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Ultrasound Use in Orthopaedics: What’s New?
Chaired by Graham Munroe

11.00–11.20
How to: Assess joints with ultrasound
Heather Chalmers
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Abstract not submitted

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How to: Assist surgical procedures with ultrasound

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Introduction

Ultrasonography (US) is commonly used in the pre- and post operative management of a large number of equine surgical conditions but rarely intraoperatively. Intraoperative ultrasonography (IO-US) is used extensively in human surgery for various minimally-invasive procedures. Although its real time capabilities allow continuous observation of an instrument/needle in the soft tissue, only a few reports have highlighted the potential use of IO-US in equine surgery during the last 20 years (Adams et al. 1987; Rose and Penninck 1995; White 2002; Tnibar 2002; Piccot-Crezollet and Cauvin 2005; Hewes and White 2006; Hilton et al. 2008).

Materials required

Ultrasound machine, transducer(s), sterile sheath, sterile paper clip, surgical pen, acoustic coupling gel, hydrosoluble sterile gel, needles and staples.

Procedure preparation

Sterilisation of the US transducer is not practical. However, a clean transducer placed in a protective sterile sheath filled with acoustic coupling gel, can be safely used in the surgical field. The transducer is connected to the ultrasound machine with the screen orientated to allow comfortable visualisation by the operator. Alcohol is applied to intact skin (hydrosoluble sterile gel on wounds) to improve contact. Blood is a good conductor of the ultrasound beam; therefore if present, does not alter the quality of the image. Preoperative scanning is an important step to allow familiarisation with the area of interest and decrease surgery time.

Intraoperative ultrasonography techniques

Two techniques can be used intraoperatively: US-landmarking and US-guidance.

The US-landmarking technique involves location and mapping of a fragment/foreign body at the skin surface prior to incision.

1. The transducer is applied to the area of interest in a longitudinal orientation. An unfolded, sterile paperclip is glided between the transducer and skin, perpendicular to the transducer. A needle can also be used; but there is a greater risk of puncturing the protective sheath covering the transducer, resulting in contamination of the surgery site. A characteristic acoustic shadow is visible between the skin and the tissues. The transducer and paper clip are moved until the edge of the fragment becomes superimposed with the acoustic shadow of the paperclip. A pen or staples are then used to mark the skin on both sides of the transducer at the level of the paperclip line.

2. The procedure is repeated for the other edge of the fragment on the same axis.

3. The probe is then rotated 90° and the procedure repeated on the short axis.

4. The depth of the fragment is measured. The fragment is then located between the grid lines at the depth measured.

5. The absence of a major neurovascular bundle crossing over the fragment is also verified with US.

US-guiding indications

- Delimitation of ligamentous or tendinous avulsion fragments, periarticular fragments, foreign body or bone sequestrum margins prior to removal.
- Assistance in screw placement for treatment of angular limb deformity (growth retardation).
- Delimitation of abscess, cyst, tumour margins prior to drainage/removal.
- Delimitation of infection site in the physis or bone.
- Delimitation of capsular tear for extrasynovial repair.
- Location of joint space or synovial recess for small joints (e.g. distal tarsus, palmar carpus, temporomandibular joint).

US-landmarking indications

- Intrasynovial injections.
- Intracystic injections for cysts open on joint space or outside (navicular bone cyst).
- IntraleSIONAL injection for tendons or ligaments.
- Splitting of tendons or ligaments.
- Removal of periarticular fragments, foreign body (e.g. tongue).
- Removal of articular fragments for which arthroscopy is not possible/practical (palmar pastern joint).
- Aspiration of fluid, FNA or tru-cut biopsy in deep abdominal or thoracic masses.
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- Minimally-invasive placement of Foley catheter into bladder (tube cystotomy).
- Placement of drain into most dependant part of deep abscess (e.g. thoracic, abdominal, retroperitoneal, pararectal, gluteal, sub-iliac).
- Placement of thrombectomy catheter through a thrombus.
- Catheterisation of small vessels and loco-regional injection of antibiotics or chemotherapeutic agents.
- Placement of catheter along path of a nerve to provide segmental analgesia.
- Transection of distal check ligament or fascia surrounding the origin of the suspensory ligament.

References

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11.40–12.00
How to: Assess muscle injuries with ultrasound
Jean-Marie Denoix
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Take home message
Ultrasonography is very useful in the diagnosis of different muscle conditions in horses. This procedure is easy to perform, even under field conditions. Comparison of homologous muscles of both sides of the horse improves its accuracy.

