1997

attenuation correction, relative to nonuniform attenuation correction achieved with transmission imaging. The spatial distribution of errors in the brain was obtained from attenuation correction factors computed from uniform and nonuniform attenuation maps, and was visualised on a pixel-by-pixel basis as an error image. It was shown that the nonhomogeneity of the head is significant enough to produce an error of, e.g., 12% in the midbrain and 5% in the striatum if uniform attenuation correction is used instead of applying the nonuniform attenuation correction. This has significant impact in SPECT imaging of dopamine systems using [I-123]β-CIT. The transmission and emission data collected on PD and normal human subjects are presently being analysed.

No. 910

EVALUATION OF SMALL 2D CONVOLUTION KERNELS FOR SLICE-BY-SLICE BLURRING MODEL USED TO CORRECT THE GEOMETRIC POINT RESPONSE BLURRING IN 511 keV SPECT. C. Bai, G.L. Zeng, G.T. Gullberg. The University of Utah, Salt Lake City, UT.

An iterative ML-EM reconstruction algorithm with a projector that models the spatially varying geometric response of the collimator is used to improve the reconstructed resolution of 511 keV single photon emission computed tomography (SPECT). An important aspect of the implementation is the development of an efficient model by using an incremental blurring technique with small kernels. For each projection angle, the blurring is accomplished by first rotating the image volume so that the face of the volume is parallel to the detector plane. In forming the projections from back to front, each coronal slice is convolved with a small, depth-dependent 2D kernel, and is added to the next slice, which is closer to the detector. This paper concentrates on a method developed to calculate the 2D convolution kernels. Measurements of point source responses were obtained at different distances from the face of a 511 keV collimator mounted on a Picker PRISM 3000 scanner. The measurements first were fit to an expression of the FWHM as a linear function of distance, assuming a Gaussian geometric response. The small 2D kernels were then determined as an analytical function of distance by least squares, fitting so that the point response function (a Gaussian with the estimated FWHM) at a particular distance (when convolved with the distance-dependent blurring kernel) obtains the point spread function for the next slice one slice-thickness closer to the detector. The resultant depth dependent 2D kernels gave a point spread function very close to the measured one. Their application in the incremental blurring model significantly improved the resolution of and computation time in 511 keV SPECT.

No. 911

STATISTICAL ALGORITHMS FOR RECONSTRUCTING CARDIAC ATTENUATION MAPS FROM SIMULTANEOUS TRANSMISSION-EMISSION SPECT SYSTEMS. EP Ficaro and JA Fessler. Univ of Michigan, Ann Arbor, MI.

We hypothesize that while iterative reconstruction algorithms are essential for truncated sinogram data, these algorithms can also significantly reduce the error in reconstructed attenuation maps and the subsequent attenuation corrected (AC) emission images compared to filtered backprojection (FBP) for short transmission scans with crosstalk contamination. To test this hypothesis, penalized (quadratic) weighted least squares (PWLS) and a penalized (non-quadratic) likelihood grouped coordinate ascent (GCA) algorithm will be compared with FBP from truncated (Tr) *and* untruncated (NoTr) transmission data with emission crosstalk contamination.

Using a digital cardiac phantom, transmission simulations were performed for transmission sinogram rates equivalent to 22min and 5min transmission scans with a 2.2GBq Gd-153 source. Emission-to-transmission crosstalk was estimated for a typical Tc-99m sestamibi distribution in the torso with a spillover fraction of 0.52. Two independent crosstalk sinogram sets were computed with Poisson noise, one being added directly to the noisy transmission sinogram. For FBP, the second crosstalk sinogram was subtracted from the transmission sinogram, while the PWLS and GCA algorithms used the second crosstalk sinogram in their objective functions. Attenuation maps were reconstructed using FBP, PWLS(16 iters) and GCA (20 iters). Root mean-square error (RMSE) was computed over the entire reconstructed map. For the NoTr-(5min) scans, RMSE values were 0.12, 0.06 ($p<.05$), and 0.03 ($p<.05$) for FBP, PWLS, GCA, respectively. For the Tr-(5min) scan, RMSE values were 0.08 and 0.05 for ICD and GCA (p=NS). AC emission images were reconstructed using noise free attenuated emission sinograms and the reconstructed attenuation maps from the 3 algorithms. Mean heart activity (normalized to 100) and %RMSE values are tabulated for 10 transmission realizations. From these results, GCA significantly

	NoTr-(22min)	NoTr-(5min)	Tr-(22min)	Tr-(5min)
FBP	100 (7%)	111 (18%)	-	-
PWLS	98 (7%)	92* (12%)	98 (6%)	92 (12%)
GCA	98 (6%)	98* (7%)	98 (6%)	98* (7%)

(*$p<0.05$) reduced the bias and RMSE for the NoTr-(5 min) case, but also outperformed ICD for the Tr-(5 min) case due to more accurate modeling of the statistical transmission process including crosstalk. While the GCA algorithm is more cpu intensive than PWLS (1.5 min vs 0.7 min for typical cardiac study), its clinical use could potentially reduce normal distribution variability permitting tighter abnormality thresholds for defect detection. Diagnostic clinical evaluation for CAD is in progress.

