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Diagnostic Equipment-Did you ever wish for Xray vision?!

Following on from the lameness examination information sheet, it is time to shed some light on the diagnostic tools that veterinarians have at our fingertips to help diagnose problems. Unfortunately, vets don't have xray vision, and it is often that further diagnostic tests are required to help solve the problem, be it lameness, colics, lumps, bumps or poor performance. Each information sheet will concentrate on the diagnostic modalities X ray (radiography), ultrasound, gamma scintigraphy (bone scan), magnetic resonance imaging (MRI) and computed tomography (CT).

RADIOGRAPHY

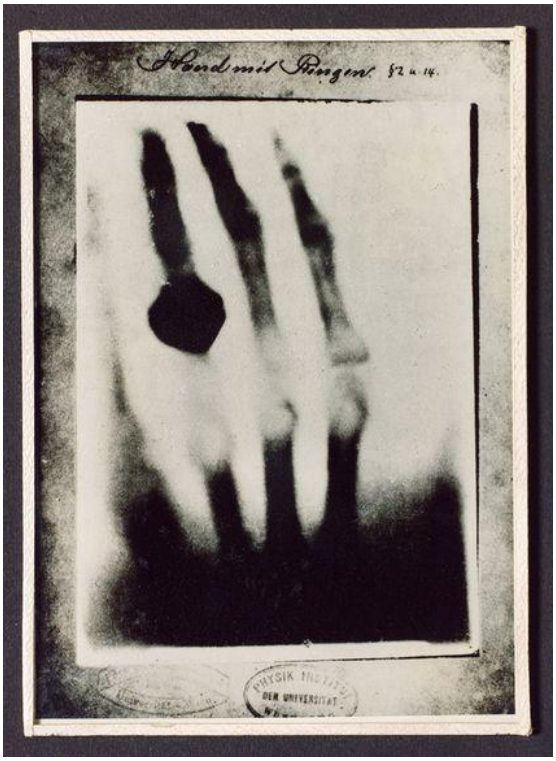
WHAT IS IT?

Xrays are a form of **electromagnetic radiation**, just the same as television, radio, microwaves and visible light. Of these, they have the shortest wavelength, and hence the most energy.

Radiography is the use of X-rays to view a non-uniformly composed material such as the human body or the horse. By using the physical properties of the ray an image can be developed which displays areas of different density and composition.

A beam of X-rays is produced by an **X-ray generator** and is projected toward an object. According to the density and composition of the different areas of the object a proportion of X-rays are absorbed by the object. The X-rays that pass through are then captured behind the object by a detector (film sensitive to X-rays or a digital detector) which gives a 2D representation of all the structures superimposed on each other.

Taking an X-ray image with early Crookes tube apparatus, late 1800s.



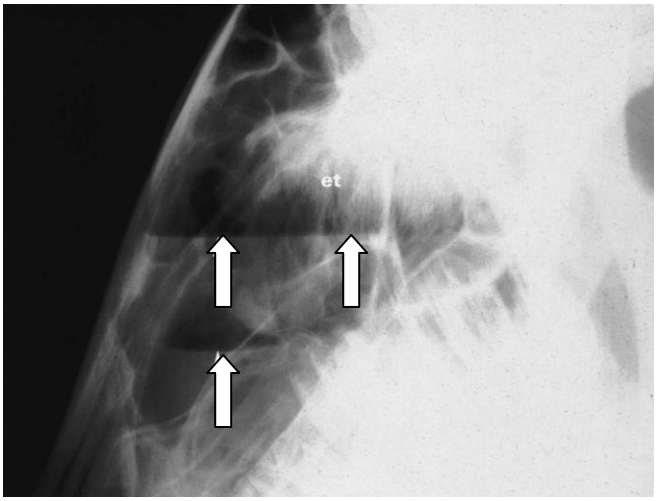
This 115-year-old picture of fingers is one of the first images ever made.
The hand belonged to Anna Bertha, wife of German physicist Wilhelm Röntgen, the discover of x-rays. The black glob on the fourth finger is a ring made of gold, which absorbs x-rays.

