No. 322

APPLICATION OF FAST CONJUGATE GRADIENT RECONSTRUCTION ALGORITHMS FOR ATTENUATION COMPENSATION IN CARDIAC SPECT. D.S. Lalush and B.M.W. Tsui. The University of North Carolina at Chapel Hill, Chapel Hill, NC.

We study the effectiveness of using fast conjugate gradient (CG) algorithms for simultaneous reconstruction and attenuation compensation of cardiac SPECT patient studies. Simulations have shown that the ML-EM algorithm provides excellent quantitative accuracy in cardiac phantoms, but requires at least 50 iterations. To reduce processing time to clinically usable levels, we apply weighted least-squares (WLS) and maximum *a posteriori* (MAP) CG reconstruction algorithms. We compare the reconstructions from SPECT studies of ten patients using ML-EM, WLS-CG, and MAP-CG. The patients underwent Tc-99m transmission SPECT studies to obtain an attenuation map. Then, Tl-201 stress and redistribution studies were taken for each patient. The emission data were reconstructed incorporating the nonuniform attenuation map in the projection model using ML-EM, WLS-CG, and MAP-CG with a simple smoothing prior. The reconstructions were followed with smoothing filters. The CG images at various iteration numbers were evaluated against the ML-EM images at 50 iterations. (The filtered images remain essentially unchanged for ML-EM iteration numbers over 50.) Evaluations were made in terms of the mean-squared error in the short axis views of the heart and the bull's-eye plots, since these are the tools used by physicians to evaluate cardiac SPECT images. We found that five iterations of the CG methods produce images that are quantitatively very close to fifty iterations of ML-EM. We also noted that, despite the post-processing filters, the noise-suppressing properties of the MAP-CG algorithm caused its reconstructions to be considerably closer to the results of ML-EM than reconstructions using the noisier WLS-CG algorithm. We conclude that MAP-CG with a simple smoothing prior produces cardiac SPECT reconstructions with short-axis and bull's-eye nearly identical to those using ML-EM with post-filtering and requiring one-tenth the number of iterations of ML-EM, and that MAP-CG provides an attenuation-compensation reconstruction technique which is accurate and fast enough for regular clinical use.

No. 323

AN APPROACH FOR REDUCTION OF ATTENUATION ARTIFACTS FROM USING THE EMISSION DATA IN SPECT TL-201 CARDIAC PERFUSION IMAGING. T.-S. Pan, D.W. Seldin, S.T. Dahlberg, and M.A. King, University of Massachusetts Medical Center, Worcester, MA and Lahey Clinic Medical Center, Burlington, MA.

Non-uniform attenuation of photons coming from the myocardium can create difficulties in interpreting SPECT TL-201 myocardial perfusion scans, especially in the inferior wall of the heart. While combined transmission and emission imaging can overcome this problem, most systems in clinical use do not have this capability. We are investigating the use of emission data to create attenuation maps to reduce tissue attenuation artifacts. In addition to photons in the photopeak window, our approach requires the acquisition of photons in a Compton scatter energy window centered at 53 keV and 25% wide. The body and lung regions can be estimated primarily from the Compton scatter data, in which the cold lung regions can be identified. The estimation of lung regions near the heart can be refined by using the photopeak data. We have developed a program which allows the user to interactively outline the regions of the body and lungs. The labeled lung regions and other soft tissue region are assigned attenuation coefficients to construct attenuation maps for the attenuation compensation. Based on our preliminary data, the method is able to reduce the tissue attenuation artifacts. Comparison of this method with correction based on transmission imaging seems warranted to determine its accuracy.

No. 324

ATTENUATION CORRECTION IN CARDIAC SPECT WITHOUT A TRANSMISSION SOURCE. J. W. Wallis, T. R. Miller, and P. L. Koppel, Washington University School of Medicine, St. Louis, MO.

The accuracy of SPECT cardiac perfusion imaging is impaired by artifacts induced by non-uniform gamma-ray attenuation. This study proposes a method to estimate attenuation in the chest without the additional hardware and expense of transmission imaging. The method was evaluated in phantoms and patient studies.

