MULTIPLE-ENERGY TISSUE-CANCELLATION APPLICATIONS OF A DIGITAL BEAM ATTENUATOR TO CHEST RADIOGRAPHY (SUBTRACTION ANGIOGRAPHY)

JAMES TALMAGE DOBBINS III

The superposition of anatomical structures in projection radiography presents both physical and perceptual problems in medical imaging and diagnostic decision-making. Physical image degradation from excessive dynamic range and perceptual degradation from reduced object conspicuity are typical problems, particularly in radiography of the human chest. Two techniques combining multiple-energy imaging with a digitally-formed primary beam attenuator (DBA) are investigated in this dissertation to address these problems, with application to chest radiography.

The DBA spatially modulates the x-ray fluence incident upon the patient to selectively attenuate regions of interest. The DBA attenuating mask is constructed from CeO(,2) powder by a modified printing technique and uses image information from an initial low-dose exposure. Corrections for detector field non-uniformity, scattered radiation, beam hardening from the patient and mask, and printing transfer error were necessary to accurately prepare the mask.

Two tissue-cancellation imaging techniques are investigated with the DBA: (1) energy-dependent information is used to form a beam attenuator that attenuates specific tissues in the primary x-ray beam for tissue-cancelled film radiography; (2) the beam attenuator is used to improve image signal-to-noise and scattered radiation properties in traditional energy-subtraction tissue-cancellation imaging with digital detectors.

The tissue-cancellation techniques in the primary x-ray beam were capable of adequately removing either soft-tissue or bone from the final compensated film radiograph when using a phantom with well defined soft-tissue and bone sections. However, when tried on an anthropomorphic chest phantom the results were adequate for cancellation of large soft-tissue structures, but unsatisfactory for cancellation of bony structures such as the ribs, because of the limited spatial frequency content of the attenuating mask.

The second technique (with digital detectors) showed improved uniformity of image signal-to-noise and a two-fold increase in soft-tissue nodule contrast due to improved scattered radiation properties. The tissue-cancelled images contained residual image contributions from the presence of the attenuating mask, but this residual may be correctable by future algorithms.