Navigator-Gated Quiescent Interval Single Shot for Pelvic MR Angiography

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Introduction:

Quiescent Interval Single Shot (QISS) is a promising new method for non-contrast magnetic resonance angiography (MRA) that provides fast data acquisition with minimal flow dependence.[1] It utilizes a quiescent inflow time that is substantially synchronized to systole in order to maximize inflow enhancement prior to a single shot 2D TrueFISP acquisition. QISS does not require tailoring of the sequence parameters for the individual patient and is robust to respiratory motion and bowel peristalsis in the pelvis. However, in some subjects respiratory motion can cause mild stair-step artifact, particularly for the right common and external iliac arteries. In this study, we present navigator-gated QISS which gates the data acquisition based on diaphragm position to minimize the effects of breathing motion. We demonstrate that our approach provides image quality comparable to breath-holding and is free of respiratory artifacts, further improving the diagnostic quality of QISS.

Methods:

Five healthy subjects (4 males, 1 female, age 23-30) were scanned on 1.5T scanners (MAGNETOM Avanto and Espree, Siemens Healthcare, Erlangen, Germany). Data were acquired using an ECG-gated QISS sequence. Typical acquisition parameters included TE of 1.42 ms, 60 axial slices (3 mm thick, 20% overlap), 1 x 1 mm in-plane resolution, flip angle of 90 deg., 5/8 partial Fourier acquisition, 40 x 32 mm FOV and GRAPPA[2] factor of 2. The QISS sequence was modified to include a navigator consisting of a single line of data from a pencil-shaped volume that crosses the diaphragm. The position of the diaphragm was used to accept data acquired within a user-specified respiratory acceptance window (typically ± 3 mm in this experiment). For each subject, the following 4 scans were acquired: (1) navigator-gated QISS, (2) breath-hold QISS, (3) free breathing without a navigator and (4) free deep breathing without a navigator. A blinded radiologist scored image quality for vessel smoothness and background suppression using a 4-point scale (3-excellent, 2-good, 1-fair, 0-poor).

Results:

For all subjects, navigator-gated QISS provides vessel smoothness and background suppression that are comparable to or better than breath-hold QISS. Figure 1 shows representative data using a navigator, breath-hold, free breathing and free deep breathing. Vessel smoothness and background signal homogeneity are virtually indistinguishable for navigator-gated and breath-hold scans (Fig. 1 A, B). On the other hand, for scans without a navigator or breath-hold, image degradation scales with depth of breathing (Fig. 1 C, D). Vessel smoothness scores were significantly higher for navigator-gated QISS than free breathing (p=0.008) and free deep breathing (p=0.002). Background suppression scores were significantly better for navigator-gated QISS than free deep breathing (p=0.02). For subjects having difficulty maintaining a constant breath-hold, image quality is actually better for navigator-gated relative to breath-hold acquisition (Fig. 2).

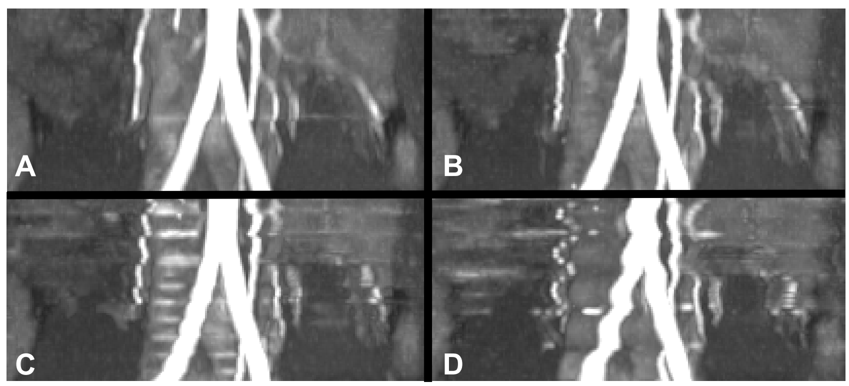

Fig. 1: Vessel smoothness and background signal superior for breath-hold (A) and navigator (B) relative to regular (C) and deep (D) breathing without a navigator.

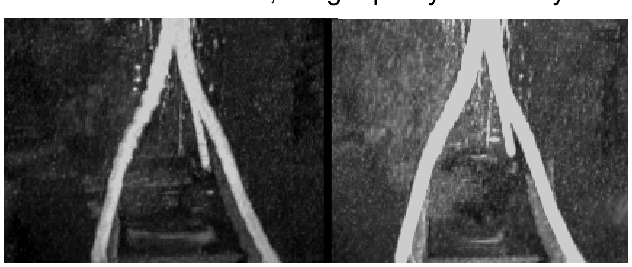

Fig. 2: For subjects with difficulty maintaining breath-hold (left), vessel smoothness is actually superior for navigator QISS (right).

Conclusion:

Navigator-gated QISS offers non-contrast pelvic MRA with comparable image quality to breath-holding. This approach is particularly suitable for patients who are unable to effectively breath-hold. Furthermore, navigator-gated QISS provides much better background suppression than free breathing without a navigator. Further studies will evaluate this approach in other regions affected by breathing including the renal arteries.

References: [1] Edelman *et al,* MRM (in press). [2] Griswold *et al*, MRM 2002 Jun; 47(6):1202-10.