Radiography started in 1895 with the discovery of **X-rays**, also referred to as Röntgen rays after **Wilhelm Conrad Röntgen** who first described their properties. These previously unknown rays (hence the X) were found to be a type of **electromagnetic radiation**. It wasn't long before X-rays were used in various applications, from helping to fit shoes to the medical uses of today. The first radiograph used to assist in surgery was taken a year after its invention in **Birmingham** by the British pioneer of medical X-Rays, Major **John Hall-Edwards**. X-rays were put to diagnostic use very early, before the dangers of ionizing radiation were discovered. **Marie Curie** pushed for radiography to be used to treat wounded soldiers in World War I.

WHAT CAN WE SEE?

There are 5 levels of intensity, with the most radiolucent being black and the most radiodense being white. The denser an object, the more xrays are absorbed, hence the less xrays pass through onto the detector and the WHITER the image will look.

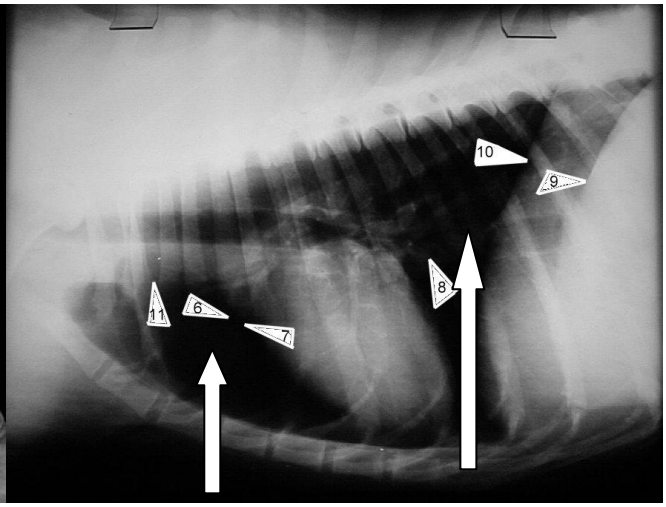
Bone will look white. Air will be black.



This is a head xray. This horse has fluid in the sinus cavities. The sinuses should normally be filled with air only. The fluid-gas interface causes a clear line to be seen on xray

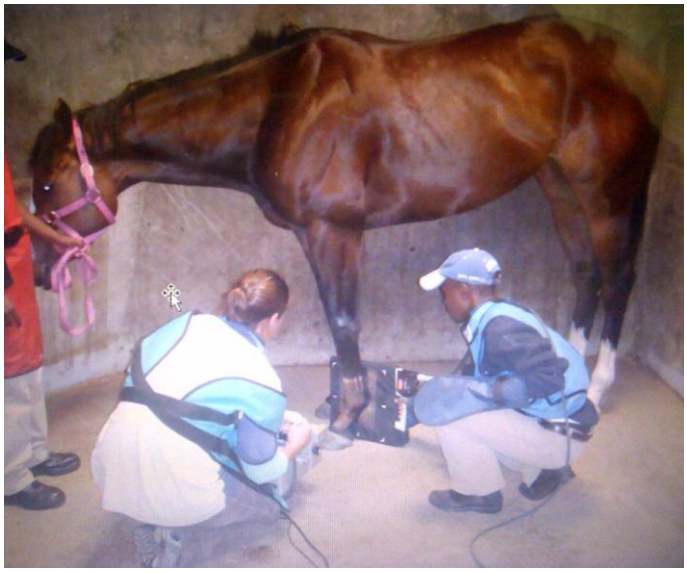
The main reason xrays are used in veterinary medicine is to assess bone and their associated soft tissue structures. They are also used occasionally for chest/lung assessment (mainly in foals) and gastrointestinal assessment (foals).

Bone is dense, so white



Air in the lungs is least dense so appears black

It is important to remember that some changes seen on xrays are historical. Bone is a living dynamic tissue that takes time to respond to an insult and can only respond in a finite way to an infinite number of insults! This information sheet will concentrate on how we can assess bone using xrays, as this is the most likely way you as the client will require the use of xrays of your horse.



