Currently, the system is designed to signal the tomograph to bin data into a new sinogram if the movement exceeds an alarm threshold. These multiple projection sets and their respective head-position estimates can subsequently be used by reconstruction algorithms to eliminate the effects of head-motion during the scan.

No. 360

SPECT AND PET RECONSTRUCTION METHODS ACCOUNTING FOR HEAD-MOTION. N.H. Clinthorne, J.A. Fessler, Division of Nuclear Medicine. The University of Michigan.

Head-motion during PET or SPECT imaging can severely degrade both resolution and quantitative accuracy. Recently, several devices have been developed that can measure a subject's head orientation during the course of a scan. Often these devices are linked directly to the acquisition computer system and can signal the system to begin storing the detected events in a new sinogram frame if the patient moves beyond some "alarm-threshold." With an appropriate reconstruction algorithm, one can correct for patient motion using the sinogram frames and the sequence of measured head-positions. The simplest reconstruction method is to use filtered backprojection (FBP) for each sinogram and retrospectively align the reconstructed image volumes based on the measured head positions. However, since SPECT tomographs do not acquire all projections simultaneously, each sinogram may contain an incomplete set of projection data. Blindly applying FBP to these *partial* sinograms can lead to artifacts in the composite reconstruction. Furthermore, in both SPECT and PET imaging, it is often desirable to impose image smoothness constraints and treat Poisson counting noise appropriately. This requires that the ensemble of projection data be considered simultaneously by the reconstruction algorithm.

The above goals can be accomplished using iterative reconstruction procedures in conjunction with a generalized forward projector that accounts for the motion between frames. Measured head-orientations, along with an interpolator, are used to transform the 3D object estimate from a standard orientation into an intermediate space of "observed" orientations at each iteration. These intermediate orientations are then projected by the standard system response matrix to obtain estimates of the measured projection data. This procedure forms the core of the iteration and can be used to implement a variety of reconstruction methods that correct head-motion while imposing common smoothness constraints and handling counting noise appropriately. Additionally, if object constraints such as kernel sieves are used, they can form the basis for the interpolation step.

The reconstruction methods are especially applicable to SPECT reconstruction where a full set of projection data may not be acquired in a single sinogram set due to patient motion; however, they are also useful in PET imaging when one wants to make the best statistical use of the data.

No. 361

XENON-133 REGIONAL CEREBRAL BLOOD FLOW(rCBF) IMAGING WITH CERASPECT, A STATIONARY RING CAMERA. A.P. Smith, S. Marenco*, S. Genna, G. Rodriguez*, F. De Carli*, M. Gambaro*, G. Rosadini*. Digital Scintigraphics, Inc., Waltham, MA, * DISM, University of Genoa, CNR, Genova, Italy.

Xenon-133 rCBF imaging has been developed for use with the CERASPECT(1) stationary dedicated brain SPECT camera. The system performs tomographic acquisitions in 3.33 seconds, rotating continuously through multiple rotations without direction-reversal. The parallel-hole collimator has, for Xenon-133 in air, a measured FWHM of 1.3 cm. to 1.7 cm. depending on transaxial position, and a sensitivity of 25.6 cts./sec./μCi. The Xenon administration equipment delivers an inhaled dose of Xenon-133 with adjustable concentrations (20-40 mCi./l. were used for initial experience.) The duration of wash-in and wash-out phases are under software control (1.5 min. wash-in, 15 min. wash-out were used.) An expired-air probe samples every 0.2 sec. the arterial Xenon brain input function.

Tomographic images were acquired every 3.33 seconds, summed into 10 second intervals, and analysed using the Obrist algorithm, the Kanno-Lassen/Celsis algorithm by rebinning the data into 4 1-minute intervals, and a generalized double integral method with data binned in 4, 8, and 12 one-minute intervals. rCBF tomographic transaxial images (early picture and sequence of pictures) were reconstructed for the last two methods on a 32 x 32 matrix, the number of contiguous transaxial slices being software adjustable, 4-8 over 10.6 cm. field were used, depending on the total number of counts/slice required for acceptable statistics (200,000-500,000.)

Monte Carlo noise simulations on real and simulated data show an decrease in error from 5% to 3% of calculated mean flow (for flows from 21 to 86 ml/100g./min.) when the 12 min. double integral method was used vs. Kanno-Lassen. In addition, the standard deviation of the flow for the double integral calculation is about 50% of the Kanno-Lassen method. The Obrist calculations, relying on finely-sampled but noisy 10 sec. binning, show flow errors between the two other methods.

