Ultrasound of the Pastern Region

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1. Introduction
Soft tissue injuries in the pastern region are a significant contributor to lameness and loss of use or performance. Ultrasound has been well established as a useful method for diagnosing soft tissue injuries in the horse. Ultrasound of the pastern requires slightly more technical probe handling skills and skills in recognizing variabilities than that of the metacarpal region, but with the current equipment capabilities and level of ultrasound familiarity amongst most practitioners, ultrasound of the pastern can and should be undertaken in the field with reasonable diagnostic expectation. Although magnetic resonance imaging (MRI) is considered the gold standard for musculoskeletal imaging of the distal limb, ultrasound as a primary method of soft imaging remains financially and often logistically more practical for many clients. The findings provided by a good-quality diagnostic ultrasound in the field may be able to provide a stand-alone diagnosis. If MRI is also an option, the ultrasound findings can be used as a platform to discuss the merits of additional MR imaging and help to better direct the area of interest of a potential MRI study. Post MRI, pastern ultrasound can be used to guide intralesional therapy and is generally the standard method for monitoring lesion healing and guiding rehabilitation protocols at the frequency required for proper rehabilitation.

2. Area of Interest (P1/P2)
For practical reasons, examination of the pastern is divided into imaging of the structures of palmar P1 and very proximal P2 and imaging of the structures at mid-P2 and distally to the podotrochlear region. The soft tissue structures palmar to P1 are best imaged with a high-frequency linear transducer (7.5-10 MHz or 9-11 MHz), with variable use of a standoff pad. A small footprint rectal linear transducer can be used in some instances, but overall, the shape of the transducer is less amenable to imaging all structures in the longitudinal and transverse planes. To visualize structures distal to the very proximal portion of P2 (middle scutum), the probe has to be placed at the level of the heel bulbs, and a small footprint curvilinear or microconvex probe is required in order to have adequate contact. This presentation will focus on the basics of ultrasound of the palmar pastern region using a linear probe available to most practitioners with a brief example of what can be visualized at the level of P2. The fore- and hindlimbs are anatomically similar and treated as such for scanning technique.

3. Anatomy
The primary anatomic structures evaluated over palmar, palmaromedial, and palmarolateral P1 include the superficial digital flexor tendon (SDFT), the deep digital flexor tendon (DDFT), the straight sesamoidean ligament (SSL), the medial and lateral oblique sesamoidean ligaments (OSLs), and the digital flexor tendon sheath (DFTS). The proximal digital annular ligament, axial and abaxial collateral ligaments, and collateral ligaments of the proximal interphalangeal...
joint may also be assessed but are outside the scope of this presentation. At the level of distal P2, the DDFT, navicular bursa, collateral sesamoidean ligament, and distal interphalangeal (DIP) joint can be assessed. Further anatomic detail is provided as referenced below. For labeling of images, the pastern is divided into three zones over P1 (P1A: proximal P1, P1B: mid-P1, and P1C: distal P1) and two zones over P2 (P2A: proximal P1 and P2B: distal P2/podotrochlear region). The combined OSL insertion provides the distal margin for P1B (Figs. 1 and 2).

4. Case Selection
Pastern ultrasound is indicated in horses who respond to palmar digital, abaxial, or low palmar/plantar...
diagnostic analgesia, horses with acute DFTS effusion or other localized swelling, or those with localized trauma or lacerations. Soft tissue lesions in the pattern may respond to palmar digital, abaxial (basi-sesamoidean), or even low palmar/plantar diagnostic analgesia depending on location, severity of the injury, or migration of the blocking agent; one must be careful to evaluate all structures that may potentially be affected by those blocks. Horses with a potential radiographic diagnosis but who are disproportionately lame or chronically lame in the face of appropriate therapy should also be evaluated for a soft tissue lesion. Lastly, soft tissue causation should be suspected in horses who have recurrent lameness in a shorter than expected therapeutic window following intra-articular or intrathecal medication/therapy.

