No. 905

QUANTITATIVE EFFECTS OF A COUNT RATE DEPENDENT WIENER FILTER ON IMAGE QUALITY: A BASAL GANGLIA PHANTOM STUDY SIMULATING [I-123] DYNAMIC SPECT IMAGING. H.J. Kim, J.S. Karp, H.F. Kung, P.D. Mozley. University of Pennsylvania, Philadelphia, PA.

The quality of the images that can be obtained with [I-123] labeled SPECT ligands can be limited by finite detector resolution, septal penetration, scatter, and poor counting statistics. A Wiener prefilter can dramatically enhance the image contrast. This study compared the effects of a count dependent Wiener pre-filter with the standard filtered back projection (FBP) on the image quantitation.

Using a triple headed SPECT system equipped with a set of low-energy high-resolution fan-beam collimators, a cylindrical phantom (19.5 x 19.0 cm) containing two small vials (1.4 x 4.5 cm) representing the basal ganglia was imaged with the same acquisition parameters that are used in a typical dynamic study of brain receptors in humans. Different concentrations of [I-123] between basal ganglia (BG) and background (BKGD) were filled to simulate the [I-123] dynamic SPECT imaging. When the Wiener prefilter was applied, the modulation transfer function (MTF) was computed from the measured line source response function obtained with an [I-123] line source placed at the center of another water filled cylinder (22.0 x 22.0 cm). The planar acquisition parameters for the line source were identical to the ones that were used to obtain the dynamic SPECT images of the BG phantom, except that a 256 x 256 matrix was used to measure the line source. The MTF contains degraded frequency components due to the finite detector resolution, septal penetration, and scatter. The Wiener prefilter improved the image concentration ratio more than the standard FBP did for most of the different concentration ratios between the BG vials and BKGD activity in the larger cylinder. For example, when the true concentration ratio was 8.7, the BG-to-BKGD concentration ratio on the Wiener pre-filtered image was 4.4. The concentration ratio on the standard Butterworth FBP image was only 3.4. The difference between the two techniques increased as the true concentration ratio increased.

These results indicate that the Wiener prefilter partially corrects for partial voluming, septal penetration, and scatter in the presence of realistic statistical noise. Although it still underestimates the true BG-to-BKGD ratio by >50%, the Wiener prefilter provides better quantitative SPECT receptor images in the human brain than standard FBP.

No. 906

DEVELOPMENT OF AND INITIAL RESULTS FROM A Xe-133 rCBF SYSTEM USING A TRIPLE-HEADED SPECT CAMERA. P. Suwondo, R.W. Walker, S. Barsamian, B.D. Kline, C.B. Lim, C. Fantanas, W.J. MacIntyre*, G.B. Saha*, R.T. Go*, M.F. D'Souza', J.R. Prince', J.J. Pahl' and E.W. Allen'. Trionix Research Laboratory, Twinsburg, OH; *Cleveland Clinic Foundation, Cleveland, OH and 'University of Oklahoma Health Sciences Center, Oklahoma City, OK.

A system with a triple-headed SPECT camera (Trionix TRIAD) was developed to allow total-volume quantitative measurements of regional cerebral blood flow (rCBF in ml/100 g/min) with Xe-133 inhalation.

An rCBF interface was designed to integrate the SPECT camera, a Xe-133 delivery system and an external gamma probe. The interface communicates directly with the host computer and synchronizes its operation with the camera. The gamma probe is used to record a lung time-activity curve at a sampling rate of 10 Hz. Automated delivery of Xe-133 is achieved through a remote-controlled self-contained delivery system. 20 mCi/L of Xe-133 was used in initial trials on healthy volunteers. Oxygen level was maintained at 21%. A custom-designed mouthpiece minimized the distance from COR to collimators to 132 mm. 2-min wash-in and 4.5-min wash-out studies were acquired at 10 sec/120° scans. Acquisition matrix was 64 X 64 (7.12 mm pixel size) and energy-window was centered at 81 keV with 20% width. High-sensitivity parallel-hole collimators were used. System sensitivity is 337 cpm/µCi and spatial resolution is 9.5 mm FWHM at 100 mm with Tc-99m. Brain data are time-integrated and 2-dimensionally filtered prior to reconstruction. Lung data are filtered (Hamming, 0.1 Hz cut-off) and time-shifted prior to deconvolution process. The processing algorithm is based on the method described by Celcis et al. [*J Comput Assist Tomogr* 1981;5:641-645] with some modifications.

