

Performance of list mode data acquisition with ECAT EXACT HR and ECAT EXACT HR+ positron emission scanners

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Recently, list mode (event-by-event) data acquisition with positron emission tomography (PET) has been widely noticed because list mode acquisition is superior to conventional frame mode data acquisition in terms of (1) higher efficiency of data storage, (2) higher temporal resolution, and (3) higher flexibility of data manipulation. The aim of this study is to investigate the performance of list mode data acquisition with ECAT EXACT HR and HR+ PET scanners (CTI PET Systems) and its feasibility in clinical applications. A cylindrical phantom (16 cm in diameter and length) filled with a ^{11}C solution for the HR and a ^{15}O solution for the HR+ was scanned several times by varying the radioactivity concentration with the list mode and frame mode acquisitions. The scans were also carried out with a septa (2D mode) and without a septa (3D mode) in order to evaluate the effect of the interplane septa on the quality of the list mode data. The acquired list mode data were sorted into a sinogram and reconstructed using a filtered back-projection algorithm. The count rate performance of the list mode data was comparable to that of the frame mode data. However, the list mode acquisition could not be performed when the radioactivity concentration in the field-of-view was high (exceeding 24 kBq/ml for the 3D mode) due to a lack of sufficient transfer speed for sending data from the memory to hard disk. In order to estimate the pixel noise in a reconstructed image, ten replicated data sets were generated from one list mode data. The reconstructed images with the 3D mode had a signal-to-noise ratio that was more than 60% better than that of the image with the 2D mode. The file size of the generated list mode data was also evaluated. In the case of ECAT EXACT HR+ with the 3D list mode, the list mode data with a generated file size of 2.31 Mbytes/s were generated for 37 MBq injections. Our results suggest that careful attention must be paid to the protocol of the list mode data acquisition in order to obtain the highest performance of the PET scanner.

Key words: PET, list mode, frame mode