HOW CAN BONE RESPOND TO INSULTS THAT WE CAN INTERPRET ON AN XRAY?

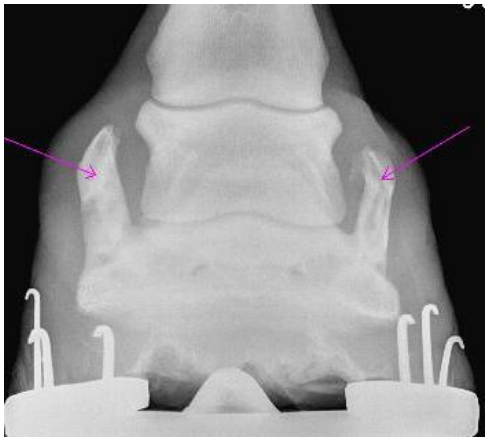
Bone can respond in a limited number of ways only. They are:

Demineralization

This is 'thinning' of the bone therefore the bone will look less white. Demineralization can be generalized due to metabolic problems or even end stage kidney disease. Localized demineralization is most likely due to lack of use of that limb, eg if the leg is in a cast for a fracture repair.

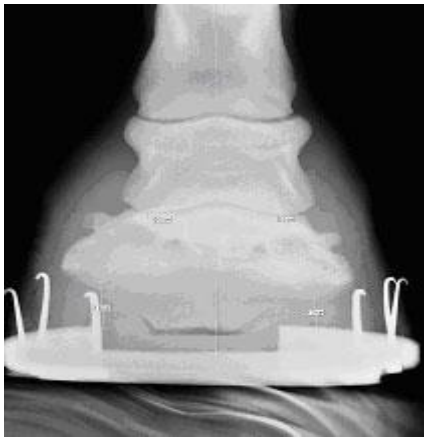
Increase bone production

Generalized bone production is not recognized in the horse, but it can occur focally. Focal new bone production areas are called **osteophytes**. They can take weeks to form and depending on their shape, vets can often tell whether they are old or new, active or inactive. Osteophytes can further be divided depending on their location. **Periarticular** means around a joint, **entheseophytes** are seen where ligaments, tendons or joint capsules insert onto the bone. These represent the stresses that those soft tissue structures are under in response to stresses traveling though the bone and they may represent tearing of the ligament, tendon or joint capsule.

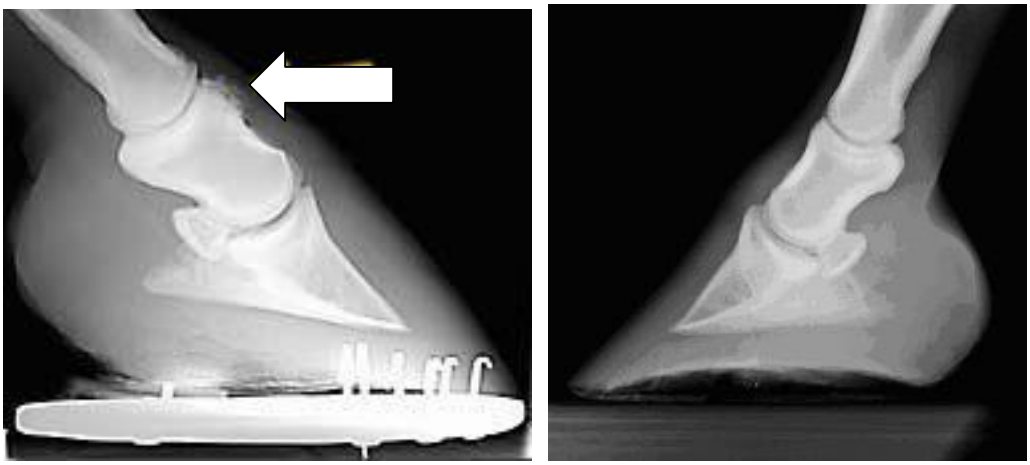


Arrows pointing to side bone which is increased bone in the collateral cartilages of the foot.

The xray machine in position to take this view.



