the ligament where the striations are usually observed. On ultrasound, these lesions are typically discrete and hypoechoic and tend to take on an oblique craniolateral to caudomedial oriented linear pattern [11]. Presence of this appearance on ultrasound examination along with other signs of pathologic change, including inflammation within the fat pad or effusion of the femoropatellar joint, should be used to help determine pathology from normal striation variations rather than relying on comparison to the contralateral limb. The non-weightbearing exam, as described below, can also help distinguish between tears and striations as shown in Figure 3.

The medial and lateral patellar ligaments also commonly contain striations near their insertions on the tibia. To the author's knowledge, in depth evaluation of the striation pattern and appearance has not been documented. However, similar principles of evaluation for pathologic change as the intermediate patellar ligament should be utilized.

Medial cranial meniscotibial ligaments

The Medial Cranial Meniscotibial Ligament of the stifle attaches from the cranial horn medial meniscus to the medial aspect of the intercondylar eminence [8]. This ligament can be injured on its own or along with the medial meniscus [15]. The ligament can be seen ultrasonographically during the non-weight bearing exam of the stifle [16]. According to Daglish et al., in which cadaver stifles underwent MRI evaluation followed by comparison to gross dissection, the medial cranial meniscotibial ligament contains prominent striations that are easily separated on gross dissection. This can make ultrasound evaluation of the ligament challenging, as hypoechoic linear regions could be either tears or striations. The lateral cranial menisotibial ligament is less obviously striated on gross examination [17]. Comparison of the left and right limb pairs was not performed in this study. Therefore, it is unknown if striation presence is bilaterally symmetric. The ultrasonographer should look for other signs of pathology, including enlargement of the meniscotibial ligament and presence of femoropatellar joint inflammation. Arthroscopy is superior to ultrasonography for evaluation of the meniscotibial ligaments [14]. Therefore, arthroscopy may be recommended if desmopathy is suspected on ultrasound exam as shown in Figure 4.

Figure 4. Striations present within the Medial Cranial Meniscotibial Ligament (CMTL) on ultrasound.

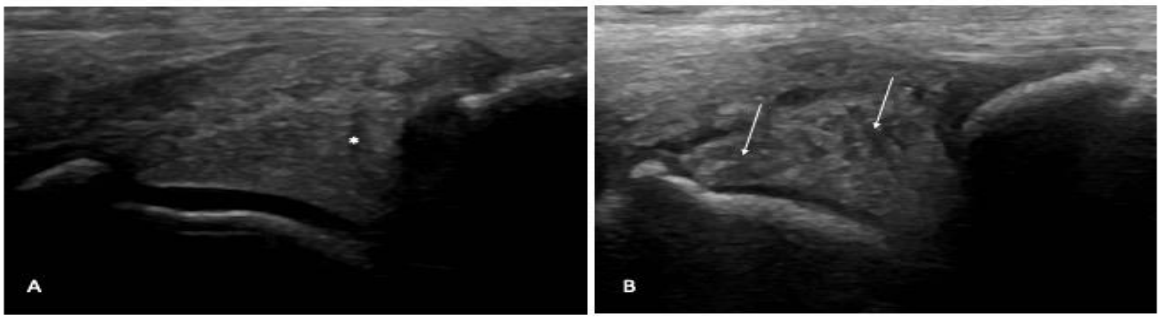


Note: Transverse ultrasound image of a normal medial CMTL near the insertion (identified with white arrow). Hypoechoic striations are denoted by the white asterisks. The CMTL was confirmed normal on arthroscopy.

Medial meniscus

The medial meniscus of the stifle is a semilunar structure that provides cushion between the femur and tibia [18]. The medial meniscus frequently contains 1 or more linear hypo- to anechoic striations when imaged in the transverse plane [16]. Injury of the medial meniscus has been reported to account for 20% of all stifle lameness [19,20]. Injury to this structure is treated frequently with arthroscopy, biologics, and extensive rehabilitation [21]. Therefore, confusion of a striation for a tear within the meniscus would be an unfortunate and costly error as shown in Figure 5.

Figure 5. Striations *versus* pathologic change in medial meniscus on ultrasound.



