How to: optimise the use of your ultrasound machine

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Introduction

Diagnostic ultrasound is an accepted and routine procedure for evaluation of soft tissue injuries in the horse. The increased frequency of the use of this technique and the rapidly improving technology enables even small portable ultrasound machines to provide good quality, diagnostic images. The techniques using this modality have evolved in recent years and this presentation will describe not only how these techniques can maximize the amount of diagnostic information achievable but also where ultrasound can be used in addition to the conventional use for examining the tendons on the palmar aspect of the metacarpus or metatarsus.

Obtaining the best image

Equipment

For musculoskeletal use, most areas can be evaluated using high frequency (>7.5 MHz) linear transducers. However, certain challenging areas can benefit from additional transducer configurations such a curvilinear for back and neck examinations and microconvex transducers for the distal pastern and foot. With respect to the facilities on the machine, the following are particularly useful:

- Broad bandwidth technology - allows scrolling through frequencies
- Easy labelling methods
- Multiple focal zones - improves image quality and resolution
- Split-screen – to allow transverse and longitudinal images or images from contralateral limbs to be displayed simultaneously for comparison
- Cine-loop – for storing movie-loops rather than still or to optimise still recording
- Trackerball – to allow ease of measurement of area and distance
- Doppler – for imaging of blood flow in soft tissues

Preparation

Careful preparation of the area to be scanned is time well spent. The area should ideally be clipped and then cleaned using a two-stage process – first with a surgical scrub to remove dirt and hairs and then with surgical spirit to remove grease and the soap bubbles from the surgical scrub. For foot scanning, the frog should be trimmed back to soft horn and the soaked for ideally at least an hour. Contact gel should be rubbed into the area and left to soak in for a few minutes. For cob-like horses with thick skin folds, this preparation is particularly important, taking care to clip hairs within the folds. Liberal use of surgical spirit and the use of lower frequencies can result in a diagnostic image!

Technique – expanding views

The maximum diagnostic information can be gleaned by expanding the number of views obtained. Our standard examination protocol for evaluated tendons and ligaments of the distal limb is as follows:

Step 1
At least two **orthogonally** orientated on-incidence weight-bearing views

Step 2
'**Lesion-orientated views**' – including **close-ups of the** injured structure plus appropriate **oblique** projections. This is particularly important for comprehensive evaluation of structures not fully visible in standard palmar views, such as accessory ligament of the deep digital flexor tendon, the proximal suspensory ligament (especially in the hindlimb), the suspensory ligament branches, the branches of the superficial digital flexor tendon and oblique distal sesamoidean ligaments in the pastern region. **Off-incidence** views can be used to assess the quality of healing of tendons and ligaments by demonstrating areas of retained echogenicity representative of disorganized tissue within the ordered tendon or ligament structure.

Step 3
Non-weight-bearing views to assess blood flow using Doppler and improve visualization of specific structures such as the suspensory ligament and the manica flexoria of the superficial digital flexor tendon. **Doppler imaging** allows staging of tendon and ligament injuries since normal tendons show no Doppler signal and the signal decreases to a low level as the tendon or ligament heals. If the Doppler signal fails to reduce or reappears, re-injury is implicated. Non-weight bearing **off-incidence** views of the proximal suspensory ligament allow the differentiation of the connective tissue from ligament tissue and hence can improve the objectiveness of the ultrasound examination in this region. In addition, it allows the entire forelimb proximal suspensory ligament cross-section to be seen within one view. Non-weight bearing views immediately proximal to the fetlock improves the ability to identify tears of the manica flexoria because it becomes more visible and tears result in proximal displacement, instability (no longer opposed to the deep surface of the deep digital flexor tendon, increased thickness, and gapping between the two digital flexor tendons.

Optimising interpretation - differentiating normal variants, artifacts, and pathology
All potential ultrasonographic changes should be identified as the more that can be identified, the more confident a diagnosis cane be made. These include changes in echogenicity, cross-sectional area, fibre alignment, margination, shape, position, and, if possible, Doppler. Always compare findings with the contralateral limb, although bear in mind that many tendon and ligament injuries of the distal limb affect both limbs, although with one limb more severely affected than the other. Be familiar with artefacts which can either mimic or hide pathology - both operator-induced artefacts which can be corrected, such as off-incidence, poor contact, inappropriately set gain controls, and excessive pressure; and ultrasound-generated artefacts of acoustic shadowing, edge refraction, and acoustic enhancement. There are also a number of normal anatomical variants which should not be confused with pathology – the most common in the distal limb are:

- Suspensory ligament - hypoechoic region within its origin.
- Straight distal sesamoidean ligament - hypoechoic region close to their insertion onto the middle scutum – should not extend further proximally than the limit of insertion of the oblique distal sesamoidean ligaments.
- Deep digital flexor tendon (DDFT) - hypoechoic line between the DDFT and accessory ligament of the DDFT fibres where they join; palmarly-located focal anechoic line within the proximal digital sheath (blood vessel); dorsal hypoechoic area on the DDFT in the proximal digital sheath in the hindlimb.

- Digital sheath - synovial plica joining the DDFT both laterally and medially in the proximal digital sheath. Poorly visible in non-distended sheaths but should not be confused with adhesions.

Maximising use

In addition to imaging tendons and ligaments of the distal limb, ultrasound should be considered a routine imaging modality for upper limb joints, for detecting fractures in bones not amenable to radiography, and all wounds other than those containing abundant air. In-plane ultrasound-guided injections improve accuracy of injection for treatment and intra-articular diagnostic analgesia. Ultrasound should also be considered for intra-operative use for the location of bony fragments and foreign bodies, intra-operative ultrasound-guided injections, tendon and ligament fenestration or transection, and optimising instrument or implant placement.