FEASIBILITY OF 3D BALANCED SSFP-ASL OF THE KIDNEYS AT 3.0T

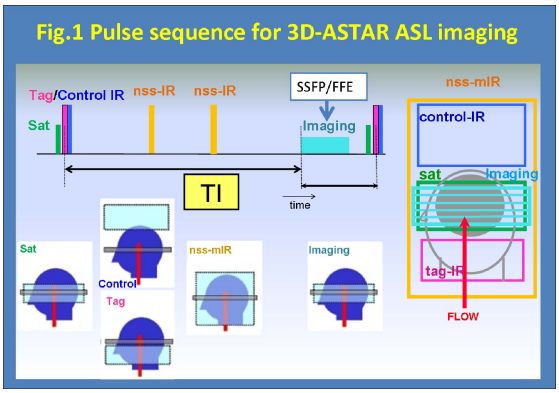
Koji Fujimoto[1], Aki Kido[1], Kyoko Takakura[1], Hajime Sagawa[1], Shigeaki Umeoka[1], Naotaka Sakashita[2], Tokunori Kimura[2], Yasutaka Fushimi[1], and Kaori Togashi[1]
[1]*Department of Diagnostic Imaging and Nuclear Medicine, Kyoto University Graduate School of Medicine, Kyoto, Japan,* [2]*Toshiba Medical Systems Corporation, Otawara, Tochigi, Japan*

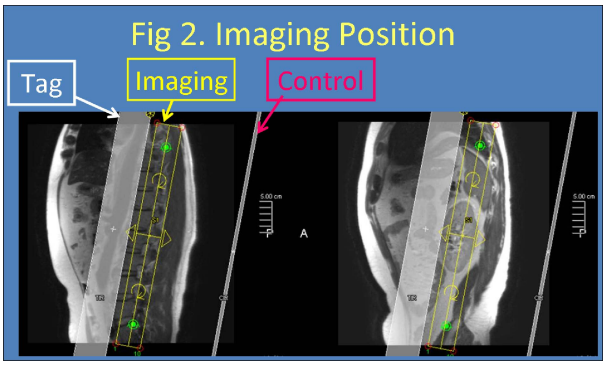
Target audience: Technicians and clinicians who are interested in arterial spin labeling technique (ASL) for the abdomen.

Purpose:

The arterial spin labeling (ASL) is a non-invasive technique that can visualize tissue perfusion by utilizing protons within the blood vessels as an intrinsic tracer. Compared to brain region, its application to the body region was very limited. Technically, for imaging of the abdominal organs, relationship between the target organ and its relevant vessels should be considered. In addition, transit time to wait for the labeled spin flowing into the target organ is critical for obtaining images of utility.

Recent progress of the 3.0T MRI system enabled us to obtain stable images in body regions with better SNR. In addition, an alternative imaging technique for ASL readout using 3D-balanced SSFP (3D-bSSFP) is recently developed (work-in-progress sequence). Because of the higher risk for nephrogenic systemic fibrosis (NSF), there is an increased need and interest for the non-invasive evaluation of the function of the diseased kidneys by using this technique [1-3]. Hence, the purpose of this study was to investigate feasibility of 3D-bSSFP MRA for the kidney by comparing with images with fast field echo (FFE) readout.

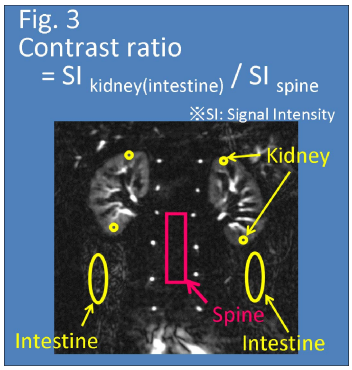




Materials and methods:

