Vetwatch

ROSSDALES EQUINE HOSPITAL & DIAGNOSTIC CENTRE
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DIGITAL ULTRASONOGRAPHY

Ultrasonography is a common imaging tool used in all aspects of equine practice. It is used to visualise soft tissue structures such as tendons, ligaments, muscles, vessels and nerves, as well as internal organs such as parts of the gut and reproductive system, liver, spleen, heart and lungs. It also can be used to assess joints and bone surfaces.

How it works

A sound wave is produced by a piezoelectric transducer (a sensor which converts one form of energy to another) which is found within the probe. This transducer converts the electrical pulses that are produced from the ultrasound machine into vibrations (sound waves). The frequency of the waves depends upon the electrical pulse signal, as well as the probe itself. The frequency of the wave can vary from 2 to 18 MHz. The sound wave travels into the body and comes into focus at a depth determined by the clinician. The sound wave is reflected from the tissues within the body, specifically from tissue interfaces of different densities. Some of these reflections return to the transducer within the probe. The returning sound waves are turned into electrical pulses by the transducer which are then read by the machine and transformed into an image. The time it takes for the sound echo to travel back to the probe is measured by the machine and is used to calculate the depth of the tissue interface that caused the echo. The greater the difference between the tissue densities at the interface, the larger the echo and the brighter the image produced. When the sound wave hits bone or air, the difference in tissue impedance compared to the surrounding soft tissues is so great that the majority of the sound waves are reflected. Thus, the image obtained at this interface is bright white and it is impossible to see any deeper. In order to obtain the best possible image of a structure, the probe must be held at 90 degrees to the tissue. By manipulating the probe, a more complete picture is obtained of the soft tissue structures. Thus ultrasonographic imaging is much more 'dynamic' compared to radiography. The structures being visualised should be assessed in two planes at 90 degrees to each other. When imaging tendons and ligaments these are called transverse and longitudinal planes. This allows a more accurate assessment of the fibre pattern of the entire structure to be obtained. Higher frequency sound waves have a smaller wavelength but less tissue penetration. So in order to assess deeper structures within, for example, the abdomen, a lower frequency transducer (probe) is required. To assess more superficial structures, such as the flexor tendons of the fore limbs, a higher frequency is used. *Figure 1* shows one of the newest types of ultrasound machines, whilst *Figure 2* shows a variety of probes that are used.

Figure 1

An ultrasound machine at Rossdales Equine Diagnostic Centre. It is the size of a laptop computer and is very portable.

Figure 2

Here are several of the probes that we can use with the machine pictured in Figure 1. The probes can be easily changed, are all different in shape and have different frequency ranges that can be selected based upon the structure being imaged. The probes house the piezoelectric transducer which produces the sound waves.

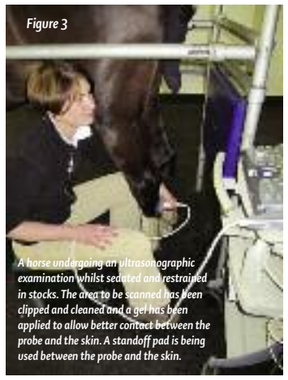
Patient preparation

Patient preparation is an important component in obtaining good images. The patient must stand still and this frequently means that the horse is sedated *(figure 3)*. Hair, dirt and grease will reduce the penetration of the sound waves into the horse and thus clipping and cleaning of the area to be scanned is often required unless the horse has very thin skin and fine hair. A stand off pad is often used when imaging superficial structures such as the superficial digital flexor tendon. Scanning superficial structures can be difficult because intense echoes are created by transducer reverberations. The pad decreases these reverberations by bringing the structure of interest into the focal zone of the transducer.

Advantages of Ultrasonography

- Good images of soft tissues, including their internal structure, as well as some bone surfaces are obtained.
- The procedure is generally quick to perform.
- Because of its 'dynamic nature', ultrasound-guided injections or biopsies can also be performed.
- There are no long-term side effects and it is a pain-free procedure.
- The equipment is generally flexible and readily available.

Figure 3



A horse undergoing an ultrasonographic examination whilst sedated and restrained in stocks. The area to be scanned has been clipped and cleaned and a gel has been applied to allow better contact between the probe and the skin. A standoff pad is being used between the probe and the skin.