Table 1. Summary of Evaluation of Each of the Four Main Structures Over P1

<table>
<thead>
<tr>
<th>Structure</th>
<th>Approach</th>
<th>Standoff</th>
<th>Confounders</th>
<th>Tips</th>
<th>Assess</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDFT</td>
<td>Palmar</td>
<td>Helpful</td>
<td>Hypoechoic proximally due to angle of incidence</td>
<td>Center over each lobe for longitudinal and fan axially and abaxially</td>
<td>Lobe symmetry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Central vessel causes artifact</td>
<td></td>
<td>Use off-incidence angle</td>
</tr>
<tr>
<td>SSL</td>
<td>Palmar</td>
<td>Less common</td>
<td>Lateral origin, P2 insertion</td>
<td>Evaluate proximal portion</td>
<td>Bilateral comparison</td>
</tr>
<tr>
<td>SDFT</td>
<td>Start palmar, follow medial and lateral branches separately</td>
<td>Helpful</td>
<td>Insertion slightly inhomogeneous axially</td>
<td>Evaluate insertion especially in longitudinal plane</td>
<td>Compare medial and lateral</td>
</tr>
<tr>
<td>OSL</td>
<td>Under base of each sesamoid, move diagonally/axially</td>
<td>Variable</td>
<td>Origins can be inhomogeneous</td>
<td>Important to evaluate origin at sesamoid</td>
<td>Compare contralateral oblique</td>
</tr>
</tbody>
</table>

Abbreviations: DDFT, deep digital flexor tendon; SSL, straight sesamoidean ligaments; SDFT, superficial digital flexor tendon; SSL, straight sesamoidean ligaments; OSL, oblique sesamoidean ligaments.

Fig. 6. Hand position to facilitate standoff usage.

Fig. 7. Transverse (2) and longitudinal (3) ultrasound images at the level of P1A, indicated on the sagittal anatomic specimen (1). On the transverse image, lateral is to the right; on the longitudinal image, proximal is to the right. The same orientation will be maintained for all ultrasound images to follow. Note narrow band of the SDFT and the off-incidence hypoechoic region seen on the DDFT. The OSLs are visible as separate medial and lateral bundles. A, Superficial digital flexor tendon. B, Deep digital flexor tendon. C, Straight sesamoidean ligament. D, Lateral and medial oblique sesamoidean ligaments.
5. Preparation

The pastern should be carefully clipped with a number 40 surgical blade, cleaned, and ample gel applied. The clipped area should extend from the distal metacarpus/tarsus to the heel bulbs along the palmar, palmaromedial, and palmarolateral aspects (Fig. 3). The pastern is a very difficult region to adequately image in an unclipped horse. Careful attention should be paid to the basi-sesamoid region and any whorls or unusual hair direction. Chronic dermatitis, thick skin, and scar tissue impede penetration of the ultrasound beam and can result in difficulty obtaining adequate images.

6. Technique

Each structure should be evaluated separately to allow for appropriate incidence angle, frequency, and focal zone location. The author finds starting with imaging of the DDFT and the SSL on the palmar aspect of the pastern, followed by the slightly medial and lateral palmar approaches for the SDFT branches and more lateral and medial approaches for the OSLs, allows one to progress in relative degree of imaging difficulty and manipulation (Figs. 4 and 5). As with any tendon or ligament, size, shape, echogenicity, and fiber alignment should be evaluated critically. Cross-sectional area measurements and/or dorsal to palmar/plantar thickness can be performed on structures that are suspected of being abnormal. Contralateral
images can be compared for appearance and size if necessary. Sizes can be compared to published normal if available or the contralateral limb; cross-sectional areas can be compared across serial evaluations. A standoff pad can be helpful to evaluate the SDFT and other superficial structures and in petite horses or ponies (Fig. 6). Standoffs can be overly attenuating in horses who are more difficult to image, and the added
size can make the probe more difficult to manipulate in horses with short pastern conformation.

