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Improved parameter-estimation with combined PET-MRI kinetic modelling

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Kinetic analysis can be applied both to dynamic PET and dynamic contrast enhanced (DCE) MRI data. We have investigated the potential of combined PET-MRI kinetic modelling using simulated FDG data. The volume of distribution, Ve, for the extra-vascular extra-cellular space (EES) can be estimated by DCE-MRI, and used to reduce the number of parameters in the PET model. We use a 3 tissue-compartment model with 5 rate constants (3TC/5k), in order to distinguish between EES and the intra-cellular space (EIS). In the standard models, k3 represents transfer from the un-metabolised to the metabolised (M) extra- vascular compartment. In our new model, k3' represents transfer from EES to the EIS M-compartment. We also define the more biologically relevant constant, k3"=Vek3', to be used together with the true EES tracer-concentration. Time-activity curves were generated using the 3TC/5k-model with 3 different Ve- values, but constant k3". Noise was added and the data were fitted with the 2TC/3k model and with the constrained and-un-constrained 3TC/5k model. 100 noise- realisations were generated at 4 different noise-levels. For the standard 2TC/3k-model, the estimated k3-values were in the range [0.053, 0.094] with SD in the range [0.002,0.043] /min. For the un-constrained 3TC/5k model, the k3"-values were in the range [0.041,0.187] and SD in [0.053,0.208] /min. With fixed Ve the range of k3" is reduced to [0.083,0.091] with SD in [0.002,0.017] /min. The true k3" value was 0.091/min. By incorporating information from DCE-MRI into the PET kinetic model, we obtained a good estimate of the parameter k3", independent of Ve.

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