Dynamic Susceptibility Contrast Imaging using a multi-echo spiral sequence

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Introduction

To characterize microvasculature, one can perform a DCE-MRI experiment (a first injection of contrast agent (CA) to estimate the vessel wall permeability) followed by a DSC-MRI experiment (a second injection of CA to estimate relative blood volume (rCBV), relative blood flow, etc.) [1]. The DSC experiment can even yield information on vessel size if a gradient echo and a spin echo are simultaneously acquired [2]. However, estimates from a DSC experiment performed after a DCE-MRI experiment (two injections of CA) may differ from the estimates derived from a single DSC experiment (one injection of CA), especially due to different T1 effects [3]. Low flip angle have been proposed to reduce these effects but this approach is not compatible with the acquisition of vessel size estimates which requires a spin echo. In this study, we investigate how T1 effects contribute to rCBV estimates in the case of one and two consecutive injections of CA. To achieve this goal, we used a multi-echo spiral sequence – which allows short echo-times – in a rat glioma model.

Material and method

Experiments were performed at 4.7T (Bruker Avance III system) using volume/surface cross coil configuration. Wistar rats (n=5), bearing an intracerebral C6 glioma (18 days of growth) were anaesthetized using isoflurane (2%) and their tail vein was equipped with a catheter for the 2 CA injections.

MRI protocol: T2w imaging for anatomy, gradient multi-echo spiral out sequence (FOV=3x3cm2, matrix=128x128, 1mm thick single slice, TR=500ms, 2 interleaves, bandwidth 625kHz, TE=[0.95, 13.8, 26.6, 39.4, 52.2ms], 1 image/s) to monitor the 1st passage of Gd-Bolus (Gd-DOTA, 200µmol/kg), 3 minutes later, same sequence to monitor the 1st passage of a second Gd injection (same concentration). Special attention was paid to the refocusing between two gradient echoes: an appropriate trim bandwidth 625kHz, TE=[0.95, 13.8, 26.6, 39.4, 52.2ms], 1 image/s) to monitor the 1st passage of Gd-Bolus (Gd-DOTA, 200µmol/kg), 3 minutes later, same sequence to monitor the 1st passage of a second Gd injection (same concentration).

Discussion

This study shows promising results in investigating 1st passage bolus with multi-echo spiral imaging. First, δR* estimates seem more robust. Secondly, the results suggest that DSC-MRI performed during a second injection of CA is less sensitive to T1 effects (at bolus peak and during the return to baseline) than DSC-MRI performed during a first injection.


Fig 1. rCBV maps computed with different methods on the same animal. (a) Classical approach. (b) Multi echo spiral. Red pixels correspond to data that could not be processed (fitting error error etc.).

Fig 2. rCBV values (arbitrary units) derived from the data acquired during 1st injection (x-axis) vs. 2nd injection (y-axis) with the 2 methods in 2 different ROI.

Fig 3. Plot estimates changes for both injections in controlateral region. (a) S0 estimates. (b) T1* estimates over time.