Deep Digital Flexor Tendon

The DDFT is one of the two most commonly injured structures in the pastern\(^3\),\(^4\) and is more commonly injured in the forelimb than the hindlimb. It is located directly palmar/plantar and normally demonstrates a homogenous echogenicity with symmetric lobular appearance and long linear fibers. Some twisting of the fibers is normally apparent on longitudinal views. Begin with the transducer in a transverse plane, focal zones at appropriate depth, and a standoff pad if needed. Angling upward just under the ergot, the probe should then be moved distally with adjustments for incidence angle until the level of heel bulbs (usually at the level of proximal P2). Proximally, the DDFT may appear hypoechoic due to off-incidence image, and care should be taken to manipulate incidence angle as best as possible and to understand the normal variation. While evaluating the DDFT at P1 and proximal P2, any lobe asymmetry or subtle differences in echogenicity or shape is
often of significance. If the classic echogenic appearance cannot be obtained at the level of P2, valuable information can be gained by rocking the probe distally and using the off-incidence view to evaluate shape and symmetry to obtain an index of suspicion of injury further distal. This type of off-incidence appearance is also helpful in determining the margins of the DFTS and the presence of any mineralization or fibrosis. The probe should then be turned 90° to the longitudinal view. Care should be taken to center the probe and evaluate each lobe separately in the longitudinal plane, particularly if a lesion is suspected in a particular lobe. Due to the narrow beam width relative to the width of the tendon when the probe is oriented in a sagittal plane, it can be difficult to confirm the lesion in both planes if one does not pay adequate attention to the lateral or medial positioning of the probe. If any abnormality or irregularity is suspected at the level of distal P1/proximal P2, further evaluation is recommended with curvilinear probe or MRI. If abnormalities are seen at the level of proximal P1, evaluation of the DDFT in the distal metacarpal/metatarsal region and non-weighted views are recommended to improve visualization in the palmar/plantar fetlock region. There is a vessel located centrally between the two lobes of the DDFT that can cast a significant side lobe artifact, usually at the level of P1B. This can be identified by the central reproducible location and the tortuous tubular shape (Table 1).

**Straight Sesamoidean Ligament**

This structure appears to be less commonly injured than the SDFT, DDFT, and OSLs, but injuries can result in severe lameness. It is located just dorsal to...
Adjusting the focal zone a level deeper, begin in a transverse orientation angled proximally toward the base of the proximal sesamoid bones and slide the probe distally to the insertion on P2, adjusting incidence angle as necessary; then, repeat in the longitudinal plane. Cross-sectionally, the shape of the ligament changes from trapezoidal to square toward the P2 insertion. In distal P1/proximal P2, it may be isoechoic to the heel bulb/bulbar cushion in the transverse plane and thus may be easier to assess on longitudinal images. The size, shape, and appearance are somewhat variable between horses, so bilateral comparison is essential in most cases to confirm a suspected lesion. A hypoechoic reflection of the metacarpophalangeal joint is often seen on the lateral aspect of the origin in transverse and longitudinal

Fig. 22. Longitudinal (left panel) and transverse (right panel) images of an acute on chronic lesion extending from the origin (1) to mid- (2) to mid-distal (3) lateral OSL.


Fig. 24. Longitudinal image of abnormal DDFT at P2B. Note the irregular contour to dorsal margin (arrowheads).

Fig. 25. Transverse image of the DDFT at the level of P2B. Note the much larger medial lobe (arrowheads). One should not technically use the term “significant” unless stats were run.

Fig. 26. Longitudinal (left) and transverse (right) images of calcification of the lateral lobe of the DDFT at the level of P2B (arrowheads).
planes. A central hypoechoic region is almost always present at the longitudinal insertion onto the scutum medium of P2. Contralateral imaging is recommended in all cases prior to considering an insertional lesion (Figs. 7–12). Fig. 13 shows an example of a lesion of the medial lobe of the DDFT. Fig. 14 shows an example of a lesion of the SSL.