Disadvantages of Ultrasonography

- The method is operator dependent and a high level of experience and skill is required in order to obtain good images and to interpret them.
- The machines are expensive to purchase.
- The depth of imaging is limited, even when low frequency probes are used.
- Any gas within the soft tissue or the organs obscures imaging of deeper structures. For example, gas within the colon prevents assessment of other abdominal organs lying on the other side of it.
- Only the surface of bone can be assessed. No information can be obtained about the internal structure of the bone or about structures lying on the other side of the bone.
- Horses with thick skin (such as cobs) are difficult to scan as the skin reflects the majority of the sound waves meaning that the ultrasound images can be of poor quality.

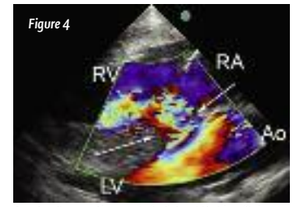
Modes of Ultrasonography

There are several different modes of ultrasound that are used in veterinary imaging:

B-mode: this is the usual mode used in equine musculoskeletal imaging. A 2D image is portrayed on the screen. This is the mode used to image tendons, ligaments, muscles and joints, for example.

M-mode: This comprises of a rapid sequence of B-mode scans that follow each other in quick succession. This enables measurement of the range of motion of the organ being imaged. This mode is useful in cardiac sonography and allows cardiac function to be assessed. **Doppler-mode:** This mode allows blood flow to be visualised and the velocity of the flow to be measured. This is useful when assessing blood flow and again is vital when performing cardiac ultrasonography to assess the functioning of the heart valves and to look for 'holes in the heart' in foals *(Figure 4)*. Digital Ultrasonography has made it much easier to store images and to send them electronically around the world. These electronic files are stored on our picture archive and communication system (PACS), as described by Marcus Head in his article (February 2010) on digital radiography. This system allows any ultrasound image to be uploaded onto any computer throughout the entire practice. Ideally images should be reviewed in DICOM (Digital Image for Communication in Medicine) format as this supplies all of the patient and image details as well as allowing the contrast and brightness of the image to be altered, allowing for accurate assessment of the image. These images are not compressed (unlike images in JPEG format) and so no detail is lost.

Figure 4



Doppler ultrasound image of a foal's heart that is suffering from a ventricular septal defect ('hole in the heart'). There is blood flow between the left and right sides of the heart (arrows) that should not happen in a normal heart. LA: left atrium; RA: right atrium; LV: left ventricle; RV: right ventricle.

Vet Profile

Name: Sarah Boys Smith
Qualifications: MA VetMB CertES (Orth) DipECVS MRCVS, RCVS and European Specialist in Equine Surgery.
Year of Qualification: 2001
Main interests: On qualifying from Cambridge University Veterinary School in 2001, I undertook a year's equine internship at the Animal Health Trust in Newmarket before completing a three year residency in equine orthopaedics and surgery at the University of Liverpool. I stayed on at the University as a lecturer after finishing the residency. I gained the RCVS Certificate in Equine Surgery in 2005 and the European College of Veterinary Surgeons Diploma in Equine surgery in 2006. I joined Rossdale & Partners in October 2006 where I work primarily in the Diagnostic Centre assessing and treating lame horses, but I also do emergency surgery.
In my spare time I enjoy competing in triathlons and am doing the London to Brighton Bike Ride in June as part of the Rossdales team, raising money for the British Heart Foundation.

A week in brief...

Monday
A 3-year-old Haflinger filly 'Blondie' is admitted to the hospital for investigation of a right hind limb lameness. On examination there is marked effusion (swelling) of both stifle joints and a moderate right hind limb lameness. X-rays of both stifles demonstrate a large subchondral bone cyst within each of the medial condyles of the femurs *(figure 5)*. Ultrasonography of the stifle joint performed with the leg flexed allows assessment of the condyle (both the bone and overlying cartilage). The opening of the cyst is seen as a 'break' in the contour of the bone *(figures 6a & 6b)*. A racehorse is admitted later that morning for investigation of a left hind limb lameness. Ultrasonography of the pelvis demonstrates a fracture of the left ilial wing. Horses with this type of injury normally can return to racing but obviously need rest in the short term *(figure 7)*.