(1) CERASPECT™ previously known by the name ASPECT: S. Genna, A.P. Smith, IEEE Trans Nucl Sci 1988, 35:654-658.

No. 362

DYNAMIC QUANTITATIVE Xe-133 RCBF SPECT ON THE PRISM 3-HEADED TOMOGRAPH: SIMULATION AND PHANTOM STUDIES. M.D. Devous, Sr., W. Gong, J.K. Payne. The University of Texas Southwestern Medical Center, Dallas, TX

Measurement of rCBF by Xe-133 SPECT is hindered by the limited availability of specialized instrumentation normally required for the procedure. We implemented this technique on a widely available 3-headed gamma camera (PRISM 3000S, Picker). High-sensitivity collimators, a commercially available Xe-133 inhalation unit (Xenamatic, Diversified Diagnostic Products) and a NaI probe were integrated with gantry electronics to perform complete scans every 10 sec for 6 min. Collimator resolution was 14mm. The probe was used to measure the lung curve as a representation of the arterial input function. Both a version of the Kanno-Lassen double integral algorithm (KLA) used on the Tomomatic 64 (Medimatic A/S) and a full convolution algorithm (CON) were implemented on the PRISM. Xe-133 rCBF imaging on the PRISM was evaluated in two stages. **Stage one:** raw count Tomomatic Xe-133 data were transferred to the PRISM and processed by both our and the Tomomatic versions of the KLA. Results show that the same raw data processed by the Tomomatic and the PRISM yield similar rCBF images. **Stage two:** our dynamic flow phantom (J Nucl Med 28:407, 1987) was used to obtain dynamic data on the PRISM. True perfusion in the phantom was compared to perfusion derived from both the KLA and CON. A linear relationship (r=.86) from 20 to 140 ml/min/100g was observed using the KLA, but rCBF below 50 was overestimated. CON also yielded a linear relationship (r=.92), but with much more precise low flow values. These data show that absolute rCBF can be determined using Xe-133 SPECT and a 3-headed gamma camera.

No. 363

USING TEBOROXIME KINETICS AS AN INDICATOR OF MYOCARDIAL BLOOD FLOW. A.M. Smith, G.T. Gullberg, P.E. Christian and F.L. Datz. Dept. of Radiology, University of Utah, Salt Lake City, UT.

The kinetics of teboroxime may provide a sensitive technique for detecting myocardial ischemia, allowing better treatment for patients with coronary artery disease. Teboroxime kinetics, estimated using tracer kinetic techniques and dynamic SPECT imaging, were compared to myocardial blood flow measured using microspheres. Three dogs were injected with 10-25 mCi of Tc-99m-teboroxime per study and were imaged using a three-detector SPECT system (Picker PRISM 3000). Sequential 5 sec acquisitions were acquired for 15 min during each study, allowing both the wash-in and wash-out of teboroxime to be measured. The projection data were reconstructed into 64x64x34 matrices and reformatted to obtain short-axis slices. Tissue and blood time-activity curves were generated from the 3D dynamic reconstructions. Four tissue activity curves were generated from each short-axis slice of the left ventricle. The blood activity curve was generated from a 3D region drawn inside the left atrium and ascending aorta. The blood and tissue activity curves were fit to a two-compartment model which characterized the wash-in and wash-out kinetics of teboroxime. On each canine, two or three studies were performed, and each study had one of Co-57, Sn-113 or Ru-103 radiolabeled microspheres injected during the image acquisition. The first study was a baseline study, and in the following studies the LAD artery was occluded 75-100%. The heart was excised at the end of the final study, sectioned similar to the reconstructed slices, and placed in a well-counter to measure the microsphere activities. Myocardial blood flow was calculated using the arterial reference sample technique and compared to the estimated wash-in and wash-out parameters on a region-by-region basis by aligning anatomical reference points on the images to the sliced heart tissue. Approximately 200 regions were compared from all the studies. Changes in the wash-in kinetic parameter correlated with myocardial blood flow. For example, for one occluded study, the blood flow was 1.16 and 0.46 ml/min/gm for two regions, and the wash-in parameter was 0.79 and 0.38 min^{-1} for the same regions. The estimated wash-in kinetic parameters for teboroxime reflect regional myocardial blood flow and may give a more sensitive indication of myocardial perfusion defects than visual evaluations of static images.