**Superficial Digital Flexor Tendon**

The SDFT is considered the third most commonly injured structure in the pastern, after the OSL and DDFT. Injuries occur most commonly in the forelimb. In the proximal pastern, it is a thin crescent shape that divides into medial and lateral branches, which insert separately onto distal P1 and the scutum medium of P2. Starting in transverse orientation with the focal zone positioned superficially, the SDFT is identified superficial to the DDFT at the level of P1. The lateral margin is then identified and the probe moved laterally to center the lateral branch in the image (Fig. 15). The probe can then be moved directly distally from that location to follow the lateral branch insertion. The branch changes from slightly teardrop in shape to a broad, somewhat inhomogeneous triangle, particularly axially (Fig. 16). With experience, the blending of fibers from the axial and abaxial palmar ligaments can be appreciated at the insertion. The probe is rotated to obtain a longitudinal image (Fig. 17). Care must be taken to ensure the probe is located over the SDFT branch itself in the longitudinal view and not a portion of another structure. The same technique is repeated for the medial lobe. Depending on conformation, it can be difficult to obtain the longitudinal image of the insertion onto P2. Fig. 18 shows an example of a large lesion of the lateral branch of the SDFT.

**Oblique Sesamoidean Ligaments**

The OSLs are increasingly recognized as a cause of lameness in sport horses, particularly dressage horses and jumpers. They are considered the most common abnormality identified in the pastern region, occurring more often in the forelimb of racehorses and in the hindlimbs of jumping and dressage horses. They can be technically more difficult to image well as they have a more heterogeneous composition of ligament, adipose, and vascular tissue, as well as overlying vasculature that results in a more naturally inhomogeneous appearance. It is generally easier for the inexperienced operator to scan the lateral OSL and then move on to the medial OSL. Two approaches can be used to find the origin of the OSLs. In the first, the probe is placed in the transverse plane on a slightly proximal oblique angle at the base of the sesamoid bone. The ligament should appear as a slightly gumdrop-shaped structure originating from the base of the sesamoid (Fig. 19). The probe is then manipulated to an angle more parallel to the ground and the ligament followed distally on a slight diagonal toward midline, with P1 visible just deep to it. At about mid-P1, the fibers of the lateral and medial oblique blend to insert together directly palmarly; at that point, the probe is directly palmar or axial on the pastern (Figs. 20 and 21). The same technique is used for the longitudinal plane and repeated for the medial oblique. The second method for finding the origin of the oblique is to obtain an image of the corresponding SL branch in the transverse plane and follow it to its insertion on the proximal sesamoid bone. The probe then continues distally over the sesamoid and is angled proximally just after crossing the joint. The OSL origin should appear on the opposite side of the joint from the suspensory insertion. The ultrasonographer should be aware that the distal 1/3 of the OSL is quite difficult to identify in the transverse plane and it is also challenging to keep the probe fully in place over the OSL, making this region difficult to evaluate well on ultrasound. Additionally, the origin of the ligament can be somewhat inhomogeneous, and corresponding longitudinal views of this region take practice to obtain accurately. Adequate effort should be made to obtain good corresponding longitudinal images in order to help determine whether hypoechoic regions are due to incidence angle, anatomic variation, or pathology. When suspected a lesion, care should be taken to obtain images in two planes, take measurements and evaluate the contralateral limb. When comparing measurements, it is important to note that the cross-sectional area of the lateral OSL can be up to 20% larger than the medial OSL normally. Figure 22 shows an example of an acute on chronic lesion OSL.

**Podotrochlear Apparatus**

It is possible to evaluate the DDFT, distal recess of the DDFT, NB, CSL, and palmar/plantar pouch of the DIP joint with a curvilinear or microconvex probe. If this type of probe is available to the practitioner, developing the skills to evaluate the podotrochlear region, in particular the DDFT, is recommended. Occasionally, a subtly abnormal DDFT has detectable lesions at the level of distal P2. A normal appearance of the DDFT over P1 does not rule out a lesion distally, especially if the clinical picture is suggestive of an injury to the DDFT. The region is scanned with the foreleg positioned behind the vertical as in a navicular skyline position for radiographs (Fig. 23). In the hindlimb, this region is generally more easily accessible than the forelimb. Longitudinal and transverse images can be obtained. Lesions most commonly present as lobular asymmetry or irregularities of the dorsal margin. Navicular bursa effusion may be present and symmetric or present and asymmetric (Figs. 24–26). Synovitis can be detected and, with experience, adhesions can be suspected.
Acknowledgments

Declaration of Ethics
The Author has adhered to the Principles of Veterinary Medical Ethics of the AVMA.

Conflict of Interest
The Author has no conflicts of interest.

References