Inflow Inversion Recovery Steady State Free Precession with Tracking Navigator

Yuji Iwadate[1], Anja C.S. Brau[2], Naoyuki Takei[1], and Hiroyuki Kabasawa[1]
[1]*Global Applied Science Laboratory, GE Healthcare Japan, Hino, Tokyo, Japan,* [2]*Global Applied Science Laboratory, GE Healthcare, Menlo Park, CA, United States*

Introduction

Inflow inversion recovery steady state free precession (IFIR FIESTA) with respiratory triggering is a free-breathing 3D technique for renal MR angiography without contrast agent [1]. In this method, an inversion recovery (IR) preparation pulse runs immediately after a trigger point, and the inversion time is set to longer than 1 sec to wait for the inflow of arterial blood. Due to this long inversion time, the patient's diaphragm position can vary between imaging periods, which results in image degradation. Here we propose a new IFIR FIESTA technique which adds a navigator echo dedicated for slab tracking to reduce the effect of inconsistent breathing.

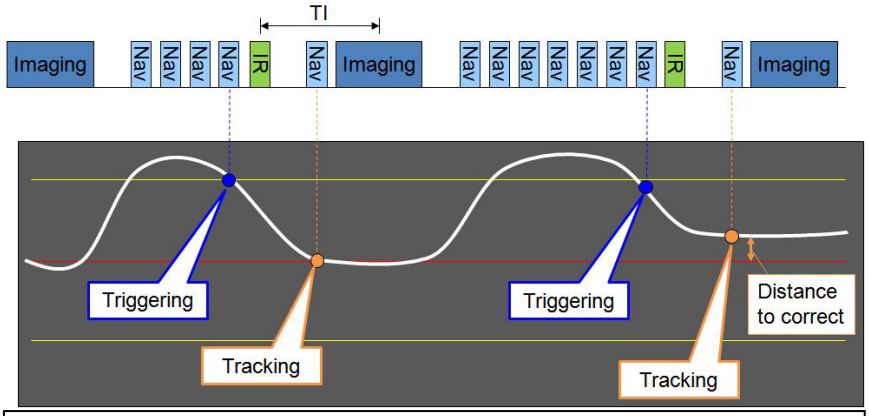

Fig. 1 Timing diagram for IFIR FIESTA with navigator triggering and tracking. The white and the yellow lines represent the movement of the diaphragm and the acceptance window, respectively. The red line is the baseline diaphragm position.

Methods

Pulse Sequence Design: Figure 1 shows the timing diagram of the proposed method. Respiratory triggering is conducted using a navigator echo, and an IR preparation pulse is applied when the diaphragm position falls within the acceptance window. Another "tracking navigator" echo is inserted between the IR pulse and the imaging pulse sequence for the sake of slab tracking to compensate the distance between the expected baseline position (red line) and the actual diaphragm position at the beginning of the imaging sequence.

Data Acquisition: We conducted investigational version of navigator triggered IFIR FIESTA sequence (flip angle=90, TR/TE/TI=4.4ms/2.2ms/1400ms, receiver BW=125kHz, FOV=360mmx288mm, matrix=256x256, slice thickness=3mm) with and without tracking navigator. The navigator consisted of a 2D pencil-beam excitation placed on the right hemi-diaphragm with a 20 degree flip angle, 10cm length, 2cm width, and 256 readout points. We performed all scans on GE Signa 1.5T HDxt MR imaging system (GE Healthcare, Waukesha, WI, USA) with an 8-channel body array coil, and informed consent was obtained from volunteers.

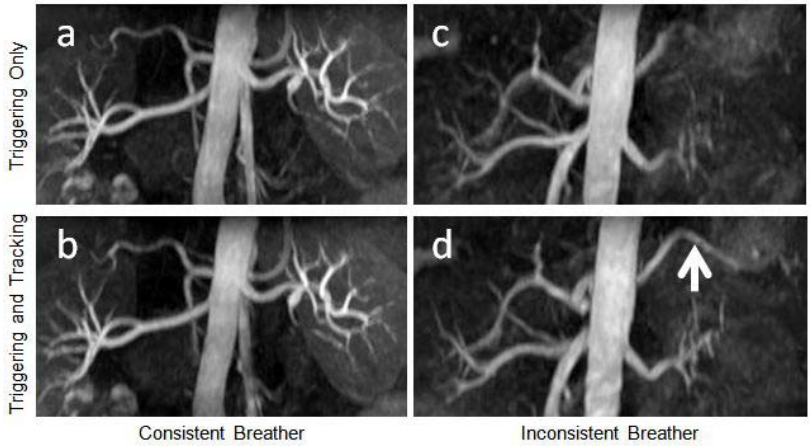

Fig. 2 Navigator triggered IFIR images (a, c) without and (b, d) with slab tracking navigator. Left hepatic artery was delineated more clearly with tracking navigator with an inconsistent breather (arrow).

Results and Discussion

In a volunteer whose respiratory displacement was consistent during the scan, IFIR depicted arteries clearly with and without the use of the tracking navigator and notable IQ differences were not seen (fig. 2a, b). However, delineation of the arteries was improved with tracking navigator in an inconsistent breather (fig. 2c, d) whose end-expiration position varied between imaging periods (fig. 3). In this volunteer scan, depiction of the left arteries was visibly improved (fig. 2d). This effect was examined by 2D coronal FIESTA imaging (acquisition time was 610ms per phase), and it was determined that the respiratory excursion of the subject's left abdominal organs exceeded that of the right side (fig. 4), offering a possible explanation for the unilateral improvement in vascular depiction.

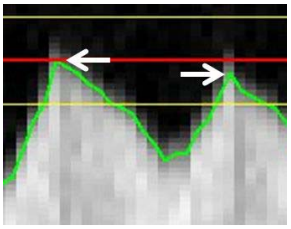

Fig. 3 Navigator signals and detected respiratory waveform (green line) of inconsistent breather. Tracking navigator detected difference of the diaphragm positions at end-expiration (arrows).

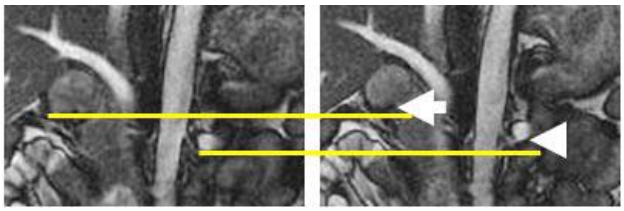

Fig. 4 Coronal FIESTA images with the inconsistent breather at end-inspiration (left) and end-expiration (right). Lower edge of the high signal structure (arrowhead) in the left side moved more than that of the head of pancreas (arrow) in the right side. Yellow lines show the lower edge positions of the described structures at end-inspiration.

Future work includes optimization of the slab tracking factor which determines the ratio of compensation distance and clinical investigation.

Conclusion

Combination of respiratory triggering and tracking navigators improved IFIR FIESTA image quality in volunteer scan with inconsistent breathing pattern

References

1. Glockner et al., J Magn Reson Imaging 31:1411-1418 (2010).