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Radiation Exposure in Computed Radiography

How Can Patients be Protected?

exposure and therefore is of international concern. Even the lowest amount of exposure to ionising radiation has some risk. According to Prasad et al. (2004), accurately determining radiation-induced cancer risk in humans is difficult due to biological variability, environment, and lifestyle related factors. Consensus has not been reached over the risk of low-level radiation exposure, though it is a legitimate concern. According to the most recent controversial report (No. 160) by the National Council on Radiation Protection and Measurements (NCRP), since 1980, there has been a seven-fold increase in public medical radiation exposure in the United States (US) (NCRP, 2009).

Creating Reference Values

Although the US has no current national standards regarding medical imaging exposure techniques, many organisations are involved in making recommendations and overseeing trends in patient radiation exposures.

The US Food and Drug Administration's (FDA) Center for Devices and Radiological Health (CDRH) is responsible for ensuring the safety and effectiveness of medical devices and eliminating unnecessary human exposure to man-made radiation from medical, occupational and consumer products. The CDRH's Nationwide Evaluation of X-ray Trends (NEXT) survey programme selects a particular radiological examination for study and captures radiation exposure data from a nationally representative sample of US clinical facilities. As a result of these surveys, reference exposure values are being developed for routine diagnostic exams.

The American Association of Physicists in Medicine (AAPM), the American College of Radiology (ACR) and the American Society of Radiologic Technologists (ASRT), are professional societies concerned with ionising radiation patient exposure and are founding members of the Alliance for Radiation Safety in Paediatric Imaging, a coalition of healthcare organisations dedicated to providing safe, highquality paediatric imaging nationwide.

The Role of CR in Radiation Exposure

Although digital imaging has been shown to reduce the number of repeat images, according to Willis (2004), the amount of radiation needed to produce a computed radiography (CR) image of similar quality to film-screen is higher. Additionally, Vano et al. (2002) believe that radiographers have realised that increasing the quantity of radiation reaching the image receptor leads to improved CR image quality. This, in turn, has raised concern in the industry of the need to better educate radiographers, radiologists, and physicians on the potential for increased radiation exposure to patients with CR.

This led to a study to evaluate the effect of a wide range of exposure techniques on the overall quality of the CR image. The research study used an experimental design to investigate the effect of varying the quantity of radiation exposure (mAs) on CR image quality. A Fuji FCR 1 Shot QC Phantom was exposed to mAs values ranging from 1 to 125. Five CR imaging plates were exposed, processed, and printed for each exposure group. Image quality was evaluated by measuring the optical density, low and high-density differences, and the number of line pairs visualised.

The findings indicate that variability in radiation exposure to the CR imaging plate does not adversely affect the quality of the digital image. Optical density and low-density differences were stable throughout the wide range of exposures. Consistent with Don (2004) regarding digital exposure latitude, the optical density was stable over radiation exposures that range from 300% lower to 400% higher than the optimal baseline mAs exposure. Radiographic contrast appeared to decrease slightly for the high-density differences when exposed to higher-than-needed exposures and resolution appeared to be compromised at extreme low radiation exposures as a result of quantum mottle (Fauber, 2009). This study confirms that excessive over-exposure to the CR imaging plate can produce quality images.

Strategies for Reducing Patient Radiation Exposure

Because of wide exposure latitude capabilities in digital imaging, a common practice known as exposure factor creep (Warren-Forward, et al., 2007; Willis, 2004) has become an international area of concern. The use of higher kilovoltage (kVp) techniques along with lower mAs values will notably decrease patient organ dose. However, in filmscreen imaging, the choice of kVp is limited due to the need for an appropriate scale of contrast. Warren-Forward et al. (2007) believe the impact of kVp on image contrast has become less of a concern in digital imaging due to the ability of the computer to process the digital image and alter the visibility of anatomic structures. When producing digital images, using a higher kVp and lower mAs technique appears to be warranted.

Automatic Exposure Control (AEC) devices have long been utilised in film-screen imaging and should equally be used in digital imaging. Because the AEC device terminates the exposure time once a predetermined amount of radiation exposure has been reached, it should limit the patient's dose to a reasonable amount of radiation exposure. Radiographers must accurately and consistently use AEC devices in an effort to limit the amount of patient radiation exposure. Additionally, radiographers need to critically evaluate the appropriateness of anatomically preprogrammed radiographic exposure techniques.

There is also a renewed interest in utilising technique charts for digital imaging. Because overexposure errors are not easily detected in digital imaging, techniques charts provide a reference that will produce acceptable quality images. Techniques charts should be experimentally developed, clinically tested, and revised for each x-ray tube.

Given that digital images don't provide the same visual cues as film-screen imaging, over- or underexposure may not be apparent. Each manufacturer provides an exposure indicator value that is helpful in determining the level of exposure to the image receptor.

Radiographers need to consistently evaluate this numerical value as an indication of the amount of radiation exposure to the patient. Because of variability in the manufacturer's description of the indicator value, the AAPM is calling for a standardised exposure indicator so radiographers can more easily recognise the indicator and its relationship to the amount of radiation exposure to the image receptor. In addition to the need for radiographers to limit the radiation dose to their patients, other practitioners are calling for guidelines to limit the number of high-quality images. Vano (2005) believes that reducing exposure technique in cases where the exam doesn't require a high level of image quality, such as routine follow-up exams, can result in a decrease to overall patient exposure.

Management's Role

Managers in radiology have an important role in limiting patient radiation exposures. High standards must be departmentally agreed on and communicated to imaging staff. The environment must respect the independence of the radiographer in selecting radiation exposure techniques along with the expectation that those departmental standards will be met. This can be accomplished, in part, through continuing education activities. Additionally, the performance of the imaging equipment must not be overlooked. A good quality control (QC) programme must be implemented to detect potential equipment malfunction. Several simple and noninvasive QC tests can easily be performed by the radiographer to isolate equipment error that may ultimately affect patient radiation exposures.

References are available on request to the Managing Editor: editorial@imagingmanagement.org

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