A foot without side bone.



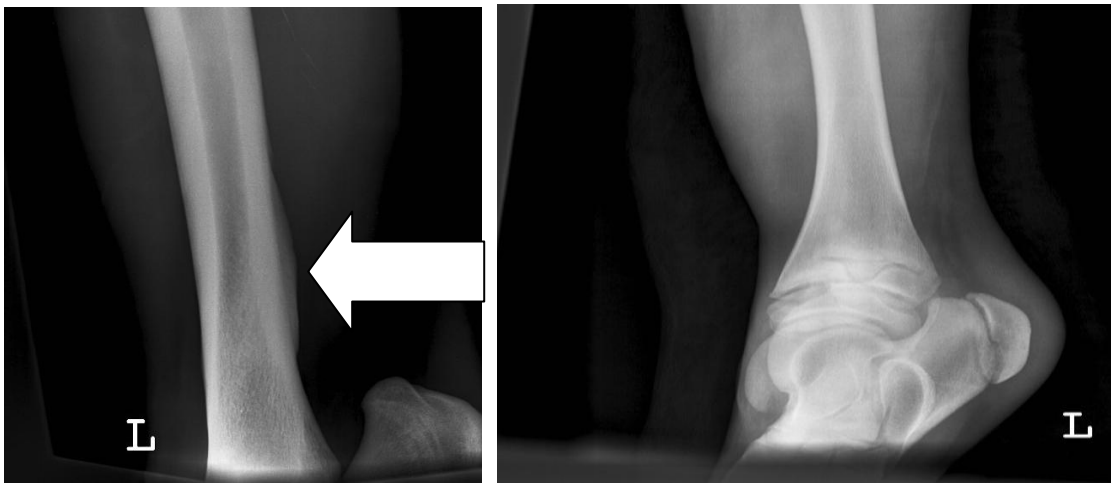
The arrow points to osteophytes-new bone production of the pastern joint, otherwise known as 'high ringbone'. The image on the right is normal.

A normal navicular bone

Large amounts of new bone, 'entheseophytes' on the back of the navicular bone

Periosteal bone reaction

The periosteum is the outer most surface of the bone. This can react by producing more bone in response to a knock or a fracture.

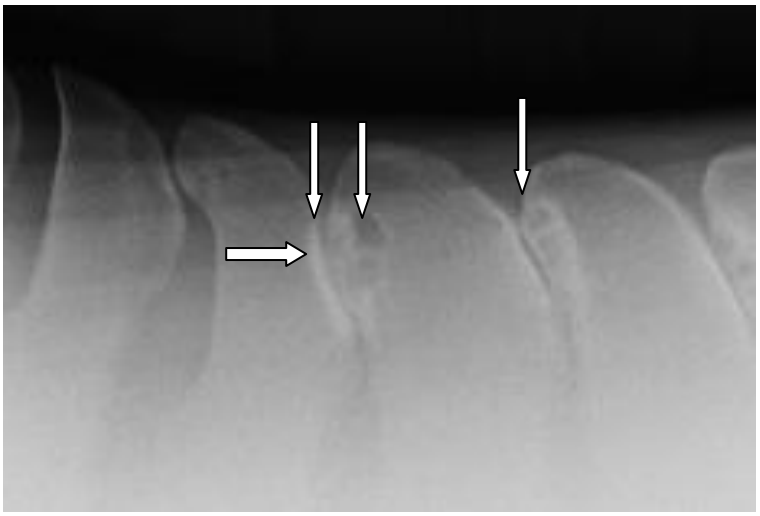


Perisoteal new bone at the back of the tibia, due to a tibial stress fracture. This reaction will only be seen sometimes weeks after the fracture occurs. The image on the right is normal.

