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Impacts of Filtration on Contrast-Detail Detectability of an X-ray Imaging System

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Abstract

The purpose of this study is to investigate the impacts of added filtration on the contrast-detail detectability of a digital X-ray imaging system for small animal studies. A digital X-ray imaging system specifically designed for small animal studies was used. This system is equipped with a micro X-ray source with a tungsten target and a beryllium window filtration and a CCD-based digital detector. Molybdenum filters of 0 mm, 0.02 mm, and 0.05 mm in thickness were added. The corresponding X-ray spectra and contrast-detail detectabilities were measured using two phantoms of different thicknesses simulating breast tissue under different exposures. The added Mo filters reduced the low-energy as well as the high-energy photons, hence providing a narrowband for imaging quality improvement. In the experiments with a 1.15 cm phantom, the optimal image detectability was observed using 22 kVp and the 0.05 mm Mo filter. With the 2.15 cm phantom, the best detectability was obtained with 22 kVp and the 0.02 mm Mo filter. Our experiments showed that appropriate filtrations could reduce certain low- and high-energy components of X-ray spectra which have limited contributions to image contrast. At the same time, such filtration could improve the contrast-detail detectability, particularly at relatively low kVp and high filtration. Therefore, optimal image quality can be obtained with the same absorbed radiation dose by the subjects when appropriate filtration is used.