AbstractID: 9652 Title: Validation of CT Dose-reduction Simulation

Purpose:

To develop and validate a CT dose reduction simulation model

Method and Materials:

A noise model was developed incorporating the mechanisms of stochastic noise in energy-integrating x-ray detectors, tube current modulation, bowtie beam filtering, and electronic system noise by adding synthetic noise to projection data (sinogram). Experiments were performed to determine the parameters required for the noise model, and the effects of various components were studied. Various scans were performed on an empty gantry, cylinder phantom, cadaver head, and a skull (an asymmetric object) at varyious flux levels. Seventeen clinical scans from three different centers were included. As a validation, the outputs of the simulations were compared to actual measurements in both the sinogram and image domain. Four-alternative forced-choice (4AFC) observer studies were performed to confirm the realistic appearance of simulated images. Tests were conducted to establish the “just noticeable difference (JND)” in noise levels, and the sensitivities of observers to changes in noise levels were determined.

Results:

The gaussian random noise generator was found to be appropriate for simulations. Measurements demonstrated a match of the noise variance to within 5% in the sinogram domain, which propagates into the image domain. The 4AFC observer studies indicated that the simulated imagery was realistic, with no detectable difference between simulated and original imagery (25%±7.9%). The JND studies indicated that observers reliably detected noise-levels differences corresponding to 20-30% changes in tube current, implying that accuracies in simulation on the order of ~9% would result in images that could not be reliably differentiated from original images.

Conclusion:

The dose-reduction simulation tool demonstrated excellent image fidelity. The methodology promises to be a useful tool for radiologists to explore dose reduction protocols in efforts to produce diagnostic images with radiation dose “as low as reasonably achievable” (ALARA).

Conflict of Interest (only if applicable): None