Periosteal bone reaction in a foal due to infection. Note the fluffy new bone on the front of the pastern

Sclerosis

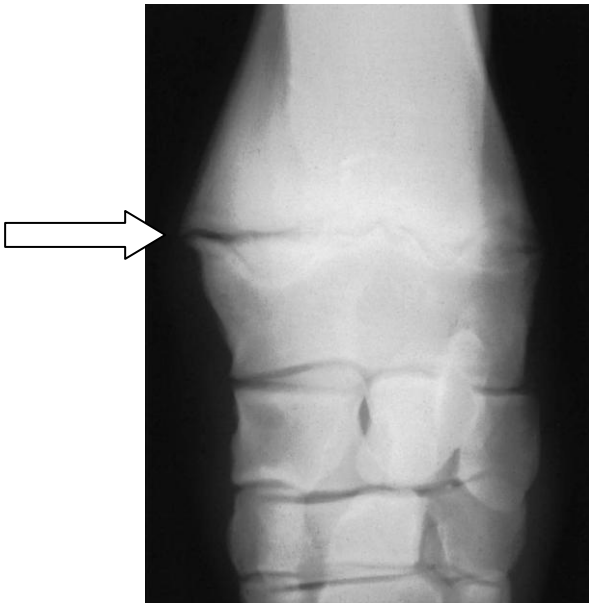
Sclerosis means a localized increase in whiteness of the bone due to an increase in the bone mass within that existing bone. It means that there has been stress on that area of bone, or that area of bone is trying to wall off/seal off infection, or it may be trying to protect a weakened area, eg a hair line fracture, or a bone cyst.



This is an image of the dorsal spinous processes of the horse which are 'over riding'. Notice the white, 'sclerotic' bone on the second spine from the left, where the spine behind it is impinging and pressing on it. Also notice the lucent, darker area of bone in the spine third from the left, due to resorption due to impingement. A similar but less marked reaction is going on between spines 3 and 4.

Growth plate inflammation

Physitis is the term used to explain inflammation of the growth plates of the bones. This is seen on the xray as widening of the growth plate, and bony irregularities in skeletally immature horses. Very occasionally, fractures can also occur through the growth plate in foals.



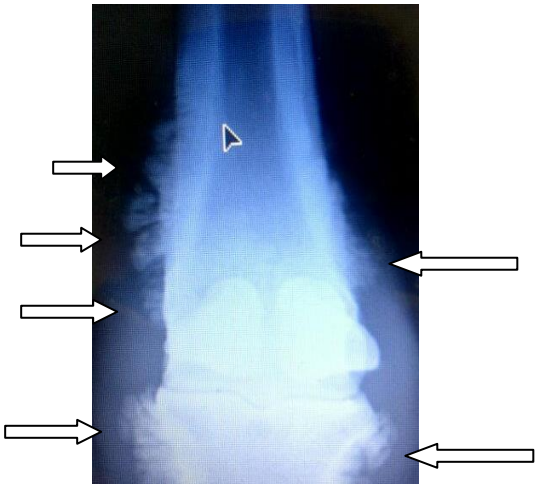
Physitis-inflammation of the growth plate. Note the widening and 'lipping' of the edge of the growth plate.

Fractured growth plate of pastern

Normal growth plate

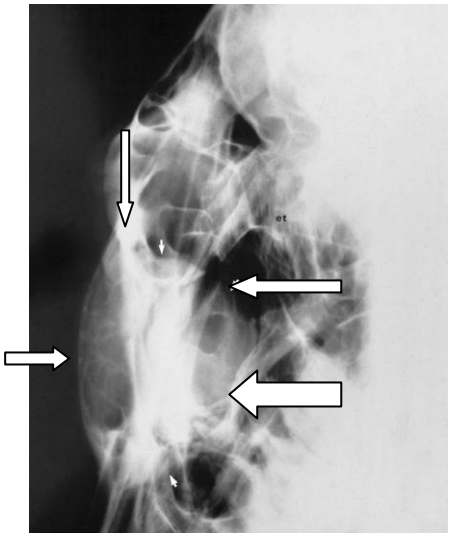
Neoplasia/cancer

Primary bone tumours are rare in the horse. If present they are seen as space occupying lesions on the xrays. Some non bone based tumours can cause secondary effects in the bone, most commonly seen as something called HPOA (Hypertrophic osteopathy). This is seen clearly on xrays and has a specific pattern. It can happen for other reasons also so doesn't always mean there is a tumour somewhere.