Initial results show rCBF maps of the volunteers' entire brain volume in transaxial, coronal and sagittal planes. Basal ganglia were clearly demonstrated. rCBF values ranged 18-30 ml/100 g/min in white matter and 42-72 ml/100 g/min in gray matter using a xenon brain:blood partition coefficient of 0.85.

No. 907

THE VIEW FROM THE TOP: WHAT'S IT WORTH? W.L. Rogers, N.H. Clinthorne, J. Fessler, D. Chien, Y. Zhang, L. Hua, M. Usman† and A.O. Hero†. The Division of Nuclear Medicine and Bioengineering Program. †Electrical Engineering and Computer Science. The University of Michigan, Ann Arbor, MI.

A simultaneously acquired vertex view of the brain may be used to augment a standard SPECT data set and can be readily incorporated into a volume reconstruction algorithm. One can expect at least a 25% sensitivity increase compared to a 2π tomographic system with parallel slice collimation. One might also expect to reduce angular sampling requirements and improve the effective condition of the inverse problem. Such advantages will be offset by vertex view counts originating outside the brain, especially from regions unsampled by the SPECT system.

We have examined a small tomographic imaging system with and without vertex data by singular value decomposition. The cylindrical object space consists of up to 3 planes 16 pixels in diameter. Plane three contains the sum of all activity seen by the vertex detector not viewed by the tomographic system. The complete system response matrix, which includes attenuation, is composed of submatrices describing a ring detector system with a rotating slit aperture and parallel slice collimation and a vertex detector with parallel hole collimation.

The singular value spectrum for the ring system alone is a smooth curve dropping rapidly over the first 30 singular values then slowly to the cut off imposed by the circular field of view. Adding the vertex view causes a scale change related to the increased sensitivity and introduces a pronounced plateau followed by a sudden drop at a point corresponding to the dimension of the vertex projection image. The vertex image of the singular functions summed from the end of the plateau to the end of the spectrum is essentially zero. This suggests that these singular vectors correspond to the null space of the vertex view. The condition changes from 13.4 to 24.7 when the vertex view is included, because the singular function corresponding to the smallest singular value is in the null space of the vertex view.

Adding a vertex view causes two- and threefold increases in singular values over a limited range of the spectrum and a corresponding decrease in the system condition. The effect of these differences on image bias and variance must be determined by simulation and a study of lower bounds.

No. 908

A NON-UNIFORM ATTENUATION CORRECTION FOR QUANTITATIVE THORAX SPECT BASED ON LUNG EMISSION. T.G. Turkington, R.J. Jaszczak, D.R. Gilland, R.E. Coleman, Duke University Medical Center, Durham, NC

We have developed a method for non-uniform attenuation correction in the thorax for lung perfusion studies which may apply to other thorax studies where quantitation is desired. In this method, we define the lungs and outer contour from preliminary reconstructions, make a non-uniform attenuation map based on these features, and reconstruct again with corrections. To test the method, we used an elliptical thorax phantom with a Teflon spine and realistically-shaped lung inserts filled with Styrofoam beads and water to approximate lung density. We put 1 mCi Tc-99m in the lung water (0.64 µCi/ml), and an additional 40 µCi in a 21 ml sphere in the heart region. Non-radioactive water filled the rest of the phantom. The phantom was scanned for 30 minutes on a three-headed SPECT system, using a 20% photopeak window and a lower 35% scatter window. The photopeak projections were reconstructed with filtered backprojection, and the lung regions were defined for all slices with a 50% threshold. The outer contour was determined from the scatter data. The three-dimensional attenuation map was based on the outer contour and the measured lung locations, using μ=0.15/cm outside and μ=0.051/cm inside the lungs. The data were reconstructed again, with scatter subtraction (k=.5) and single-iteration Chang attenuation correction (I). Additional reconstructions were done with uniform correction (II) and no attenuation correction (III) for comparison. Activity measured in the sphere was 45 µCi (+13%), 60 µCi (+50%), and 6.7 µCi (-83%) for methods I, II, and III, and lung measurements averaged over 17 ROI's were 0.58 µCi/ml (-9%), 1.09 µCi/ml (+70%), and .22 µCi/ml (-66%), respectively. The uniformity throughout the lungs was also best for method I (5% s.d. over 17 locations). Improved quantitation resulted from the proposed correction method, and it may serve as an alternative to transmission scanning in lung perfusion or ventilation studies, or other thorax imaging wherein a preliminary perfusion or ventilation scan is done to locate the lungs.