



DIGITAL RADIOGRAPHY

It is easy to regard radiography as the poor relation of imaging, especially as more advanced techniques such as magnetic resonance imaging (MRI) and computed tomography (CT) come into regular use. However, it is worth remembering that Wilhelm Roentgen's discovery of x-rays in 1895 and his subsequent work prompted the award of the first Nobel Prize for physics in 1901. More than 100 years later, the technique is still in widespread everyday use throughout human and veterinary medicine.

Radiographs (the pictures produced by x-ray beams) are best used to visualise bone pathology and although the technique has been refined (much lower doses of radiation are required now and the image quality has improved dramatically), it changed little until the late 20th century and the introduction of digital radiography. Conventional film-screen radiography (FSR) was the way virtually all images were obtained until recently. The pieces of film that you see, clipped up on light boxes, started off coated with light-sensitive chemicals. In dark room conditions, the film is sandwiched between two screens within a robust metal or plastic cassette. The cassette is placed so that x-ray beams produced by a generator (x-ray machine) pass through the patient and hit it. Once removed from the cassette and exposed, the film is not re-usable and is the only copy of the image that is produced. The screens can be used many times but eventually degrade and require replacement.

Digital radiography (the technique in which the information is captured and can be transmitted, stored etc. as electronic numbers) can refer to two different techniques - direct (DR) or computed radiography (CR). The results for you, the client, are similar and there is little to choose between them in terms of image quality or usefulness. However, as veterinary surgeons, we have to choose which system is most appropriate for our needs: each practice will be different. So what are the differences? With CR, the process is identical in appearance to the older FSR - cassettes are used in much the same way, except that the cassette film is replaced with an image plate that has to be 'developed' by a laser reader (it is removed



In this photo, the DR unit is set up. Note the portable computer on the right showing the image that has just been taken. The image plate is the blue rectangle in front of the small portable x-ray machine at the bottom left - this captures the x-rays and transmits the information through the cable to the computer.



In contrast to the small portable units, this is the ceiling mounted high-power unit at Rossdale's Equine Diagnostic Centre. Although digital radiography offers greater versatility, you still need a more sophisticated unit to x-ray the upper limbs, neck and back.

mechanically, read then wiped, so it can be used thousands of times). DR uses a sensor attached to a cable and this is joined to a computer directly. The image appears on the computer screen a few seconds after acquisition. A hard copy of the image can be produced on a piece of plastic which replicates the film used in conventional systems. Each system has its pros and cons depending on the size of the practice, the type of work done, the number of veterinary surgeons, whether there is a central clinic to refer horses to, and so on. There are also significant cost implications - practices easily can spend over £50,000 on

files can be stored easily on servers, perhaps on a picture archive and communication system (PACS). Instead of rooms full of envelopes containing the only copy of those precious images, they can be replicated for safety and accessed from anywhere (Rossdale's system allows our veterinary surgeons to look at their cases from any networked computer throughout the practice, from home, or anywhere in the world).

With digital, however, it is no longer a matter of just putting the films up onto a light box: practices need to consider extra hardware to manipulate and view the images - computers, high resolution screens and so on. Special programs may need to be purchased to allow the images to be viewed and the files are large in size (a single radiograph is 5 to 15MB).

The universal standard for all modern medical imaging is DICOM (Digital Image for Communication in Medicine). The images are as taken, complete with all of the other information (e.g. horse's name, clinician's name, time and date of exposure) that we need. Due to the large size of the files they are difficult to email, but they do tell the full story. All other file types (e.g. jpegs) are unsuitable for medical images. Digital cameras often use jpeg compression to reduce file size when the image is taken. However, this increases the possibility that the image has been altered or that information has been lost. So, should your veterinary surgeon be happy reading jpegs and making recommendations? Well, that depends on the case - if the situation demands a quick

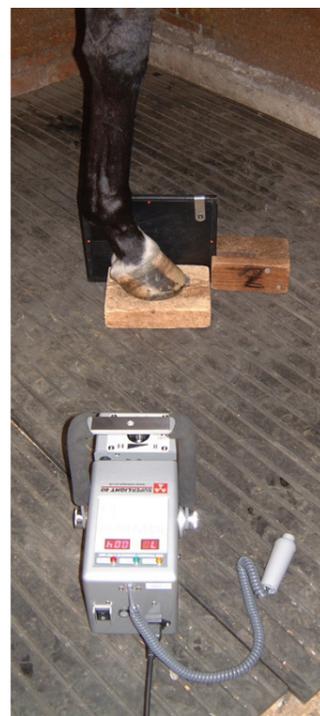
these systems.

Overall, digital radiography offers significant advantages to the clinician, the client and the horse in most situations. Undoubtedly, there will be a gradual shift towards digital and a phasing out of the FSR systems, but that doesn't mean that digital is best in every respect.

With FSR, each exposure produces one image which cannot be altered in appearance once the button is pressed. With digital, not only can you produce as many copies as you wish of any image, you can also alter the 'brightness', zoom in and out, attach labels, perform measurements and much more. This means less re-takes (and therefore less radiation exposure) and instantly more versatility. These electronic



The image on the left is of a horse with a fractured shoulder taken with FSR. The image on the right is a different horse, with the same injury, taken with digital radiography. Note the improved clarity that is achieved through manipulation of the image by the computer.



