

DIGITAL IMAGING: WHAT ARE YOUR OPTIONS?

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PART 2: CR: A NEW ERA

In Part 1 of this series, we discussed the evolution of the use on conventional film-screen imaging and its advantages and disadvantages. In Part 2, we will focus on the introduction of computers in the acquisition and display of medical radiographic images.

Often there is a great deal of confusion because of the various names given to the technologies that utilize non-film image receptors and computers for the acquisition, archiving and communication of x-ray images. For purposes of this article, the following terms will be used:

Computed Radiography or “CR” – A system that uses a Photostimulable Plate (PSP) and a plate reading unit. In general, the PSP is housed in a cassette that is very similar in appearance to a conventional radiographic cassette. The plate reading unit scans the PSP and then sends the image to a computer.

CCD based Direct Digital Radiography or “CCD DR” – A system that uses a Charge Coupled Device (CCD) to acquire the image and then send the image directly to a computer.

Flat Panel based Direct Digital Radiography or “Panel DR” – A system that uses a Charge Coupled Device (CCD) to acquire the image and then send the image directly to a computer.

All three of the above technologies accomplish the same task: sending a radiographic image to a computer. With CR, special cassettes are used whereas the other two technologies eliminate the need for these special cassettes.

In the early 1980's, the concept of converting the data from an x-ray beam transmitted by the patient into a digital format that could be displayed on a computer monitor was introduced by the Fuji Corporation. This technology was termed Computed Radiography or CR and is still a widely used method of acquiring medical radiographic images.

The logistics of CR are very similar to that of conventional analog F/S radiography. A conventional x-ray unit is used to make the exposure. As explained above, the CR system utilizes a Photostimulable Plate (PSP) and a plate reading unit which eliminates the need for film and chemical processing. In general, the PSP is housed in a cassette that is very similar in appearance to a conventional radiographic cassette. This cassette can be used in a cassette tray in the table or wall cassette holder or may be used table top. The x-ray exposure is made in the same manner as with using a conventional film screen system. The next step is what differentiates CR imaging from film-screen imaging. Instead of taking the cassette into a darkroom and processing a film, the PSP is placed in a CR reader. It is in the CR reader that the PSP is scanned by a laser beam. There are phosphors in the PSP that release light when scanned by the laser beam. This light is

proportional to the energy of the x-ray beam that has struck the PSP. This light is converted to an electrical signal by a photo-multiplier tube than converted to a digital signal via an A-D converter. At this point, the digital signal is sent to a Central Processing Unit (CPU) where image processing occurs. The image can now be displayed on a computer monitor.

One important operation takes place with all three types of computer based imaging. An algorithm is applied to the “raw image” that adjusts the “raw image” so that the contrast and density levels for similar examinations are essentially consistent.

All three types of computer based imaging offer many advantages when compared to conventional film-screen radiography. These benefits include but are not limited to:

- 1. Utilize Existing Equipment:** Making a transition to computer based imaging often does not necessarily involve replacing all of your existing x-ray generating equipment that you use for film-screen imaging. Most of the time your existing equipment that produces the x-ray radiation can be used as part of a computer based imaging system. However, it should be noted that some CCD DR systems do not work well with older technology analog x-ray equipment.
- 2. Reduced Cost:** Cost for supplies such as film, chemistry, ID cards, file jackets and the associated cost with storing and transporting these items are eliminated with computer based imaging. In our experience, the greatest savings are generally related to efficiency gains for the physicians and support staff. In some instances, it is possible that the savings realized by eliminating film, related supplies, and related service costs offset the cost of a lease for digital imaging equipment. Further savings may be realized once the lease terms are complete.
- 3. Image Quality:** Computer based imaging can result in images with high resolution and can provide excellent image quality.
- 4. Reduced Repeat Rate:** The wide dynamic range of image detectors and the algorithms applied virtually eliminate repeat examinations due to improper exposure factors. This results in less patient and operator dose, reduced operating cost and a more efficient examination.
- 5. Post Processing:** One of the major benefits of any digital imaging system is the ability to manipulate the image once displayed. The ability to adjust contrast and density of images via window and leveling tools allows soft tissue and bone to be displayed on the same image. The ability to zoom and magnify small structures allows for the detection of subtle changes.
- 6. Improved Efficiency:** Images are displayed in a matter of seconds with CCD DR and Panel DR. While the display of CR images takes longer (generally between 45 and 85 seconds), all three are faster than conventional film processing. In addition, since a computer is used for routing, storage, retrieval, and viewing of images, there is a much more efficient workflow that can result in considerable savings.

7. **Archive:** Images are stored on a hard drive of the computer saving valuable office space. It is not unusual to have 50,000 or more studies saved on a PC. In addition to saving on storage space, files can be backed up to another storage space for a disaster recovery plan.

8. **Study Portability:** Studies can easily be shared with a colleague for consultation or copied to CD for the patient or referring physicians. This is a duplicate of the original image without taking the risk of original images leaving your office and potentially becoming lost.

Because there are differences between the three computer based imaging technologies, you should evaluate each technology before you decide on which one to purchase. Some of these differences are as follows:

1. **Positioning Flexibility:** Since CR utilizes imaging plates that are used in the same manner that conventional cassettes are used, CR enable the facility to use the plates in cassette trays, table top, cross table and for “portable” use. In addition, since CR studies may be performed table top and in most cases DR studies must be done “bucky”, the technologists is able to use a lower table top exposure factor with CR.

2. **CR System Cost:** In general, CR systems are less expensive than the other two systems.

3. **Proven Technology:** CR has been utilized since the mid 1980’s as the primary method for imaging departments to go “filmless”. The reliability and detector longevity is well known and will offer many years of reliable service. CCD DR and Panel DR technologies are more recent developments and to date have performed very well. What is not clear is the life cycle of this technology. If needed, the repair or replacement of major components of CCD DR or Panel DR systems will likely be much more expensive than the repair or replacement of major components of CR systems.

4. **Workflow:** CR imaging procedures still require the technologist to handle the imaging plate. This reduces the efficiency of workflow when compared to CCD DR or Panel DR systems which will be discussed in greater details in the next installment. In clinical situations where the case load is low to moderate, workflow is generally not considered to be a major disadvantage of CR imaging.

Summary: CR represents an excellent option for facilities wishing to make the transition from conventional Film/Screen to digital imaging. This is especially true for those with a low to moderate workload.

Next PART 3: CCD DR