Non-Contrast-Enhanced Renal Venography Using Spatial Labeling With Multiple Inversion Pulses (SLEEK)

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Introduction

Renal venogram is often used to diagnose renal vein thrombosis or evaluate renal venous system for kidney transplant patients and donors. The existing MRI technique for renal venogram is delayed Gd enhanced MRA. The contrast enhanced technique has its limitations: 1: the arterial contamination; 2: the potential association between the gadolinium-contrast and the nephrogenic systemic fibrosis (NSF). Therefore, it is desirable to develop a non-contrast-enhanced (NCE) MR renal venography, especially for those patients with renal malfunction. In this study, we propose a new NCE method to image the renal veins using **S**patial **L**ab**E**ling with multiple inv**E**rsion pulses (**SLEEK**) preparation.

Materials and Methods

The sequence consists of a SLEEK preparation and a FIESTA readout. The SLEEK preparation can have more than one, typically two spatial selective IR pulses, one IR pulse with broad spatial band is to saturate the blood flow and the second IR pulse with narrower spatial band is to recover the wanted signal from the imaging volume. The SLEEK bands can be geographically localized during scan prescription. TI is selected to null the inflow blood signal. Adiabatic SPIR chemical saturation pulse is applied prior to the data acquisition for fat signal saturation. The diagram of the pulse sequence was shown in Figure 1.

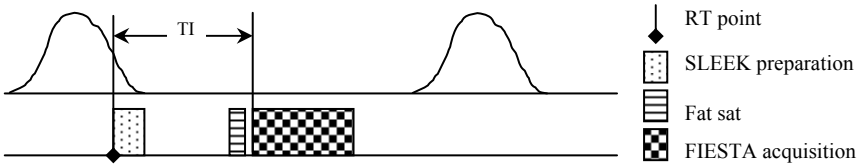

Fig 1: Respiratory triggered fat-sat FIESTA sequence, with SLEEK preparation.

The new pulse sequence has been tested with 7 volunteers on 1.5T MR scanners (EXCITE HD, GE Healthcare, Milwaukee) using an 8-channel phased-array coil under RT-gating. Parameters were optimized for balancing resolution and SNR: TE = 2.3ms, TR = 4.7ms, Flip angle = 70, TI = 1100ms, slice thickness = 2mm, FOV = 38cm x 30cm, matrix = 256 x 256, receiver bandwidth = ±125kHz, NEX = 0.79, sense factor = 2, respiratory interval = 1, 40-50 sections acquired in axial or coronal view. For subjects with respiratory rate = 16 bpm, the scan time was around 3 minutes.

Results and Conclusion

Prior to the NCE renal venography scan, localization sequence was performed to assist in positioning the SLEEK bands. Renal venograms were successfully obtained from all volunteers. Figure 2a demonstrates the SLEEK bands prescription for a 3D axial scan and Figure 2b shows one of the axial images from the 3D scan. Renal veins were depicted well. Figure 3 shows an example of a 3D coronal scan, the relationship between the IVC and renal veins are clearly visualized.

To evaluate the image quality of renal venogram, the SNR of the renal vein and the CNR between renal vein and abdomen aorta were measured for each volunteer. The mean SNR value was 46.5 (minimum was 32.1, maximum was 74.3). The mean CNR was 35.4 (minimum was 24.4, maximum was 57.8). Renal veins were clearly visualized from the background and arteries. The preliminary results suggested our method is a very promising solution for NCE renal venography.

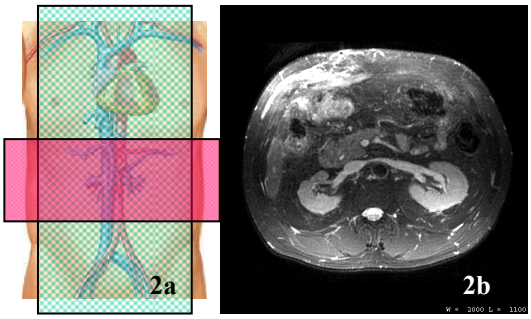

Fig 2: 3D axial renal venogram. (a) Prescription of SLEEK bands. Green band means the first broad IR band, and pink band means the second IR band; (b) Reformatted axial view.

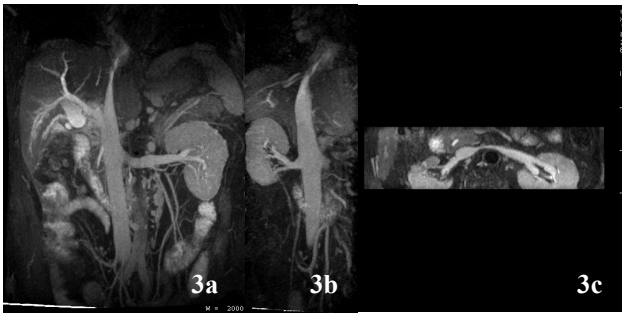

Fig 3: An example of 3D coronal renal venogram. (a): Reformatted view of left renal vein; (b): Reformatted view of right renal vein. (c): Reformatted axial view.

References

[1] Bley T. A. et al. ISMRM 2009, 1881

[2] Masui T. et al. ISMRM 2009, 3898