Introduction
Exertional myopathies are well known but muscle injuries involving the anatomic and architectural integrity of muscle bodies are poorly described. The objective of this paper is to show how ultrasonography can be used to diagnose and document a variety of muscle injuries in horses.

Technical aspects
A high frequency probe (7.5 MHz or more) is adequate for superficial muscles. A low frequency (6–2.5 MHz) convex linear probe is required for examination of deep or strong muscles, especially when covered by a thick skin such as at the lateral aspect of the thigh or dorsal aspect of the back. Examination of symmetric muscles is essential for improving sensitivity and specificity of the findings.

Ultrasonographic anatomy of muscles
In the equine limb, a muscle is usually made up of a body and one (or sometimes 2) tendon(s). In the axial areas, the muscle body inserts directly on the corresponding bone surface.

Muscle architecture is quite complex. The muscle body is made of striated muscles fibers separated by connective tissue (endomysium) containing vessels and nerves. In heavy or fat horses, fat accumulates in these septae and alters considerably image quality.

The muscle body can be homogenous or divided by aponevroses (e.g. *multifidus* muscle, *biceps brachialis* muscle, digital flexor muscles in the front and hindlimbs) (Fig 1). Some of them, such as the *infraspinatus* muscle, present an intramuscular tendon which continues to the distal tendon.

Abnormal findings
Only lesions involving the muscle body are considered in this paper. Tendinopathies and enthesopathies are not.

a) Decreased size
- Fibrotic myopathy is the most documented muscle condition in horses. The semitendinosus muscle is the most commonly affected (Fig 2), but the *seminembranosus*, adductor and *gracilis* muscles can also be involved. In the forearm this condition has been found in the digital flexor muscle bodies secondary to rupture.
- Complete rupture of the muscle body is usually followed by a fibrotic muscle atrophy.
- Muscle atrophy is severe when associated to nerve injuries or fractures. Fracture of the *tuberculum supraglenoidalis* induces an atrophy of the *biceps brachialis* muscle body showing reduction of size and increased echogenicity. A marked increased of muscle echogenicity correlated to atrophy of the striated muscles fibres is found in neurogenic muscle atrophy. Atrophy of the *infraspinosus* muscle following suprascapular nerve paralysis is the most common example in horses.

Fig 1: Muscle architecture of the left and right brachiocephalicus and *biceps brachialis* muscles on horizontal section. The first shows a nice regular fascicular architecture; the second (bottom of the image) presents numerous aponevroses increasing its echogenicity. A hypoechoic spot is seen in the left *biceps brachialis* (crosses).

Fig 2: Fibrotic myopathy of the right semitendinosus muscle (right image) in a 3-year-old Thoroughbred. Echogenicity is increased compared to the same muscle of the left limb (left image).

Fig 3: Rupture of the brachiocephalicus muscle in a 4-year-old Selle Français female.
b) Increased size

- Muscle body retraction is observed following complete tendon rupture or avulsion at the enthesis. The shortening of the muscle body is accompanied by an enlargement of it.
- Muscle body rupture following stressful muscle contraction has been found in the brachiocephalicus muscle (Fig 3), the caudal femoral muscles, the caudal antebrachial muscles and in the caudal crural muscles. In muscles presenting numerous intramuscular aponevroses, rupture of these fibrous components increases homogeneity of the muscle body.
- Abscess: can be found in different injection sites (neck, breast, croup, thigh: Fig 4). In the acute stage, thickening, cavities with mixed content (hypoechoic fluid and echogenic fibrin and debris) as well as diffuse limits can be seen; when chronic, the abscess is surrounded by echogenic fibrous material and the centre remains heterogeneous.
- Traumatic injuries and foreign bodies can be found in several areas (breast, thoracic wall, lateral and medial aspects of the thigh). Hyperechoic images induced by gas or air can hide foreign bodies.
- Muscle tumours are rare in horses. They have been found in the gastrocnemius, the triceps brachialis and the dorsal cervical muscles. They showed up as heterogeneous masses with anechoic or hypoechoic areas of necrosis. Identification of the tumour type requires an histopathological evaluation; the most common is haemangiosarcoma.

c) No change of size

- A specific fascicular hyperechoic myopathy can be found in race and sport horses. The involved fascicles show uptake on nuclear scintigraphic images. The most frequently involved muscles are those responsible for the propulsion (glutei, caudal femoral, latissimus dorsi muscles).

Fig 4: Abscess in the dorsal cervical muscles on dorsoventral section (left image) and craniocaudal section (right image).