A fetlock joint with HPOA. Note all the palissading new bone.

The bones from the above xray.



This is a head xray showing a tumour mass growing in the sinus.

Infection

Bone can become infected too. This is called osteitis or osteomyelitis. There will be areas of new bone production and areas of bone loss, leading to irregular white and dark patches. Bone infection is usually accompanied by a nearby wound or joint infection, or in 'joint ill' foals.

Severe joint infection of the knee that has spread to the surrounding bones. The xray on the right is normal.

Growth plate infection

Fractures

Fractures can be seen on xrays. Xrays can then be used to monitor progression of fracture healing. Early stress fractures may not be seen initially and when fractures are suspected but seen on initial xrays, repeat xrays are taken 7-10 days later, to allow time for bone resorption to have occurred along the fracture line.

Tibial fracture in a foal

'split pastern' a common racing fracture

Small avulsion fractures off the sesamoid bones, associated with the suspensory ligament branches

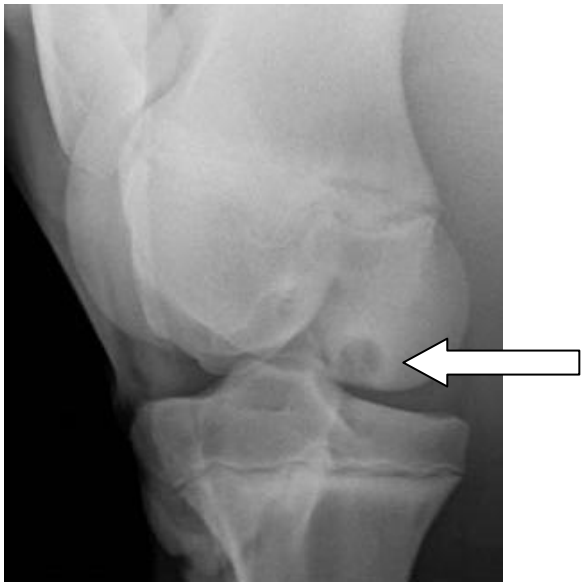
Now you see it……..Now you don't. This is why we need to take multiple views of joints when looking for problems. This is a complete articular fracture of the pedal bone.

Cysts

Osseous/bone cysts are circular lucent/pale areas in the bone, often with a sclerotic/white border. They are often close to joint surfaces and can communicate into the joint. Cysts may or may not be associated with lameness. Some cysts are a form of OCD (see later).

Fetlock cysts

A large stifle cyst. Note the sclerotic white border

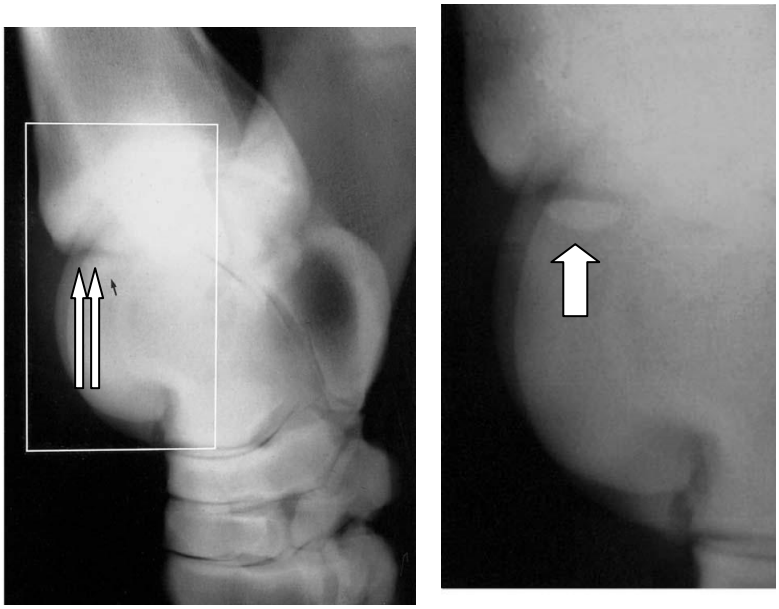


A stifle cyst seen from a slightly different angle.

