RENAL PERFUSION IMAGING WITH FAIR AND FIESTA AT 3.0T MR

J. Wang[1], D. Liu[2], X. Yang[3], Y. Dang[1], X. Wang[1,3], J. Zhang[1,2], and J. Fang[1,2]
[1]Academy for Advanced Interdisciplinary Studies, Peking University, Beijing, China, People's Republic of, [2]College of Engineering, Peking University, Beijing, China, People's Republic of, [3]Dept.of Radiology, Peking University First Hospital, Beijing, China, People's Republic of

Purpose

Arterial Spin Labeling (ASL) being a non-invasive detection method has mostly been used for brain blood flow imaging to evaluate vascular disease, stroke and tumor [1, 2]. For abdominal imaging, the respiratory, cardiac, and peristaltic motions present major challenges when applying ASL [3, 4]. The purpose of our study was to develop a new breathhold abdominal ASL method using single-shot fast imaging employing steady-state acquisition (FIESTA) combined with flow-sensitive alternation inversion recovery (FAIR) perfusion preparation [5] for the measurement of renal blood flow (RBF) on clinical 3.0T MR scanner.

Materials and Methods

This study was approved by the Ethics Committee of Hospital. Five healthy volunteers (four males and one female, 22-27 years old) and one patient (female, 40 years old) were examined with informed consent obtained. All examinations were conducted on a 3.0T GE clinical whole-body MR system (High Definition, Milwaukee, WI) operating with a maximum gradient strength of 40mT/m and a slew rate of 120T/m/s. After FAIR perfusion preparation, images were acquired using a single-shot FIESTA imaging pulse sequence on the MR scanner (Fig.1). Single 8 mm coronal slice was acquired with flip angle = 90°, inversion time (TI) = 1.6 s, tag thickness = 10 cm, and tag-slice gap = 1 cm. FOV was 46 cm and the matrix was 128×128, with centric reordered full k-space phase encoding. The echo train (interecho spacing = 2.6 ms) was acquired with balanced steady-state free precession readout. A total of effective 6 scans (TR = 3s, scan time = 20 s) for breathhold and 10 scans (TR = 5.5s, scan time = 55 s) for nonbreathhold were obtained.

To avoid respiratory motion artifacts, breathhold and nonbreathhold strategy were employed during scan. In both strategies, images were acquired in end expiration state. To yield the highest perfusion signal, TI was optimized at 1600 ms by comparing the perfusion signal intensity of 5 images obtained with various TI values (Fig.2).The apparent T1 values of blood and tissue were assumed to be similar in evaluation [6].

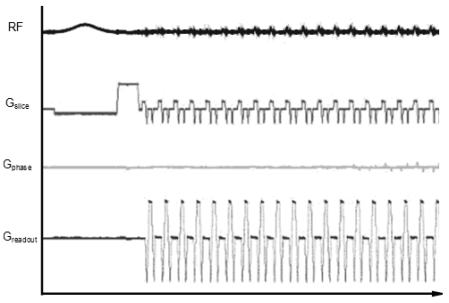

Figure 1: FAIR FIESTA sequence waveform.

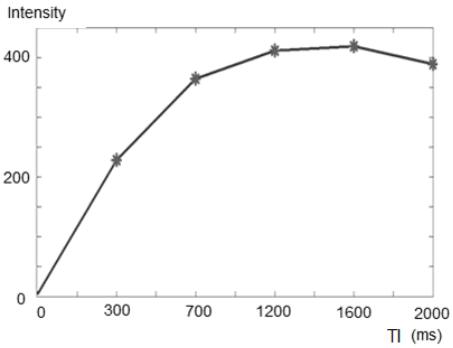

Figure 2: The perfusion signal intensity with various TI values (300, 700, 1200, 1500 and 2000 ms).

Results

Acceptable imaging quality of breathhold and nonbreathhold were achieved for all subjects with neglectable susceptibility or distortion artifacts, as confirmed by an experienced doctor (Fig.3). The typical values of RBF in breathhold and nonbreathhold obtained from healthy subjects were given in table 1. In the case of a 40 years old female patient with an angioleiomyolipoma in right kidney, the renal perfusion examination using the FAIR FIESTA sequence well revealed a significant reduced perfusion in the renal lesion, shown in Fig. 4, indicated by the white dot circle.

Table 1: RBF values in breathhold and nonbreathhold modes obtained from healthy subjects (ml/100g/min).

Examination Protocol	Entire Kidney	Medulla	Cortex
Breathhold	243±49	108±21	303±69
Nonbreathhold	240±57	105±25	302±77

Conclusions

In this study, we demonstrated the renal perfusion measurement on 3.0T MR scanner using the proposed FAIR FIESTA technique, which can be used repeatedly without the cost of an exogenous contrast agent.

Results of limited number of healthy subjects showed that the FAIR FIESTA technique had the ability to satisfy the renal perfusion quantification requirements in breathhold and nonbreathhold mode, whereas it presented more reliable results with less motion artifacts and shorter scan time in breathhold mode.

Moreover, the preliminary result revealed the low renal perfusion area of a patient with an angioleiomyolipoma, indicating that it could be helpful to provide valuable information in diagnosis of renal lesion.

Figure 3: Images of the kidneys of a healthy subject acquired in a single breathhold. (a) Anatomical FAIR FIESAT image after non-selective inversion. (b) Anatomical FAIR FIESAT image after selective inversion. (c) Perfusion weighted FAIR FIESTA image.

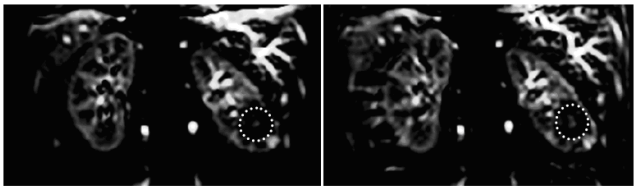

Figure 4: FAIR FIESTA perfusion weighted images of the kidneys in a 40 years old female patient with an angioleiomyolipoma in right kidney. (a) TI = 1200 ms. (b) TI=1600 ms. The tumor was clearly identified as a weakly perfused region (white dot circle).

References
1. Detre JA, et al. Neurology, 50(3):633-641 (1998).
2. David A.Roberts et al. Radiology, 196:281-286 (1995).
3. Petros Martirosian, et al. MRM, 51:353-361 (2004).
4. Michael Fenchel, et al. Radiology, 238:3 (2006).
5. Eric C. Wong, et al. NMR in Biomedicine, 10:237-249 (1997).
6. Cedric De Bazelaire, et al. Academic Radiology, 12, No 3 (2005).