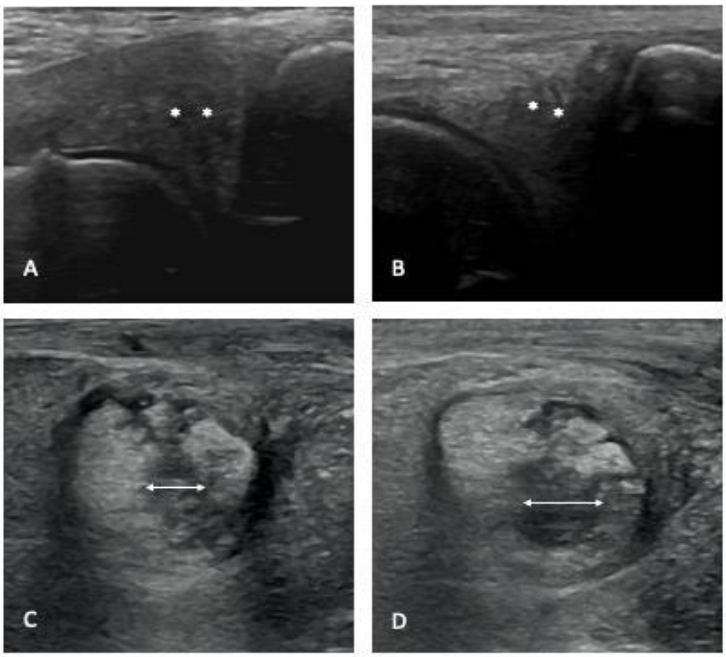
Note: A. Transverse ultrasound image of a normal medial meniscus. A single hypoechoic striation is denoted by the white asterisks. Note that one or more striations can normally be present.
B. Transverse ultrasound image of an injured medial meniscus. Note the overall degenerative (heterogenous) appearance of the meniscus. Two hypoechoic foci are present (white arrows), which became enlarged when imaged non-weightbearing.

Tearing of the medial meniscus could be confirmed by presence of a degenerative appearance to the meniscus (heterogenous appearance on ultrasound), effusion within the medial femorotibial joint recess, abaxial protrusion of the meniscus, presence of osteoarthritis within the medial femorotibial joint with chronic cases, and presence of a moderate to marked lameness [22,23]. In addition, as detailed below, the non-weightbearing exam can help distinguish between a striation and tear as shown in Figure 5.

The non-weightbearing exam

For all the previously mentioned structures, the non-weightbearing can help distinguish between a striation and a tear. Examples are present in Figure 6. When a tear is present, unloading the limb will result is enlargement of the tear (i.e. larger anechoic space present), as there is no connective tissue present to hold the adjacent tissue together. When a striation is present, unweighting the limb will result in no change in the width of the striation, as the fat present acts as a connecting tissue.

Figure 6. Examples of the non-weightbearing ultrasound for confirmation of tissue tearing.



Note: A. Transverse, weightbearing ultrasound image of a normal medial meniscus. The hypoechoic striations are denoted by the white asterisks.

B. Transverse, non-weightbearing ultrasound image of the same medial meniscus in A. Note that there is no enlargement (widening) of the hypoechoic striations, denoted by the white asterisks.

C. Transverse, weightbearing ultrasound image an injured the intermediate patellar ligament at the mid-aspect. The hypoechoic tear is noted by the white-double-headed arrow.

D. Transverse, non-weightbearing ultrasound image of the same intermediate patellar ligament in C. Note the hypoechoic tear (white double-headed arrow) is enlarged when the limb is off-weighted.

Non-weightbearing ultrasound exam for the structures of the stifle requires only that the horse rest the hind toe. For the structures within the pastern region, the limb can be picked up and held by the ultrasonographer or assistant. Because the meniscotibial ligaments can only be imaged in the non-weightbearing position, use of this technique is less helpful.

CONCLUSION

Striations are present within multiple musculoskeletal soft tissues of the horse. These striations should not be confused with tearing and pathologic change. Knowledge of the soft tissues which contain striations is important to prevent misdiagnosis. The non-weightbearing exam can be used to distinguish between striations and tearing. Additional signs of pathologic change should also be present in the case of injury.

AUTHOR CONTRIBUTIONS

Katherine Ellis was responsible for manuscript concept, literature review, and preparation.

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