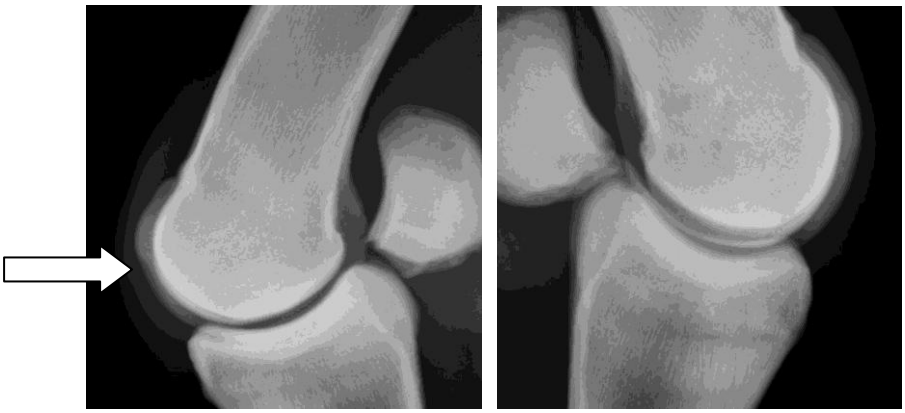
OCD

This stands for Ostechondrosis Dessicans. This is a disease of young, growing horses, due to defects in the cartilage-bone interface. Certain breeds have predilection sites for these lesions. 'Joint mice', i.e. Small fragments of bone and cartilage can end up 'free' within the joints.

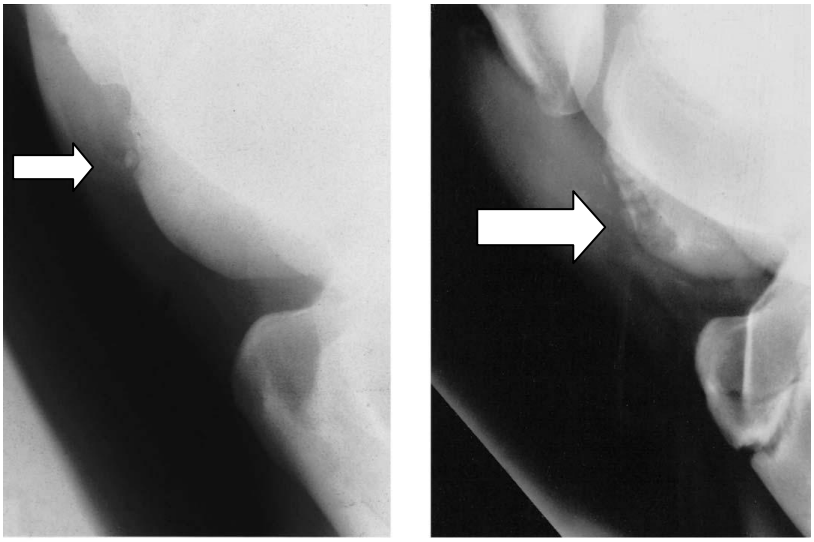
An OCD joint mouse in the hock



A joint mouse in the hock. The image on the right is an enlarged image of the square on the left.



OCD in the fetlock. Note the flattened area of cartilage/bone interface on the xray on the left. Right is normal.

