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Meeting abstract

306 Cardiac sodium imaging with phased arrays at 3 Tesla using a 3D Ultra-short TE (UTE) approach

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Background

Sodium MR imaging has potential for assessing acute and chronic ischemic heart disease, due to increased sodium concentration after myocardial infarction. However, ^{23}Na imaging is challenging owing to its low sensitivity. We have adopted a three-pronged approach to this problem:

1) Use a 3 T imaging system with higher SNR compared to 1.5 T

2) Implement phased-array reception, which has previously shown [1,2] to increase SNR, improve coil coverage, and reduce variability from patient positioning

3) Implement a 3D acquisition with short TE, which is required for SNR efficiency. This needs to be compatible with non-isotropic acquisition for short-axis slicing.

Our hypothesis is that the combination of these enhancements will provide us with a more powerful scientific tool for investigation of sodium in myocardial disease. Further we anticipate that the higher SNR will allow us to further improve image quality by correcting for physiological motion.

Methods

B0 field

Experiments were performed on a Siemens TIM Trio equipped with multinuclear capabilities. FID acquisitions at 1.5 T and 3 T were performed with a phantom spaced 8 cm from the anterior coil. Our standard quadrature 1.5 T surface receive coil was use for comparison with the 3 T array.

RF Coil

The ^{23}Na coil array (Fig. 1) consists of two identical coil halves (anterior and posterior) that each contain a transmit loop and 4 receive-only channels. These are driven in a Helmholtz-like configuration with tuning that was very robust against variations in their distance. The ^{23}Na receive-elements (6 × 20 cm) are centred on the transmit loops. Rx elements are decoupled using a shared inductor design. All Rx elements are actively decoupled by a tuned ^{23}Na trap whilst the Tx loops contain switched PIN diodes for detuning. Tuned and shielded cable traps are used to avoid further coupling in the connecting cables. ^{1}H traps permit the use of the Tx/Rx ^{1}H body coil.

3D Acquisition

The sequence is a k-space stack of Ultra-short TE 2D acquisitions (stack of spokes). The addition of a slice phase encoding gradient after half-pulse excitation adds < 200 µs to TE. Imaging parameter were TR 20 ms 4 × 4 × 30 mm with an acquisition time of 8 min, TE ~0.5 ms is dominated by the duration of the RF pulse. No gating was performed. Reconstruction was implemented on the scanner, which performs regridding of the centric-radial data (in 2D) and then uses a conventional Fourier Transform in the slice selection direction. The accuracy of image reconstruction was confirmed at both the sodium and proton frequencies.

