Title: Development of a non-invasive hybrid PET/MRI technique for measuring the cerebral metabolic rate of oxygen

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Structured Abstract:

Introduction: Given its high energy demands, regulation of energy metabolism is fundamental to neuronal activity and long-term brain health. Even mild disruptions in energy production, such as related to ageing, has been speculated to potentially affect cognition. Despite its importance, imaging the cerebral metabolic rate of oxygen (CMRO2) is challenging. Positron emission tomography (PET), is the gold standard, but the procedure is lengthy (requiring three tracers: 15O2, H215O and C15O) and invasive (requiring arterial blood sampling). Hybrid MR/PET imaging can overcome these limitations using MRI to measure global CMRO2, which can be used to calibrate PET 15O2 imaging. This avoids invasive arterial sampling and eliminates the need for H215O and C15O.

Hypothesis: Absolute CMRO2 can be imaged non-invasively by hybrid PET/MRI.

Objective: To validate the hybrid method in an animal model in which CMRO2 is measured by the proposed hybrid method and by stand-alone PET.

Methods: Experiments will be performed on a 3T MRI/PET system (Siemens mMR biograph). CMRO2 will be imaged in a large animal model (swine), in which cerebral metabolism will be altered by manipulating the anaesthetics. At each anaesthetic level, CMRO2 will be measure by hybrid PET/MRI and the gold-standard 3-step PET method. For the latter, the arterial input function for each 15O-tracer will be measured using an MR-compatible arterial blood sampling system (Swisstrace).

Expected results: These experiments will enable us to determine if hybrid PET/MRI can accurately measure CMRO2 over a range of metabolic levels. The long-term goal is to extent this hybrid imaging method to include functional MRI to provide a unique imaging method of measuring cerebral metabolism at rest and during functional activation. Ultimately, these non-invasive tools will provide a means of better understanding how brain energetics are altered by factors such as ageing and neurodegenerative diseases.