CHARACTERIZATION AND CONTROL OF SCATTERED RADIATION IN ABSORPTION EDGE FLUOROSCOPY

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Absorption Edge Fluoroscopy (AEF) is a technique developed at the University of Wisconsin for enhancing the image perceptibility of small quantities of radiographic contrast materials containing iodine or xenon. Enhancement is achieved through subtraction of electronically stored images produced by specially filtered x-ray beams whose energies bracket the K-absorption edge of the contrast medium. Radiation beams generated with three combinations of x-ray tube voltage and filter material (45 kVp, Iodine; 50 kVp, Cerium; 55 kVp, brass) are used to produce three images. These are then employed in a differencing process which produces a single image in which the iodine or xenon component is enhanced and soft tissue and bone contributions are suppressed.

Scattered radiation results in degradation of the images produced by each of the AEF beams, as well as in the resultant subtraction image. Because of the paucity of published data concerning the scatter associated with the use of low energy x-rays for tissue-equivalent phantoms up to 20 cm in thickness, a study was performed employing the three AEF beams. The angular distributions and energy spectra of scatter from 9.8 cm and 14.5 cm thick blocks of Lucite were measured using a spectrometer with an intrinsic germanium detector rotated around the exit surface of the phantom. In addition, scatter intensity produced by irradiation of polystyrene phantoms ranging in thickness from 5 to 25 cm was determined from integration of energy spectra measured with a NaI(Tl) scintillation spectrometer. The energy scatter fractions (fraction of total intensity which is scatter) increased by up to 50% for x-ray fields from 5.3 x 5.3 cm to 16.2 x 16.2 cm, and from 0.26 to 0.78 over the range of phantom thickness, but exhibited little energy dependence for the average primary energies of 29 kev (Iodine-filtered beam), 35 keV (Cerium-filtered beam) and 46 keV (brass-filtered beam). Average energies of the scatter distributions ranged from 2 to 8 keV less than the energies of the transmitted primary beams.

A group of antiscatter grids was evaluated to determine the feasibility of utilizing this method of scatter control in AEF. Nine grids with ratios from 5 to 12 and interspacer materials of fiber and aluminum were tested under the same exposure conditions used to measure scatter with the polystyrene phantom. Parameters of grid performance calculated from the measured spectra included the primary transmission, the scatter transmission, the Bucky factor, the selectivity, and the contrast improvement factor. Based upon these calculations, it was determined that: (1) A single grid could be used with all three AEF beams; (2) Fiber-interspaced grids were slightly superior to aluminum-interspaced grids because of their higher primary transmission for the low energy photons; and (3) For phantoms greater than 15 cm in thickness, use of a 12 ratio grid was indicated, while for smaller thicknesses, a grid of ratio 8 would suffice.

Sample calculations and measurements of the impact of scatter on AEF images without and with a grid present were performed. Possible directions for future investigations into the characteristics of scatter resulting from the use of low energy x-rays were suggested.