QUANTITATIVE DYNAMIC 3D PET SCANNING OF THE BODY AND BRAIN USING LSO TOMOGRAPHS

A thesis for the degree of PhD

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Positron emission tomography is a molecular imaging technique that enables the investigation of tissue function in vivo. Following the injection of a radiotracer into a person, the dynamic acquisition of PET data enables the time course of the radiotracer to be measured. Application of a bio-mathematical model to the data then allows inferences of tissue function to be made. This thesis describes two PET scanners that can be used in such a manner, the Biograph-6 HiRez PET-CT scanner and the High Resolution Research Tomograph. Phantom experiments were conducted to investigate the physical performance characteristics of these two scanners. [15O]H2O PET scans from cancer patients were analysed, providing quantitative estimates of blood perfusion in tumours. Methods to improve the scanning protocol by optimising the injected activity were developed. The variance characteristics of the dynamic PET images were investigated and a new, separable variance model was developed and tested. The performance of iterative image reconstruction for low-statistics data was qualified using patient data. The impact that low-statistics bias has on quantitative estimates of kinetic model parameters was determined using simulations.

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