《招待講演 1 》

SPECT: Recent Advancements in Instrumentation and Image Reconstruction

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The introduction of appropriate detectors, new radiopharmaceuticals, and improved reconstruction strategies, coupled with rapid advancements in the areas of computers and electronics have made single photon emission computed tomography (SPECT) an important imaging modality in unclear medicine. SPECT provides true 3-D or total organ imaging and is capable of eliminating overlying and underlying source activities.

The goal of SPECT is to determine the relative or absolute regional concentrations of radionuclides as a function of time, and a number of factors affect the quality and quantitative accuracy of the SPECT image. These factors include system resolution and sensitivity, and the physical and biokinetic properties of the radiopharmaceutical that was used for the study. The trade-offs associated with these characteristics may lead to difficulty in acquiring sufficient counts within clinically acceptable imaging times. Other important factors include attenuation and detection of scattered gamma rays, change in collimator response with distance, patient and/or organ motion, center-of-rotation calibration, and compensation for flood non-uniformities.

Recent trends in SPECT instrumentation have included the development of methods to improve sensitivity while maintaining adequate spatial resolution. Converging beam geometries (such as fan beam, cone beam and astigmatic collimation) and system designs that incorporate larger active detector areas (for example, dual and triple large field-of-view, scintillation cameras and special ring geometries) are increasingly being used. Even multi-scan, whole-torso SPECT imaging is being evaluated.

To improve SPECT imaging of the heart, methods to compensate for non-uniform attenuation are actively being investigated by several groups throughout the world. These approaches generally require the acquisition of a gamma ray transmission scan to determine a map of the linear attenuation coefficients. This map is then used with an appropriate reconstruction algorithm which compensates for non-uniform attenuation within the SPECT image. Similarly, several methods are being developed to compensate for detected scattered photons.

Recent trends in SPECT image reconstruction have included the investigation of iterative methods that more accurately model the physical acquisition process and account for the statistical nature of the emission process. These methods include Maximum Likelihood-Expectation Maximization (ML-EM) algorithms and Bayesian reconstruction approaches. The Bayesian methods can use *a priori* source information obtained (for example, from MRI or X-ray CT) to further improve the SPECT reconstruction.

Iterative algorithms start with an initial guess for the source distribution. Calculated projections are compared with the measured projections, and then a correction is applied to the previously estimated source distribution. This process is iteratively repeated until a source estimate is obtained that satisfies a certain preselected criterion. Since iterative approaches are computationally intense, methods need to be developed to accelerate the rate of convergence, and practical rules must be established to determine when the iteration process should be stopped.

SPECT imaging provides a new three-dimensional perspective when registered with images from other modalities such as MRI and X-ray CT. It is anticipated that new developments in instrumentation, reconstruction algorithms, 3-D display, and radiopharmaceuticals will result in the increased use of SPECT to non-invasively measure important physiologic and pathologic processes.