Update on Digital Radiography: What Technicians Need to Know
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Digital radiography is the latest advance in veterinary imaging and is now the standard in human diagnostic imaging. It is just a matter of time—all practices will eventually utilize this modality. Vendors are continuing to offer better equipment and competition in the free market will likely lower start-up costs for practitioners. The following is an update on this exciting modality, where veterinary technicians will play a very important role.

There are two basic digital imaging systems: 1) computed radiography (CR) and 2) direct digital radiography (DDR). (See figure below).

Computed radiographic detectors are similar to a large floppy computer diskette. These flexible detectors are placed in a standard x-ray cassette sans intensifying screens. A two-step process is used for recording the CR image. First, the latent image is captured or “trapped” with x-ray sensitive phosphors of the image plate (this is similar to recording the latent image on conventional x-ray film). Second, the image plate is processed by a reader that changes the latent image of the phosphor to light photons that are converted to an electrical signal. The reader is a stand-alone unit similar to an x-ray processor. An analog to digital converter transforms image data to a digital format and sends it to a computer where a preview image is displayed on a monitor. Processing time for CR is 45 seconds or less, depending on the system used. Next, the image preview is assessed for quality by the radiologic technician and if no corrections are needed, it is sent to the image viewing station (workstation) for interpretation. The final step in CR image acquisition is erasing the phosphor, once this has been performed the cassette is extracted from the reader and can be used again. Computed radiographic systems were developed in the 1980s and remain a major player the human and veterinary imaging markets.

Direct digital radiographic (DDR) systems are named so because unlike CR they send digital information directly to the image computer without a reading step. Types of DDR detectors include: 1) flat panel detectors and 2) charge coupled device (CCD) detectors. Flat panel detectors are rigid plates that look like a conventional x-ray cassette. They have several of layers of semiconductors for image capture, transistors and microscopic circuits. Flat panel detectors convert x-ray energy into electrical signals, which are digitized and sent directly to a computer. Charge coupled device detectors use a small chip that is similar to those used for digital cameras. A scintillator converts incoming x rays to light photons. The light signal is minified by an optical system before reaching the chip where light is converted to electric charges. A digital signal is sent from the chip directly to the imaging computer. Some energy is lost during the minification step and this often results in higher exposure factors (mAs) with this form of digital radiography. CCD systems are actually a subcategory of direct digital units and it should be kept in mind that most have a fixed tube head that cannot be angled for obtaining off 90 degree views or cross table views. These units cannot be used in equine studies. A principal, overall advantage of DR systems is a faster acquisition time as the image preview is available in 7-15 seconds. Advantages in a busy small animal or equine practice are obvious.

Advantages of digital imaging include:
- Improved contrast
- No films and no film storage
- No processor and no chemicals
- Computer friendly

Improved subject contrast is one of the main features of digital radiography. This allows a wide range of gray shades (gray scale) that can be applied to the finished image. With correct settings, a digital exposure will allow visualization of more structures than on an analog image made of the same patient-especially in the abdominal cavity. An increased number of gray shades will allow manipulation of the digital image (post processing) so a particular structure can be maximized while others are suppressed. For example, using the computer mouse, contrast and brightness of the lung field can be adjusted so small airways and vessels are well seen; at the same time the conspicuity of the heart and other soft tissue structures would be minimized. This is known as “windowing” and has been used for years to optimize computed tomographic and magnetic resonance images. Exposure latitude is also increased with digital imaging, thus the range exposures that will produce a diagnostic image is greater than with analog radiography. Therefore, the number of retakes may be reduced in a busy practice. However, digital radiography will not help with retakes due to positioning errors. Obviously a conversion to a digital system will eliminate the processor, need for a dark room and eliminate expenditures for x-ray film and processor maintenance. Finally, and importantly, digital radiography is computer friendly, allowing electronic transfer of images, duplication, on site digital storage and archiving. The advantages of a digital format are perhaps the most important feature of digital radiography.

It is also noteworthy that digital imaging can help with environmental concerns; toxicity for heavy metals (silver halide emulsion on analog films) is not an issue and paper film jackets are not used. Digital image plates (CR and DR) can be used thousands of times.
before they need to be replaced, and they can be disposed in an environmentally safe manner. Lastly, digital imaging does not use water or chemicals.

Disadvantages of digital imaging include:

- Less resolution (detail) compared to conventional radiography
- High exposure factors
  - More personnel exposure
  - Shorter tube life
- Initial startup cost

Fortunately, disadvantages of digital imaging do not overshadow advantages. The inherent reduced detail (image resolution) of digital systems can be limited by use of sharpening algorithms during image processing. In addition, lack of detail is less noticeable because of improved subject contrast; borders between structures are better visualized than with analog systems. Exposure problems do exist with some digital systems, but can usually be overcome with calibration of the x-ray machine to obtain quality images with the least possible exposure. Contrary to common opinion, a technique chart is needed to optimize digital equipment. Unfortunately, there is a misconception that digital images should be purposely overexposed and during post processing adjusted with brightness and contrast to achieve proper image quality. This is incorrect. Exposure to personnel is increased, x-ray tube life is shortened and image quality may be reduced because of saturation of pixels representing area with low subject density (lung, fat, thin soft tissue areas). Technological advances are rapidly overcoming many of the early problems with digital imaging, and cost is decreasing. Computed radiographic systems have enjoyed a large share of the veterinary market, but DR flat screen units are becoming cost effective.

All digital radiographic images should be acquired and stored in a **DICOM** (Digital Image & Communications in Medicine) file format, the industry standard, which also the FDA standard. DICOM files are rather large, but cannot be permanently altered and thus serve as original data for storage and are considered “legal” images in case of litigation. These files are preferred for manipulation by software programs because they are universal and contain all of the image data. While they cannot be altered, they can be manipulated for imaging interpretation and saved in different (smaller) formats such as .jpg, .tif, etc. for distribution to clients or for documentation purposes. It should be noted that smaller file formats are not acceptable for true image interpretation with standard imaging software programs because they do not contain all of the original data.

Monitors are an important consideration when installing a digital system. A monitor with size and resolution acceptable for image interpretation is included with digital hardware package. However, monitors are also needed for viewing images in the examination rooms, surgical suites and treatment area of the hospital. The best option is to hardwire monitors at various locations within the hospital so image data can be fed directly from the workstation. If this cannot be done images can be accessed via Internet connection at various locations in the hospital or a laptop computer can be used to display images downloaded from the workstation.

One of the most troublesome issues with digital to analog conversion is insuring that adequate IT (information technology) is available. Technicians can play a vital role here and should be encouraged to do so. Busy practitioners do not have time manage image acquisition, post process, store images or troubleshoot software and hardware problems, or recognize and correct image artifacts. Getting up to speed will vary with the individual and the help your vendor is willing to provide. Often the best solution is to hire someone with expertise for a day or two of onsite training.

Digital radiography is an exciting technology and is the future of veterinary imaging. Veterinary technicians must be fully utilized for optimum results.

**Figure 1**

**Types of Digital Radiography**

- **Computed Radiography (CR)**

- **Direct Digital Radiography (DDR)**

**Reference**