After the standard Tl-201 or Tc-99m sestamibi delayed images were obtained, Tc-99m macroaggregated albumin (MAA) was injected and dual energy SPECT acquisition was performed with windows centered at 140 keV and 94 keV. Lung contours were obtained by thresholding the on-peak (140 keV) reconstructions. Outer body contours were defined from images produced by reconstruction of the lower energy "scatter" window obtained simultaneously at the time of the lung (MAA) imaging. Following assignment of standard attenuation values to the lung and non-lung (soft tissue) regions, attenuation correction was achieved by means of a modified iterative Chang algorithm. The results were quantitatively evaluated by imaging of a cardiac phantom filled with uniform activity placed in a chest phantom.

Images of the phantom demonstrated substantially more uniform myocardial activity following attenuation correction when compared to uncorrected images. Although this method involves the use of an estimated lung attenuation coefficient (μ), variation of μ within the expected range of lung attenuation values resulted in little change in the reconstructions. Variation in the lung sizes due to choice of threshold values also had little effect on the reconstructions. Sensitivity to attenuation map registration error was also assessed; a 1.3 cm error had little effect, while 2.5–4.0 cm errors were significant. Application of this technique in patients imaged with both Tl-201 and Tc-99m sestamibi resulted in improvement in artifactually decreased inferior wall activity without adversely affecting the other walls.

Thus, this simple method corrects for non-uniform attenuation and compares favorably with published transmission-based techniques.

No. 325

MONTE-CARLO STUDY OF CIRCUMFERENTIAL VARIATIONS IN CORTEX ACTIVITY IN I-123 SPECT. J.Q. Luo[1], K.F. Koral[1], M. Ljungberg[2], J.A. Fessler[1], R.A. Koeppe[1], and D.E. Kuhl[1]. University of Michigan, Ann Arbor, MI[1], and Lund University, Lund Sweden[2].

This study investigates whether Compton scatter of gammas from hot striata can cause circumferential variations in activity concentration within the cortex of human-brain tomograms. Coarse count-density variation for the cortex has been observed clinically at 4 and 22hr in the case of SPECT imaging of the tracer (-)-5-[I-123] iodobenzovesamicol [IBVM], an in-vivo marker of cholinergic neurons. Reconstruction is by filtered back projection with first-order Chang attenuation correction (FBPC). Herein, a simplified brain model which consists of an elliptical cylinder containing a highly attenuating skull at its edge and water-density structures is the source of Monte-Carlo-simulated data. The structures (with relative activity concentration given in parenthesis) are an elliptical-annulus-cross-sectioned cylinder for the cortex (4), white matter (1) within and 5 spheres which simulate the caudate nuclei (25), the putamen (25) and the thalamus (12). The simulation tags the scattered gamma rays that are detected within the 20% photopeak window to separate them from the unscattered 159 keV gammas. The attenuation map used in reconstruction exactly fits the distribution of attenuation coefficient employed in the simulation. Algorithms are FBPC and maximum likelihood (ML). Both neglect camera-system resolution.

Clinically, the count density in the temporal cortex (side of brain) is 20 to 40% larger than in the frontal cortex or the occipital cortex. The reconstructions of Monte-Carlo data show little variation whether scattered counts are included or not. ML and FBPC give almost the same region-averaged values. (There is a 6% decrease from front to back with finite-resolution data but this asymmetry almost disappears with perfect-resolution data which matches the reconstruction algorithms.) We conclude that Compton-scattering effects do not distort coarse cortex circumferential profiles.

Radiopharmaceutical Chemistry: Positrons III

1:30–3:00 **Session 54** **Room: 20E-G**

Moderator: Paul Jerabek, PhD
Comoderator: Jerry Nickles, PhD

No. 326

AL_2O_3/KF IN RADIOCHEMISTRY: FAST PREPARATION OF L-[11C-METHYL]METHIONINE WITHOUT HPLC.
F. Schmitz, A. Plenevaux, G. DelFiore, C. Lemaire, D. Comar, A. Luxen. Cyclotron Research Center, Liège University, B.4000 Liège, Belgium.

L-[11C-methyl]methionine is one of the most widely used amino acid for PET oncology. Numerous syntheses were reported for it and