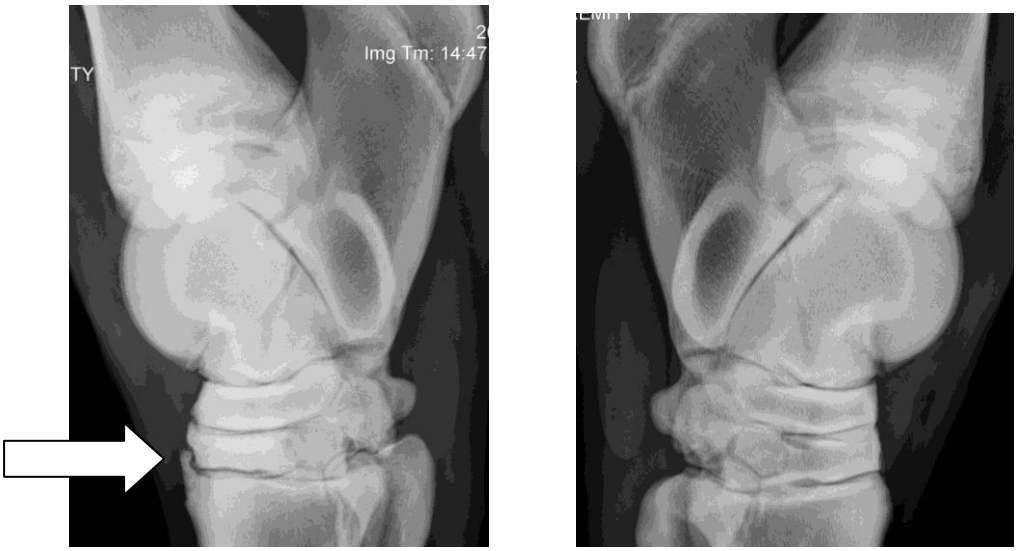


Joint mice in the stifle

Osteoarthritis

Otherwise known as degenerative joint disease. Arthritis simply means inflammation of a joint. Osteoarthritis means that the adjoining bone has also become involved. There are several signs of

osteoarthritis on an xray including osteophytes, joint swelling, narrowing of joint spaces, loss of bone density/whiteness and sclerosis.



Osteoarthritis of the hock joints. Note the new bone formation in the small hock joints. The xray on the right is normal.

AND NEVER FORGET THE WEIRD AND WONDERFUL…….

Horses are amazing, dynamic living creatures and as a vet you can always expect to get the unexpected

Can you guess what this is?? Answer at the end of the info sheet!

FAQ FOR XRAYING YOUR HORSE

Is the xray machine portable?

Yes!! We use and Eklin Mark II machine in Capetown, which is a digital machine. This means that it is highly portable and images appear almost instantly on the screen. This leaves us with few limitations! We use a DR system (direct radiology) which means that there is a sensor attached to a cable which is joined directly to a computer.

Xraying the weird and wonderful with the portable machine

Can I see the images immediately?
Yes!!! The xray image appears immediately on the computer screen. The vet can then alter certain values on the machine to enhance the image. All the images get transferred onto our main viewing screens at the clinic which improves the image quality even further. Final diagnostic decisions aren't made until the images have been looked at on theses screens.

Why do the vets often ask for the horse to come into the hospital?
If the xrays are part of a full lameness work up then it is often better for the horse to be admitted to the clinic. Lameness work ups (see previous info sheet) can be complicated and time consuming. Neck and back xrays require the horse to be positioned perfectly so often require the horse to stand in stocks, and many sets of eyes to align the xray beam and detection plate.

Can I as the owner have a copy of the xrays?
Yes. We can put the xrays on CD or email them to clients. The recognized digital storage system is DICOM (digital image for communication in medicine). These are very large files but cannot be altered.

Images can be converted into jpegs but these can then be altered, which hence can have legal implications. Xrays are only released to the owner/client.

Will my horse be sedated for xrays?
Quite often, yes. For clear, sharp diagnostic images the horse has to keep perfectly still. A small amount of sedation makes it much quicker, easier and safer for all handlers involved. The horse will quickly wake up from the sedation, within 20-30 minutes usually. If we are xraying young foals, then these are often put onto the ground using the muscle relaxant Valium, which has no deleterious effects on the foals blood pressure, heart rate or breathing, but completely relaxes the foal so that it can be manipulated easily.

Are xrays part of a routine pre purchase examination/ vetting?
No, xrays are not routinely performed. If on the clinical examination, the vet is concerned about certain areas, then xrays and/or ultrasound examinations will be advised. Horses being sold for large sums of money are often routinely xrayed, but care has to be taken in how the xrays are interpreted. Lots of sound horses can have changes on xray which don't necessarily cause a clinical problem.