Contrast Imaging and Image Quantification With the Monochromatic CT - MECT *	X17B2

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One of the advantages of monochromatic x-ray beams for computed tomography (CT) is in imaging with contrast agents, where the monochromatic beam energy can be tuned just above the K-edge of the contrast element. Comparative iodine phantom studies between Multiple Energy Computed Tomography [MECT] at X17B2 and a conventional CT [CCT] showed that 33.3-keV MECT has a 3-fold advantage in iodine image contrast over 120-kVp CCT. However, iodine's K-edge is too low an energy for the CT of human body, except for the neck and the limbs. The present studies show that such an advantage exists also for Gd as a contrast agent.

An 18-cm diameter acrylic phantom with thirty 11-mm diameter channels filled with Gd solutions from 0 to 1600μg Gd/ml was imaged with MECT at 50.34 keV and with CCT at 120 kVp. For the 1600 μg Gd/ml channels, MECT yields 138 HU while CCT only gives 64 HU. The noise ratio of MECT (50.34keV) to CCT(120kVp) is 1.4HU:1.9HU, as obtained from computer simulations. These simulations used the experimental MECT system parameters for both MECT and CCT (i.e., 3 rad surface absorbed dose, 3 mm beam height, 0.922 mm detector pitch, and 0.25 mm detector-element dead space). Defining "constrast-to-noise ratio" (CNR) as the figure of merit for judging CT image quality, we find from the above-mentioned results a $\sim$3-fold CNR advantage for MECT compared to CCT.

The Gd image contrast for the above measurements was accurate within the limits of the solution's concentration accuracy. For CCT, however, such a quantification requires the knowledge of the effective beam energy throughout the image. Our computer simulations with an 18-cm water phantom that included small bone inserts as image-contrast indicators exhibited an average of 2.5 keV beam hardening for a 120-kVp CCT, despite the 1st-order beam hardening corrections (i.e., Cupping corrections). The simulations also show that the difference between the bone image contrast at the phantom's center and at its edge is 20 HU (typical noise was 2-3 HU). This corresponds to a 0.5 keV differential beam hardening. These results indicate the potential value of MECT in contrast imaging and in image quantification.

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