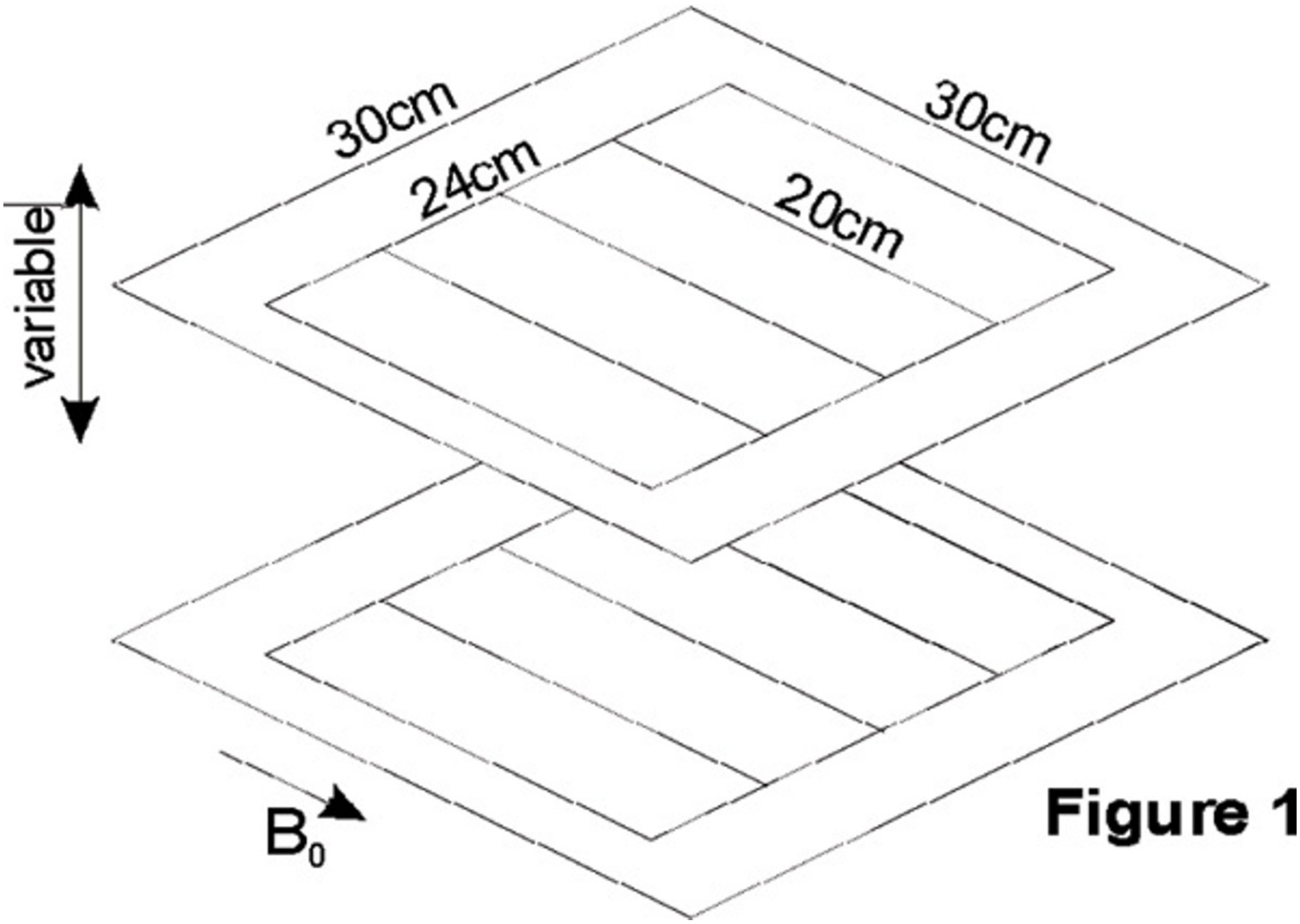

Figure 1

Results

RF Coil

The Q factor of the Rx elements drops from 220 by a factor of 2.8 when loaded physiologically. The Q drop of the Tx elements is 5.5. The shared inductor method did allow decoupling of neighbouring elements resulting in a decoupling better than -20 dB. The active decoupling of the Rx elements as well as of the Tx loops is better than -20 dB.

3D Acquisition

Fig. 2 shows the HLA view of (left) a ^{1}H True FISP acquired with the 1 H body coil and (right) the corresponding 2D-UTE ^{23}Na image (8 mins).

Discussion

The Q drop of the elements proves sample noise dominance and confirms that it makes sense to use array technology for improving SNR in ^{23}Na imaging of the heart at 3 T. The 3D stack of spokes approach provides a method that offers rapid reconstruction, short TE and efficient coverage of k-space when sampling at non-isotropic spatial resolutions. It also has the benefit of being amenable to acceleration, which is challenging for the Twisted Projection method [3]. Further developments will focus on removing blurring due to respiratory and cardiac motion.

References

1. Lee , *et al.*: *MRM* 2000, **43:**269-277.
2. Lee , *et al.*: *MRM* 2006, **55:**1132-1141.
3. Boada , *et al.*: *MRM* **38:**1022-1028.

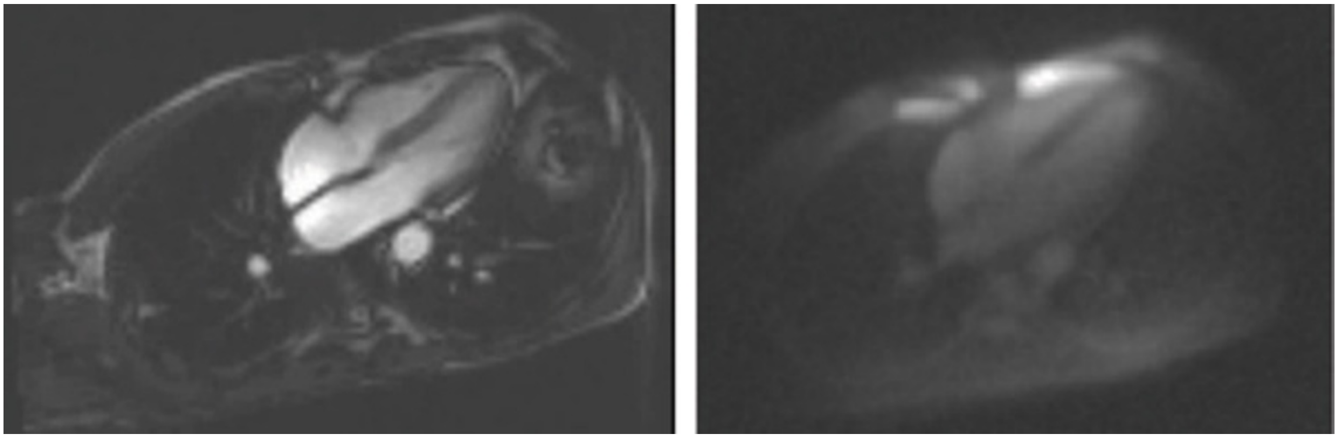

Figure 2
Proton image True-FISP 8 sec (left) and sodium image 8 min 2D-UTE. Sodium imaging is presented using a 3 T MRI system, an 8 channel RF array, and 3D imaging methods. The acquisition incorporates a ultra-short TE (UTE) and benefits from non-isotropic resolution. Considerable improvement is found over previous 1.5 T single channel methods.