Figure 7: Ultrasound image of an ilial wing fracture. The break in the normally smooth bone contour indicates the fracture (arrow).

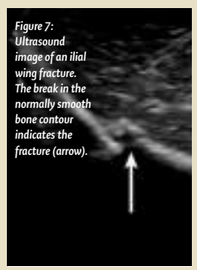


Figure 5: X-ray of the subchondral bone cyst within the right femur (arrow)

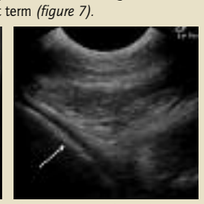


Figure 6a: Ultrasound image of the weight-bearing surface of the distal femur in a normal horse. The bone surface (arrow) is bright white and smooth and the overlying cartilage (black layer) is also smooth and of an even thickness.

Figure 6b: Ultrasound image of the weight-bearing surface of 'Blondie's' right distal femur. The bone surface is disrupted at the opening of the cyst (arrow).

Figure 8: Ultrasound image of a core lesion (arrows) within the SDFT. The lesion is evident in both transverse (left image) and longitudinal section (right image).

Figure 6c: Ultrasound image of Blondie's right stifle cyst being injected whilst the horse is under standing sedation. The arrows depict the needle (bright white line) being directed into the cyst.

Tuesday
An 8-year-old eventer mare 'Topper' is presented for investigation of swelling to the front right fore tendons. The mare had completed a one-day event the previous weekend and some swelling had been noted once the mare had returned home. On admission there was swelling in the region of the right fore superficial digital flexor tendon (SDFT) which was also painful on palpation. The mare was sound at the trot. Ultrasonography demonstrated a core lesion within the SDFT *(figure 8)*. It is very important not to underestimate swelling, pain or heat in the tendon following hard exercise and to remember that horses with tendon problems are not necessarily lame. A bone marrow sample was obtained from the sternum of the horse and the sample sent to the laboratory, where the stem cells will be separated. Once sufficient stem cells have been cultured, they will be injected back into the core lesion. In the interim period, the mare is discharged and is to be kept on strict box rest until she is re-admitted to the hospital in 2-3 weeks' time for the stem cell injection to be performed. Blondie's stifle cysts are both medicated with a small dose of corticosteroids under ultrasound guidance and standing sedation *(figure 6c)*. She will be reassessed at the hospital in 3 months' time.

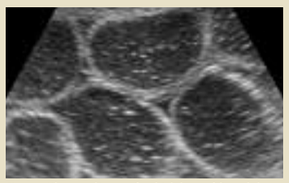


Figure 9: Ultrasound image of multiple loops of distended small intestine. This is an abnormal finding indicating either a functional or mechanical blockage of the small intestine is present.

Wednesday
A 17-year-old mare 'Polly' with severe colic is admitted to the hospital as an emergency. She is in a great deal of pain and has a very high heart rate. Both rectal examination and abdominal ultrasonography demonstrate multiple loops of distended small intestine *(figure 9)*. Given the pain and clinical parameters, surgery was immediately indicated. At surgery, a pedunculated lipoma (a fatty mass) was found strangulating ten feet of small intestine which had to be removed. The two cut ends of small intestine were then sewn back together again. The mare recovered well from the general anaesthetic and remained comfortable following surgery.

Thursday
A gelding 'Rupert' with a wound to the back of the right fore fetlock region is admitted to the hospital as an emergency. The injury had been sustained whilst exercising. On ultrasound examination, the inside aspect of the superficial digital flexor tendon had been torn *(figure 10)* and in addition there is infection within the digital flexor tendon sheath. The gelding was taken to surgery where the damaged tendon was cleaned and the sheath was flushed with sterile saline. Rupert also recovered well following the anaesthetic.

Figure10: Ultrasound image of the superficial digital flexor tendon. The inside portion of the tendon has been completely torn and is no longer present (outlined by the dotted white line).

Friday
Polly is progressing well following surgery and is to be introduced to picks of grass today. She is also going to be weaned off her intravenous fluids. Rupert is also comfortable following surgery but he will need a very long convalescent period before he can be worked again. His prompt referral and accurate assessment of the extent of the damage helped to ensure a happy outcome.

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