This image shows a horse's foot being x-rayed, using a CR cassette. This horse was x-rayed at home and the pictures reviewed once the cassettes had been 'developed' by the laser reader back at the practice.

response on an obvious lesion, then it's fine. But don't be surprised if they ask for full size images in other cases. Finally, there is a persistent rumour that digital images are 'high definition' or higher resolution compared to FSR. This is untrue. While in most cases digital radiographs are no worse than the images you get with FSR, they are not superior. Don't forget that you need to take into account the type of file that you are looking at, on what screen and under what conditions. A digital system is no substitute for skill and experience in taking the picture. 'Old-fashioned' films, produced by an experienced radiographer, are likely to be superior to crowding around a dirty laptop screen propped on the bonnet of the car!

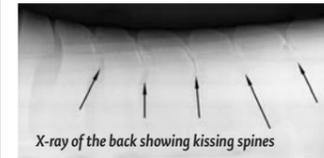
When to use radiography?

Radiography is used principally for the assessment of bone, but we can also get information about the soft tissues around a joint and, by careful interpretation, make assumptions regarding the health of other structures such as cartilage and ligaments within the joints. It provides high detail for assessment of fragments or fracture edges (much more so than MRI or CT) but does not help us to see in three dimensions (whereas MRI and CT can do this). This is why we often need to use several different techniques on your horse.

A week in brief...

Monday

A 10-year-old gelding is admitted with suspected back pain. He has been with his current owner for 4 years but recently has become increasingly resistant during ridden exercise, sometimes coming to a standstill for no apparent reason. Over the last few years we have seen an increasing number of cases like this so we have developed a detailed protocol for investigation. After a thorough physical examination including seeing him walk, trot and canter on the lunge, we see him ridden - recording a video to compare with later assessments. The problem is obvious and still evident when we change his saddle for one of ours and see him ridden by one of our grooms as well as his owner. X-rays were taken of his neck, back, stifles and hocks before ultrasound scanning his back, lumbosacral and sacroiliac regions. The x-rays show evidence of kissing spines. Before we nerve block him, we will bone scan that area tomorrow to see if it's active.



X-ray of the back showing kissing spines

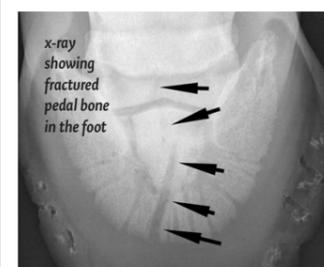
Tuesday

Front foot lameness is very common and these cases make up a substantial part of our working week. Two cases today have obvious x-ray changes: one is treated with an injection of anti-inflammatories into the coffin joint and goes home. We will re-assess him in two weeks' time. The other, with a pedal bone fracture will have a special shoe fitted by our farriers tomorrow. Two more cases will be examined by MRI tomorrow because the x-rays are inconclusive.

The bone scan of yesterday's back case shows 'hotspots' in the area we were suspicious of. We will block that area tomorrow before exercising him with one of our riders to enable us to decide what treatment is required.

Wednesday

A racehorse is admitted as an emergency case after pulling up very lame on the gallops. We x-ray him to confirm a fracture in his lower leg. We stabilise the limb in a splint before walking



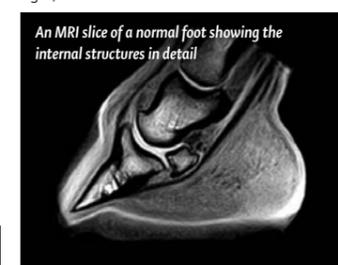
x-ray showing fractured pedal bone in the foot

him very carefully to the operating theatre. By the time the anaesthetists are getting him ready for surgery, his radiographs are up on the big computer screens in theatre and the surgeons are planning his treatment. The pastern is repaired using 3 stainless steel screws. The horse will be box rested for a period of 8 weeks before returning to us for further x-rays and resuming exercise. The prognosis for a full recovery should be very good - as long as these injuries reach us promptly and are not too severe, almost all of them are successfully treated.

The horse with kissing spines performs much better with local anaesthetic injected around the affected area. We will discuss with the owner whether we try medication or go straight for surgery. Although anti-inflammatory injections can work well, especially if combined with physiotherapy, surgery results in a more permanent cure in some cases.

Thursday

Due to yesterday's emergency case, I did not get time to look at the MRI images taken yesterday by my colleague Sarah Powell, so we're in early to review these (each foot produces about 400 images). Both cases have a diagnosis now - one has a bone bruise and should do well with rest and controlled exercise, whilst the other has a large tear in his deep flexor tendon. The prognosis for these tears is not good as only about a third come right, even with months of rest.



An MRI slice of a normal foot showing the internal structures in detail

Friday

A stallion at one of the studs we service has fetlock trouble (see image right). This case has been ongoing for a while and although the horse is doing well, we like to monitor his progress. I visit the stud with the portable digital radiography (DR) system, which allows me to take the picture, show it to the stud manager on the spot, and email it to a colleague for his opinion.



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Main interests: I qualified from the Royal Veterinary College (RVC), University of London in 1994 and subsequently spent time in mixed practice in Bedfordshire before undertaking an internship at the Animal Health Trust, Newmarket. This was followed by a further internship, when I returned to the RVC, before joining Rossdale & Partners in 1996. Originally concentrating on the racehorse side of the practice, I became a partner in 2000 and took responsibility for running the state of the art Rossdale Equine Diagnostic Centre in 2004. I am particularly interested in imaging techniques and lameness diagnosis and see a wide variety of horses. My main interests outside work include cycling and photography. I love gadgets. This article was written in between attending to fatherly duties: my wife, Sam, gave birth to our first son, George, on 6 December.



The stallion has arthritis of this hind fetlock - the arrows indicate all of the bone spurs and reaction around the joint



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