Plenary Lecture 1,2

PL1

CEST MRI: Principles and Application to Disease

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Chemical Exchange Saturation Transfer (CEST) is a relatively new field that combines principles of MRS (chemical selectivity of proton pools) and MRI (imaging of water protons with high sensitivity). It is based on magnetization transfer, exploiting the interaction of exchangeable protons in probe molecules with the water protons to achieve large sensitivity enhancements (several orders of magnitude), allowing imaging of molecular information with MRI sensitivity. CEST MRI can use paramagnetic and diamagnetic probes, but the ultimate strength and hope for fast clinical translation lies in the use of diamagnetic agents, expected to have lower toxicity and to be more applicable for regulatory approval and patient acceptance.

After an introduction of the basic principles of CEST to provide insight into the type of molecules that can be studied and the sensitivity of this approach, several applications will be presented to illustrate its potential. 1) imaging of endogenous proteins, carbohydrates, tissue metabolites, and pH, allowing fast translation to the clinic. 2) Use of simple sugar derivatives (e.g. D-glucose, dextran) as a probe for imaging tissue perfusion, membrane permeability and metabolism. 3) Novel approaches for substrate binding, including targeted imaging of prostate specific membrane antigen (PSMA) using CEST probes.

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Keywords : CEST, MRI, Cancer, Stroke

Plenary Lecture 1,2

PL2

Advances in the Assessment of Cerebrovascular Disease using Magnetic Resonance Imaging

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Cerebrovascular disease is a major area of healthcare burden and active research, spanning diseases such as stroke, transient ischaemic attack, vascular atherosclerosis and vascular dementia. Magnetic resonance imaging offers a unique tool to assess a number of manifestations of cerebrovascular disease, including vessel wall pathology, lumen status, tissue perfusion, collateral flow status and tissue metabolism. The talk will introduce new areas of active methodological research. These include developments in arterial spin labelling that provide information on lumen flow and collateral flow, as well as quantitative tissue perfusion; techniques to assess the stability of atherosclerotic plaque; and methods to assess tissue metabolism, including insights into pH via chemical exchange saturation transfer (CEST), and insights into oxygen metabolism via venous blood oxygenation. MRI may also have a role in assessing small vessel pulsatlity, a possible additional marker for (small) vessel disease.

By use of pseudo-continuous arterial spin labelling (ASL) it is possible to gain valuable information about collateral flow by encoding signal from specific feeding arteries and by tracking the destination of signal as it moves from the large feeding arteries towards the tissue bed. Hybrid sequences can obtain information in both these phases via tailored post-hoc image reconstruction. Similar pulse sequence preparation modules, but designed instead to crush signal from lumen spins, are able to yield black-blood images that allow the vessel wall to be imaged. When combined with a quantitative T2 readout the image data is able to map unstable lipid-rich plaques that are at risk of rupture.

MRI measures of metabolic stress may also be useful, including measures of pH via CEST (albeit with confounds from other contributions to the CEST effect, such as protein concentration), and oxygen extraction fraction via measurement of venous blood T2.

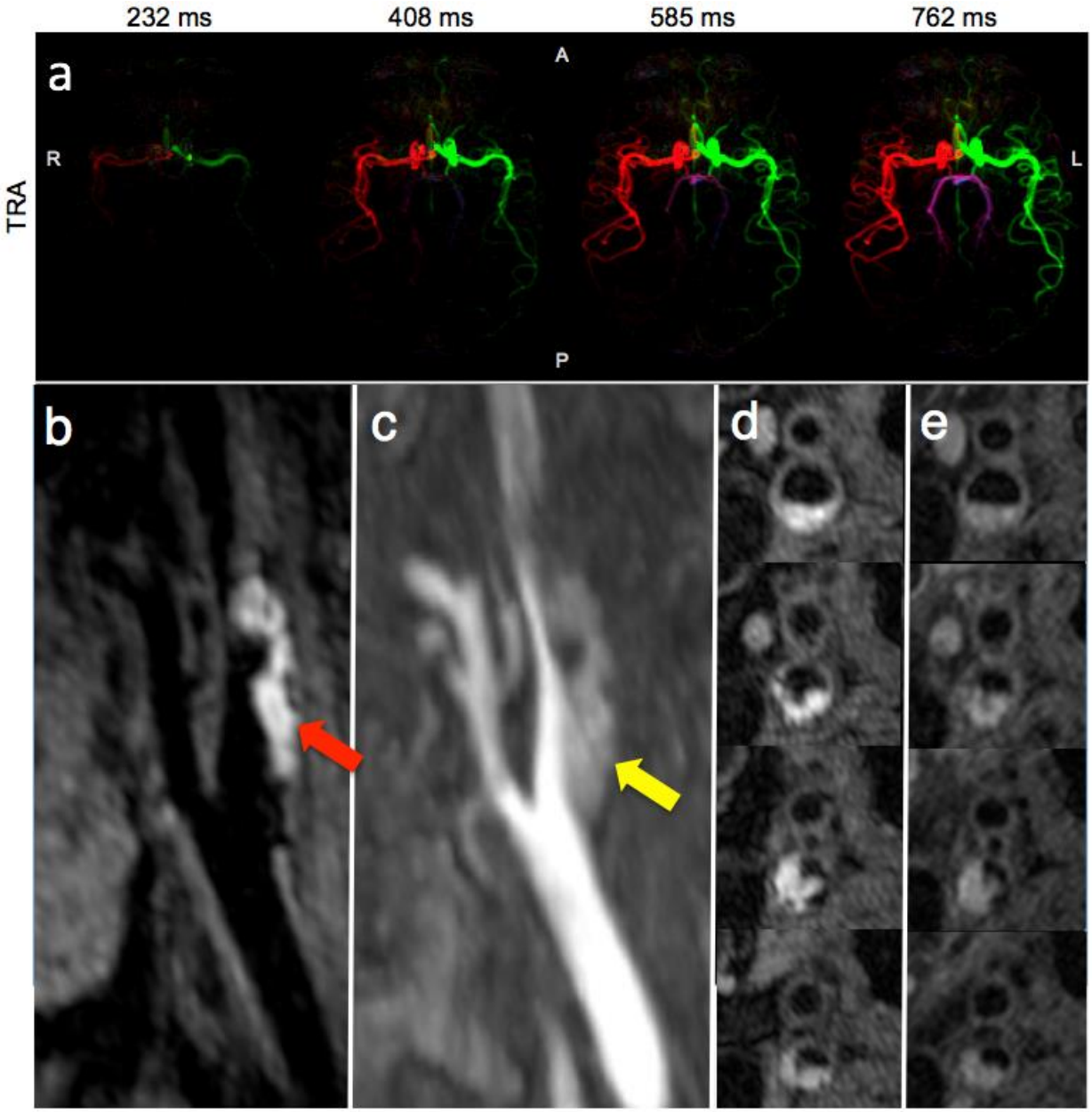

Fig.1. Example of collateral flow around the circle of Willis, as depicted by vessel-encoded arterial spin labelling, and vessel wall intra-plaque haemorrhage using a fast black-blood T1-weighted sequence.

Keywords : Brain aneurysm, Phase-contrast mri, 4D-flow MRI