After completing this article, the reader should be able to:
- Describe the various biopsy types that require specimen imaging.
- List methods of guiding biopsy procedures.
- Explain the reasons behind specimen imaging.
- Describe various methods for imaging specimens.

Best Practices in Digital Radiography

Best Practices in Digital Radiography


The amount of radiation Americans are exposed to as a result of diagnostic medical imaging increased about sixfold from 1980 to 2006, and for the first time in history, estimates of medical radiation exposure nearly equaled those for background radiation. The reasons for the increase were varied, and the highest percentage of collective dose (taking into account the effective dose and the size of the exposed population) easily was explained by the corresponding increase in computed tomography (CT) and nuclear medicine scanning over the same time period. All the same, the total number of medical imaging studies rose dramatically, and radiography was no exception. The number of radiographic and fluoroscopic studies skyrocketed from 25 million in 1950 to 293 million in 2006.

As reports on medical imaging use have been released, the focus on cumulative dose from regulatory bodies, clinical societies and the public has intensified, leading to concerns about utilization of medical imaging. Historically, radiation exposure from diagnostic medical imaging was not considered a problem, and there was no evidence that exposure to low doses of ionizing radiation increased cancer risk. The benefits of radiography have remained clear over the more than 100 years of diagnostic medical imaging’s history. Another fact that has remained clear is the critical role that radiographers play in ensuring patient radiation safety during medical imaging procedures. Radiographers must adhere to the “as low as reasonably achievable” (ALARA) principle by keeping radiation dose as low as is reasonably achievable when performing digital radiography.

As radiographers have adjusted to the advent of digital radiography, they have had to refine exposure technique selection and pay closer attention to radiation protection. Newer digital technologies offer many benefits over film-screen technology, such as time savings, greater dynamic range, wider exposure latitude and postprocessing capabilities, plus advantages such as image manipulation that enable radiologists to adjust images at their workstations. As a result, there is a tendency to be less concerned about exposure technique and the opportunity to use more radiation than necessary, a trend that often is referred to as “dose creep.” Exposure techniques that radiographers can use to ensure that digital images are of optimal quality and minimal patient radiation dose differ from those used for film-screen imaging. Because digital imaging technology is relatively new and rapidly changing, radiographers’ skill levels vary, and resources often are scattered and even conflicting. Radiographers, and their patients, would benefit from a single source that offers background information, best practices and recommendations on optimizing digital radiography and patient radiation safety.

Digital Radiography Background

The first form of digital imaging, digital subtraction angiography, was introduced in 1977 and put to clinical use in 1980. Today, the term digital radiography is used...
in the literature and in practice to include computed radiography and direct digital radiography. Computed radiography (CR), is a system that replaced film with a storage phosphor plate as the image receptor. The latent image on the exposed plate is scanned by a laser beam and converted to digital data to produce the image. Direct digital radiography (DR), which also might be further classified as direct and indirect image capture, involves acquiring image data in digital format, without laser scanning to extract the latent image.

In CR, storage phosphor image plates were first used to record general radiographs in 1980. The direct capture of x-rays for digital images was introduced with DR using of a charge-coupled device in 1990. The technology evolved and improved over the next decade and by 2001, flat-panel thin-film transistor detectors could expose and display images in near real time. Growth in digital image receptors has risen slowly and steadily, and within a few years could increase to double-digit annual rates. Today’s technology includes a variety of devices and materials such as storage phosphor plates, charge-coupled devices, thin-film transistors, photoconductors and x-ray scintillators. Cassette-based and cassette-less systems have blurred the lines between CR and DR.

An analysis by the technologies market research firm Technavio reported that the global digital radiography market could increase by a compound annual growth rate of 3.3 percent through 2014. The complexity of the operation of these systems has created misconceptions about the best practices for the use of digital radiography.

In general, radiography examinations represent 74 percent of all radiologic examinations performed on both adults and children in the United States, and contribute to about 40 percent of radiation exposure. Although much attention in recent years has focused on lowering CT dose in particular, the prevalence of radiographic examinations, exposure and a rise in transition to digital image receptor technology necessitates a thoughtful and thorough examination of best practices for radiographers regarding digital exposure techniques and radiation safety.

**Dose**

When following the ALARA principle, radiographers should minimize patient exposure from digital radiography procedures. The use of digital image receptors can result in lower radiation dose than the use of film-screen image receptors, without loss of image quality. Using digital image receptors requires careful and consistent attention to institutional protocol and practice standards, however. Conventional film-screen radiation exposure techniques are based on the specific film-screen system and the conditions under which the radiographer processes the film. Digital radiography separates acquisition, processing and display, which enables a radiographer to produce an image that has acceptable diagnostic quality, but could be underexposed or overexposed. Adjustments to compensate for exposure technique errors can be made at the time of display, although doing so is not a best practice. The best practice is to select the appropriate exposure technique factors for the patient’s size and condition, based on a planned exposure system designed in collaboration with radiologists, to determine adequate image quality for diagnosis.

Image quality depends heavily on contrast, or the relative differences in brightness or density in the image. Image contrast has two primary components, subject contrast and display contrast. Subject contrast is related to the absorption of the x-ray beam by the subject’s tissues. Display contrast can be adjusted in postprocessing and by adjusting the monitor display’s window width. Very low contrast (many shades of gray) makes it difficult for a radiologist to differentiate between structures and identify anomalies or pathologies; an image must have contrast to demonstrate different structures and to be diagnostically useful. Very high contrast reduces the image to a scale of mostly black-and-white brightness or densities, which hinders visibility of the anatomic details. In digital imaging, contrast is the ratio of brightness of adjacent structures to one another, and gray scale represents the range of brightness levels.

Subject contrast is determined by different absorption of the x-ray beam by various tissues, anatomic thicknesses and tissue densities in the body and the penetrability of the beam primarily controlled by kVp. Unlike image contrast, subject contrast cannot be manipulated or recovered with postprocessing; it is directly affected by how the x-ray beam is attenuated in anatomic tissues, such as bone and soft tissue.
In 2010, the U.S. Food and Drug Administration’s (FDA) Center for Devices and Radiological Health began an initiative to decrease unnecessary exposure from medical imaging procedures. As a result the FDA has supported the development of educational materials and a safety checklist for digital radiography via the Image Gently campaign. The FDA also has recommended that manufacturers design medical imaging equipment with pediatric populations in mind. Through education, research and reports in the literature and change in practice, culture change can occur. Much work still can be done to compel the culture and practice changes needed to ensure radiation safety and minimize patient dose in digital radiography.

ACR Practice Guideline for Digital Radiography

The ACR developed a practice guideline for digital radiography in 2007. The document’s intent was “to provide guidance and assistance in the understanding and clinical use of digital radiography equipment in order to deliver optimal image quality at appropriate radiation doses, and to ultimately provide excellent safety and care for patients undergoing digital radiography examinations.” In general, ACR practice guidelines for any examination or process undergo literature and field review, summary of expert opinion and informal consensus that results in recommended conduct. The guidelines are not intended to be legal standards of care; providers can use them as the basis for practice and modify them according to individual circumstances and resources.

The ACR guideline on digital radiography provides information lost in the gap between film-screen and digital imaging, and some of the key points of the guidelines are included in this paper. By clearly outlining information such as personnel qualifications, grid use, prevention of dose creep and determining proper exposure factors, the guidelines laid the groundwork for facility protocols and standardization of digital exposure technique. The ACR guidelines also compare film-screen and digital technologies, helping radiographers and other medical professionals better understand the nuances they face in working with digital imaging.