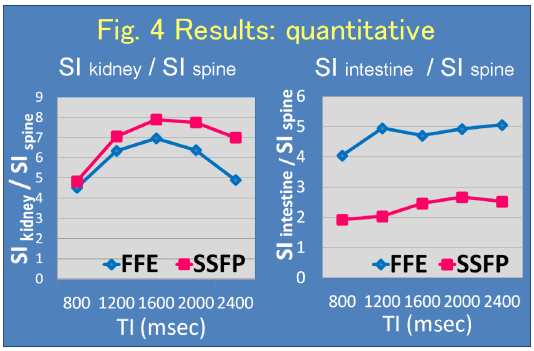
MR imaging

MR examinations were performed for five healthy volunteers at 3.0T MRI system (Toshiba Medical Systems). A pair of 4 x 4 phased array receiver coils was placed at the front and the back of the subject. ASTAR (Signal Targeting with Alternated Radio frequency using Asymmetric Inversion Slab) technique is used for ASL preparation [4], and 3D-bSSFP or FFE is used for readout (Fig. 1). Parameters for 3D-bSSFP sequence were: TR/TE, 4.3/2.2ms; flip angle, 101-119°; field of view (FOV), 360×360mm; matrix, 192×192; average, 2(tag on/off); bandwidth, 781Hz/pixel; slice thickness, 4mm; number of slices, 10; SPEEDER factor, 2; number of selective inversion recovery (nss-IR), 2. Parameters for FFE were identical with 3D-bSSFP except for: TR/TE, 5.9/2.1ms; flip angle, 15°; BW, 244Hz/pixel. For both readout, inversion time (TI) between the saturation pulse and readout varied from 800, 1200, 1600, 2000, 2400 msec. Orientation of the images was oblique-coronal, which is parallel to the long axis of the kidneys (Fig. 2). Respiratory trigger was used.

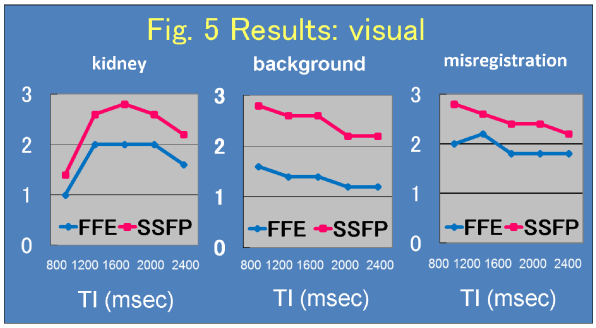


Data analysis

For the quantitative analysis, signal intensity of the kidney, intestines, and vertebra were measured by taking the average of several ROIs placed on each organs (Fig. 3). Contrast ratio of the kidney/vertebra, and intestines/vertebra was calculated. For the qualitative evaluation, one radiologist scored obtained images with respect to 1) visualization of the renal perfusion, 2) effectiveness of background suppression, and 3) degree of misregistration by using three-point scale (Good 3; Moderate 2; Poor 1).



Results: Contrast ratio of the kidney/vertebra and intestines/vertebra for the FFE and bSSFP were shown on Fig.4 respectively. Qualitative evaluation score for kidney, background and misragistration for the FFE and bSSFP were 1.72±0.68 vs.2.32±0.69, 1.36±0.57 vs. 2.48±0.51, 1.92±0.49 vs. 2.48±0.59 respectively (Fig.5).



Discussion: The bSSFP-ASL was superior to the FFE-ASL both in qualitative and quantitative evaluations. This was mainly due to higher flip angle for bSSFP readout. Other advantage for bSSFP include smaller background signal due to T1/T2 contrast. On the other hand, interpretation of signal intensity of bSSFP in transient state is complicated for quantification of blood volume or blood flow, although the changes in relative SI against TI was similar to that of FFE, as well as previous report [2]. Limitations include lack of analysis of reproducibility, smaller number of subjects, limited subject variability.

Conclusion: 3D- ASL of the kidney was feasible at 3.0T. bSSFP was superior to FFE in a wide variety of TI.

References: [1] Winter, JMRI 34:608-615(2011), [2] Cutajar, MAGMA 25:145-153(2012), [3] Gardener, MRM 63:1627-1637(2010), [4] US patent #6564080 (2003)