Accelerated Time-SLIP Cerebral MR Angiography by Use of Dual Inversion Pulse for Background Suppression

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Introduction

Time-Spatial Labeling Inversion Pulse (time-SLIP) which is a technique of magnetic resonance angiography (MRA) based on arterial spin labeling (ASL) are utilized in various situations [1]. However, to visualize cerebral angiograms, the background signal cannot suppress enough in the conventional time-SLIP technique because of longer T1 and T2 value of cerebrospinal fluid (CSF). Therefore, a subtraction between on/off of ASL is used and it takes double time to acquire corresponding data [2]. In this study, we tried to achieve sufficient visualization of cerebral angiograms with single acquisition time-SLIP using multiple inversion technique [3].

Methods

Figure 1 shows the change of longitudinal magnetization of representative tissues with pulse sequence. 1st inversion recovery (IR) pulse is applied as slab selective. Although this IR pulse is used as ASL at the upstream of blood flow in conventional time-SLIP, it is used for background suppression at the imaging slab in this study. This is not enough to suppress background signals even if the data acquisition is performed at the null point of cerebral parenchyma. Therefore, 2nd IR pulse is added as non selective during inflow time. If an optimal timing is chosen, the data acquisition can perform at the null point of brain and CSF.

We validated this 2-IR time-SLIP technique using phantom (pure water and $CuSO_4$ 1 mM solution with agarose 1 w/v% in a 12 cm ϕ cylinder, steady flow of $CuSO_4$ 1 mM solution at the speed of 30 cm/s in a 6 mm ϕ tube). And then we validated this technique in the examination of four healthy volunteers with appropriate parameters. Image quality and imaging time were also compared with conventional time-SLIP technique.

All MR imaging was performed using a 1.5-T MR scanner (Exelart Vantage 1.5T, Toshiba Medical Systems, Tokyo, Japan) with a 5ch head speeder coil. Peripheral pulse gated 3D true SSFP pulse sequence (TR/TE = 5.2/2.6 ms, FA = 120 degrees, FOV = 21cm, slice thickness = 4mm, number of slice = 30, matrix size = 192x192, zero fill interpolation +, speeder factor = 2, k-space order = slice sequential and phase centric) with fat saturation was used for all examinations.

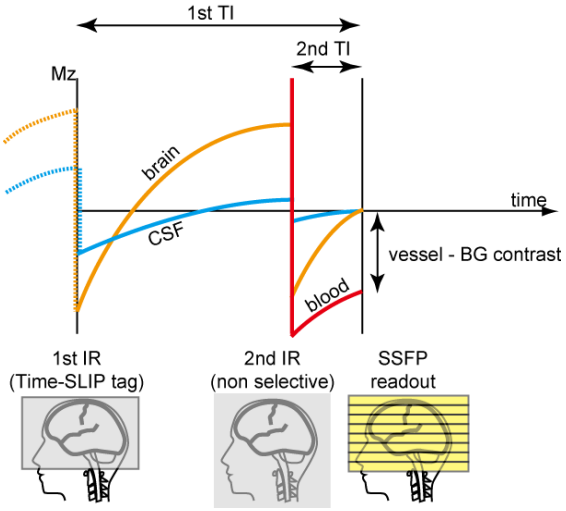

Figure 1 Scheme of pulse sequence. Combination of 1st spatial selective and 2nd non selective IR pulses suppresses background (BG) signals. SSFP imaging sequence is performed at the null point of BG.

Results and discussion

Figure 2 shows maximum intensity projection (MIP) images of time-SLIP angiograms. Although conventional subtraction technique can depict finer vessels, 2-IR technique can depict sufficient angiograms in a half imaging time. Further optimization is needed for clinical use because the blood velocity and the pulse rate vary among individuals. Different pulse rate results in different recoveries of longitudinal magnetizations because gating trigger is used in time-SLIP technique. If the appropriate parameters are chosen, compared to time-of-flight MRA, this technique will be useful in terms of imaging time, flexibility of scan plane, effect of turbulent flow and so on.

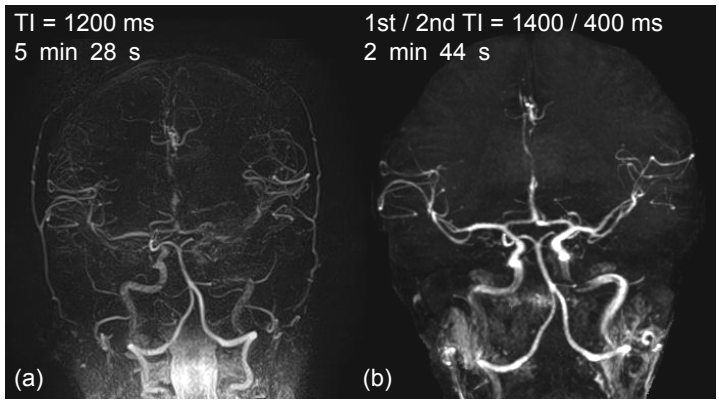

Figure 2 MIP images of time-SLIP angiograms. (a) is conventional subtraction technique and (b) is 2-IR technique. Imaging parameters are also shown at the upper of corresponding image. 2-IR technique can depict sufficient angiograms in a half imaging time.

Reference

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