Digital radiography conquers the veterinary world

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Increasingly, veterinarians are using medical imaging to diagnose their patients. There is a corresponding tendency towards replacing conventional film-screen systems with digital medical imaging systems, such as computed radiography (CR) and direct radiography (DR). With these systems, many veterinarians around the world are enjoying considerable benefits, including time savings and optimal image quality.

From analog to digital

X-ray generators are used to make radiographic exposures. As the X-rays pass through the patient, the way in which they are absorbed varies depending on the density of the body tissues (bone, fat, water, air, etc.). With a conventional exposure, the unabsorbed X-rays are captured in a special cassette with a fluorescent screen, and the remaining radiation is converted to visible light. This light hits the film, reacts with the silver bromide and causes the silver ions to precipitate. After the development, fixation, drying and rinsing of the film, a conventional X-ray image is obtained.

Conventional radiography delivers solid results, but the technology is labor-intensive and time-consuming. In addition, so-called ‘wet’ development requires the use of chemicals that must be dealt with in an environmentally-sound way.

Computed radiography gains ground

Computed radiography (CR) and direct digital radiography (DR) also use a standard X-ray generator. CR is an indirect digital imaging technology that became popular in the 1980s within the human healthcare domain. In the veterinary world, equine veterinarians, who must often work in the field, were the first to make use of this technology. Around the year 2000, veterinarians began using the technology – which had become more compact and affordable – on a larger scale.

With CR, the X-rays are captured using a phosphor plate – rather than a fluorescent screen in combination with conventional film. When the plate is exposed to X-rays, some of the radiation energy is absorbed, causing the excited electrons to create a temporary image on the imaging plate. This latent image is then scanned with a reader using laser light, capturing the visible light that is released when the excited electrons return to their ground state under the influence of the laser beam. The energy that is captured is converted into electric signals. The result is an extremely accurate image that appears on the computer monitor some 30 to 60 seconds after the exposure.

After each exposure, the images on the phosphor plates should be erased. Some systems do this in conjunction with image reading, after which the plate can be immediately re-exposed to X-rays. The phosphor plates can be re-used thousands of times, but are eventually subject to wear and tear.

Imaging plates are available in many sizes. In addition to larger sizes, Agfa HealthCare also offers smaller plates for intra-oral applications, both for small pets and for horses.
CR systems include one or more phosphor plates (available in different sizes), a laser scanner, a computer with a high-quality monitor and, optionally, a printer.

High-quality images in seconds

DR moves another step forward. These systems use a detector plate (flat panel detector) to capture the X-rays. A scintillator converts the X-rays into visible light that is then converted into a digital signal using photodiodes and ‘Thin Film Transistors’ (TFT). Just a few seconds after the exposure, the image already appears on the computer screen. There is no need for a reader or scanner to process the image.

The type of scintillator determines to a large degree the quality and cost of the detector. Scintillators with powder phosphor are relatively easy to produce, as opposed to scintillators with needle phosphor. But the latter offer greater sharpness and better noise, at an identical exposure.

The major benefit of DR is that it is even faster than CR. If necessary, retakes can be performed immediately; there is no need to replace the cassette. Moreover, the intrinsic image quality can be considerably better.

The reverse side is that this technology is much more expensive and requires a higher investment compared to CR. In addition, the detector plate is more sensitive to damage: a kick from a horse, for example, could require the complete replacement of the system. Considering the cost, many veterinary practices prefer CR.
DR systems consist of a flat panel detector, a computer with a high-quality monitor and, optionally, a printer. There is no need for a scanner.

Indirect DR Detector with GOS Scintillator

- Granular powder scintillator compound

Indirect DR Detector with CsI Scintillator

- Crystalline needle scintillator compound
Ease of use

In general, digital imaging systems such as CR and DR are easy to operate. The veterinarian selects an exam type on the computer and the correct parameters are transmitted to the X-ray generator. As soon as the images are taken, they are sent to the workstation, where they can be optimized for interpretation. With the more advanced systems available, the entire workflow is automated.

When a hardcopy is needed, the image can be printed on paper or transparent film, similar to conventional X-ray film. Paper images from an office printer can be useful in client communication, while prints from high-quality film printers produce diagnostic-quality films.

Both CR and DR are particularly suitable for mobile applications. A small footprint CR system, used together with a laptop computer, can easily be transported in a car. There are also smaller, light-weight and very practical DR detectors on the market. The cream of the crop for house calls – e.g. for equine healthcare – are the wireless flat panel detectors.

Excellent image quality

Conventional silver film has a number of disadvantages. Film has a limited linear response to radiation, which means that it cannot tolerate a wide radiation exposure range without risking saturation. In some studies, that latitude limitation means certain areas may be overexposed while others will be underexposed on the same film.

Digital radiography eliminates this disadvantage. With the linear character of the system and its higher dynamic range (more shades of grey) an image can be made darker or lighter, enabling the possible detection of lesions not visible on conventional film. Moreover, details of both soft tissue and bone are visible on the same image. Retakes, which require additional radiation exposure for both operator and patient (along with the possibility of additional sedation for the latter) can be avoided; the exam is completed more quickly, at a lower cost.

In addition, digital images can be manipulated: the veterinarian can adjust contrast and brightness, invert or crop the image, zoom in on a specific lesion, and even make text annotations. The software also makes it possible to perform measurements, such as heart dimensions, hip angle in a dog or hoof angle in a horse, etc. The manipulated image can be stored next to the original image.

Proper image processing is an important component of the chain. Nearly all suppliers have built image processing software into their CR and DR systems, but the methodology and quality of this software determine to a large extent the quality of the diagnostic image. The best systems offer software that is specifically tailored for veterinary applications, with settings for various species. This results in high-quality images for both small and large animals. One example is Agfa HealthCare’s MUSICA² image processing, which today is considered the gold standard in both human and veterinary radiology. This software analyzes each image and automatically applies the appropriate image enhancement parameters independent of the exam type.
**Time savings**

In addition to the generally better image quality, CR and DR also offer significant time savings. As film development is no longer necessary, images are available considerably more quickly. CR produces images in 30 to 60 seconds, while DR takes just a few seconds.

The subsequent workflow steps have also become much easier. Images can be stored electronically and sent to another veterinarian for a second opinion. And after the exam, they are easier to retrieve. Physical storage space and a darkroom are no longer necessary.

The client no longer needs to wait till the image is developed, and treatment can be started sooner. Veterinarians can also present their clients with a CD containing the X-ray images of their animal.