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How to: Perform ultrasound-guided injections

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Introduction
Although more technically demanding, ultrasound-guided (UG) injections are nowadays commonly performed in equine practice. Compared to ‘blinded’ techniques based on palpation of anatomic landmarks, UG injections have been reported to be more accurate, more reliable and safer for a large number of deep anatomic structures in the horse. Problems such as difficulty in palpating the external anatomic landmarks in large or heavily-muscled horses or inter-individual variations, or disease-related alterations of normal anatomy can be bypassed using UG injection techniques.

Indications
Ultrasoundography is routinely used to inject deep synovial structures (navicular bursa [Sriet et al. 2004], coxofemoral joint [David et al. 2007], sacroiliac area [Cousty et al. 2008], scapulohumeral joint [Carnicier et al. 2008], articular facet of cervical vertebrae [Nielsen et al. 2003; Mattoon et al. 2004] and tendinous core lesions or to perform FNA/tru-cut biopsy of abdominal or thoracic masses.

Materials required
Ultrasound machine, transducer and needle, all adapted to the depth of injection. Curvilinear transducers are preferred to linear transducers as they produce a wider acoustic window that facilitates needle identification.

UG injection principles
On a long axis, a metallic needle appears sonographically as a hyperechogenic straight line. On the short (transverse) axis, the needle appears sonographically as a hyperechogenic dot. To locate and guide the needle towards a target, it is mandatory to keep the long axis of the needle parallel to the ultrasonographic beam.

Preparation for the procedure
- Skin/horn prepared for ultrasonographic examination.
- Ultrasound machine placed in a safe area with the screen orientated such that the operator may comfortably visualise it.
- Transducer applied on area of interest in order to locate the ultrasonographic landmarks that will be used to guide the needle.
- Machine set up to get the best image quality.
- Doppler may be used to identify the presence of significant blood vessels on the needle path and around the target.
- The main objective of this step is to acquire a ‘pre-injection’ image. On this image, the target should be visible on one side of the screen and the future needle progression path on the rest of the screen. Once the appropriate ‘pre-injection’ image has been obtained, the image is frozen and the distance between target and skin is measured to select the most appropriate needle.

Procedure
- Sterile hydrosoluble gel or alcohol applied on the skin to allow good contact between glove and skin.
- ‘Pre-injection’ image recovered.
- Orientation of the image has to be such as the movements of the needle are exactly reproduced on the screen. For example, when the needle goes from right to left in the horse, the hyperechogenic line should progress from the right to left of the screen. If you don’t get this, rotate the transducer (180°) or invert the image if you have this function on the machine. This is crucial to perform ultrasound-guided procedures, as the brain will guide the needle naturally to the target without any effort.
- Needle inserted through the skin on the edge of the transducer opposite to the target. Subcutaneous lidocaine injection may be required at the needle insertion site. It is important that the needle is inserted just next to the transducer and parallel to it.
- Insert the needle over 2–4 cm ‘blindly’ as it is usually difficult to retrieve the needle in the near field. The operator can then locate the needle on the screen by slightly rocking the probe in parallel plans. Once the needle is identified, it is important to ensure that the target is still in view. If not, draw back the needle and re-insert it underneath the transducer.
- Once the needle is ‘in focus’ and aligned with the target, the depth angle is adjusted and the needle is advanced towards the target. Revision of the depth angle may be necessary for injection of very deep structures.

Pitfalls
- Horse movements are detrimental as they make the procedure very difficult especially for narrow targets. Nevertheless the risk of needle breakage with spinal needles is very low. A bad setting/positioning always impairs the quality of the UG injection, especially for operators with less experience.
- Identification of the needle in the near field can be difficult. This is one of the most common problems following needle introduction, particularly with linear transducers. The needle should be introduced a good few centimetres in and aimed deep before you can easily see it. Revision of the angle of the needle relative to the probe is also essential to identify the needle. An aiming device can be attached to the transducer. It is useful as it keeps a permanent parallelism between the probe and the needle. Unfortunately the range of movements the operator can get with this device is restricted.
- Once the needle is pushed towards the target, a common pitfall is to lose the needle tip and focus on the middle of the needle. Gently rocking the probe allows the operator to keep the needle tip ‘in focus’ and makes sure the target is properly reached.
- Needle tracks can remain in certain tissues after needle withdrawal and are seen as hyperechogenic lines. This can confuse the operator if the target is not reached on the first attempt. It is not recommended to advance the needle towards the target if the angle does not seem good enough to reach it.
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Table 1:

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<tr>
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<th>Navicular bursa and cyst</th>
<th>Hip joint</th>
<th>Sacroiliac region</th>
<th>Vertebral facets</th>
<th>Shoulder area</th>
<th>SDFT core lesion</th>
<th>SBC femur; MC3/MT3</th>
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<tr>
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References


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