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Metabolite-Corrected Plasma Input Function Estimation in Dynamic PET Imaging Using Physically Informed Deep Neural Networks

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The full quantification of dynamic Positron Emission Tomography (PET) data requires the measurement of the arterial input function(AIF),i.e. the concentration of the free tracer in the plasma over time. This invasive measure heavily constrains the more extensive adoption of dynamic PET imaging for clinical research studies and diagnostic workups. Current alternatives include image-derived or population-averaged input functions, which still face many challenges and requires correction for rediometabolites in plasma. We introduce a novel approach for the evaluation of the metabolite corrected plasma input function and validate it on dynamic [11C]PBR28 PET data. Our method employs 3D depthwise separable convolutional layers to analyze dynamic PET images together with a physically informed deep neural network, which incorporates a priori knowledge about the functional form and shape of the AIF, for the prediction of the whole blood and metabolite-corrected plasma curves. We found an average cross-validated Pearson correlation between measured and predicted whole blood and parent plasma curves of 0.86 and 0.89, respectively demonstrating the model's effectiveness in retrieving information related to the tracer metabolism in blood from brain images only.Furthermore, the volumes of distribution obtained by fitting tissue time activity curves of several key regions of interest while using true and predicted AIFs with a two-tissue compartmental model showed no statistical differences.

Field

Software and quantification

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