No. 912

A QUALITY CONTROL PROTOCOL FOR TRANSMISSION-EMISSION TOMOGRAPHIC SYSTEMS. EP Ficaro and AJ Harris. University of Michigan Medical Center, Ann Arbor, MI.

Several quality control procedures exist for evaluating the performance (resolution, uniformity, contrast) of SPECT systems. With the routine clinical use of transmission/emission systems, we developed a protocol for routine quality assurance of our attenuation correction tomographic systems based on transmission resolution, the precision and uniformity of reconstructed attenuation maps and the uniformity of attenuation corrected (AC) emission images. While the parameters were determined for a PRISM XP3000 system with a 5.5Gbq Am-241 transmission source with a fanbeam collimator (focus=65cm), the protocol can be adapted to any geometry and transmission source. To measure uniformity and transmission resolution in a single measurement, a cold rod insert (Data Spectrum, NC) was attached to the bottom of a 20cm od. cylindrical tank filled with water and 185MBq Tc-99m. The emission activity was determined such that the crosstalk-to-transmission (C/T) ratio at the projection midline of the cylinder was less than 1.0 (global ratio was 0.11). Transmission and emission (LEHRP collimators) projection data were acquired in 128x128 matrices for 120 angles over 360° for a total time of 24 minutes. Sinogram events were 230K and 450k for transmission and emission sinograms for the cylinder. A 30 minute (120M) blank scan was also acquired. Crosstalk was removed from the transmission data prior to reconstruction. To evaluate resolution, the cold rods were reconstructed using FBP (ramp filter, f=0.5) onto a 128 matrix with a 3.56mm pixel size. Only the 4.8mm rods were not clearly resolvable; all rods ≥6.4mm were resolvable. To increase the statistical accuracy of the uniformity measurements, 7.1cm thick transmission and emission sinograms were reconstructed onto a 64x64 matrix with a pixel size of 7.12mm. The FBP attenuation maps had a mean attenuation value of (0.204±1.5%)/cm (expected 0.206/cm for 60 keV photons). The integral uniformity was 12%. The AC emission images were reconstructed with a statistical iterative algorithm and had an regional image variance of 4% and an integral uniformity of 16%. To estimate the measurement variance, the phantom was acquired 5 times and processed. The measured variance was 0.002/cm for the attenuation value and a variance/mean ratio of 6% for the emission image. Based on the stability of these last measures, the cylinder mean values could be used to determine errors due to blanks scale factors, crosstalk measurements, source-detector collimator alignment and could also be used to determine the useful lifetime of the transmission source. The cold rods also serve as a sensitive measure for artifacts resulting from source-detector misalignment.

No. 913

QUANTIFICATION OF BRAIN PERFUSION SPET MAPS WITH DIFFERENT DENOMINATORS - A COMPARATIVE STUDY. D.C. Costa, J.M.P. Oliveira, P.D. Acton. UCL Medical School, London, UK.

The performance of several reference structures (denominators) in the calculation of brain perfusion ratios with Single Photon Emission Tomography (SPET), was investigated in 40 Ceretec™ SPET studies from our database. The studies were chosen according to 4 different diagnostic groups and previous SPET findings, as follows: normal volunteers (**C**; n=10; 23 to 84 years old), temporal lobe epilepsy (**TLE**; n=10; 19 to 39 years old), myalgic encephalomyelitis/Chronic Fatigue Syndrome (**ME/CFS**; n=10; 22 to 61 years old) and major depression (**D**; n=10; 24 to 68 years old).

Data processing was according to routine protocols. Data analysis followed routine methodology (squared ROIs sampling 2.05 cc of brain), was blind to group classification, and ratios used the following references: hemicerebellum with maximum higher counts per pixel (**Cer**), visual cortex (**VC**), basal ganglia (**BG**), white matter (**WM**), total acquired counts (**TAC**), total reconstructed counts (**TRC**) and maximum counts per pixel in the study (**Max**). Unpaired student's t test (comparison between different diagnostic groups), coefficient of variation (CV) to assess the reliability of each reference, followed by ANOVA, were used for statistical analysis.

The lowest mean CV's were found in the **VC**=4.5%; **Cer**=4.8%, and **TRC**=5.1%. All the others were significantly higher ($p<0.0001$).