Prospective real time correction of head motion using NMR probes at 7 Tesla

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INTRODUCTION

Motion is one of the primary sources of artifacts in MRI. High resolution neuroimaging at ultra high fields is particularly sensitive to millimeter level head motion. Nuclear magnetic resonance (NMR) probes have recently been employed successfully to correct for rigid body motions at 1.5 Tesla [1,2]. We have previously demonstrated correction of synthetic motion at 7 Tesla using this technique [3]. Here, we report the use of NMR probes for prospective motion corrections of real in vivo head motion in high-resolution gradient echo (GRE) imaging at 7 Tesla.

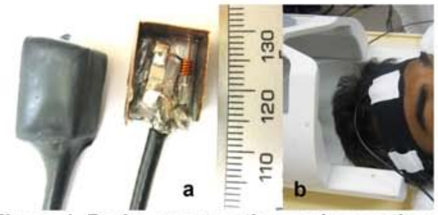

Figure 1. Probe construction and mounting on a volunteer's head.

METHODS

Three receive-only ^{1}H probes were built for use on a whole-body 7 Tesla MR scanner (Philips Healthcare, USA) with a 32 channel receive head coil (NOVA Medical, USA). Each probe (Figure 1a) contained a 1 mm outer diameter glass capillary filled with 2.5mM gadolinium-doped tap water, within a copper wire solenoid. Copper plate shields around the probes reduced the signal pickup from the head. The probes were mounted on the volunteer's head using an elastic headband with pockets (Figure 1b) and connected to three receive channels on the RF interface box.

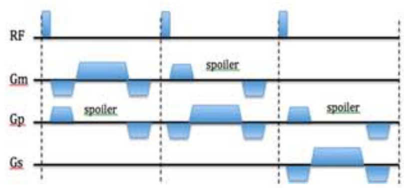

Figure 2: Probe navigator (T_{aq}= 12ms)

A 12 ms linear navigator with three non-selective 3° excitation pulses was interleaved every TR for 3D position encoding of the probes (Figure 2). Probe position data were extracted and analyzed in real time on the scanner spectrometer to calculate rigid body rotation and translation parameters as reported in [1]. Imaging geometry was then updated prospectively to compensate for the motion in 6 degrees of freedom (DOF).

High-resolution GRE scans with four motion patterns: **1.** Stationary head, **2.** Slow continuous random motion, **3** Right-Left nodding, **4.** Foot-Head nodding (through slice) motion, were performed with normal volunteers to evaluate the system (1 mm^3 voxel, 256^2 matrix, TR/TE = 40/4 ms). Scans were performed without and with real time motion tracking and compensation.

RESULTS

Figure 3 shows images without and with prospective motion correction demonstrating effective real time compensation for each type of motion tested. Particularly significant improvements in image quality are seen in the frontal areas of the brain. Motion parameters shown for scans 3 and 4, exemplify the compound 6 DOF motion handled by the system. In scan 4, spin history shading effects due to through plane motion are also corrected.

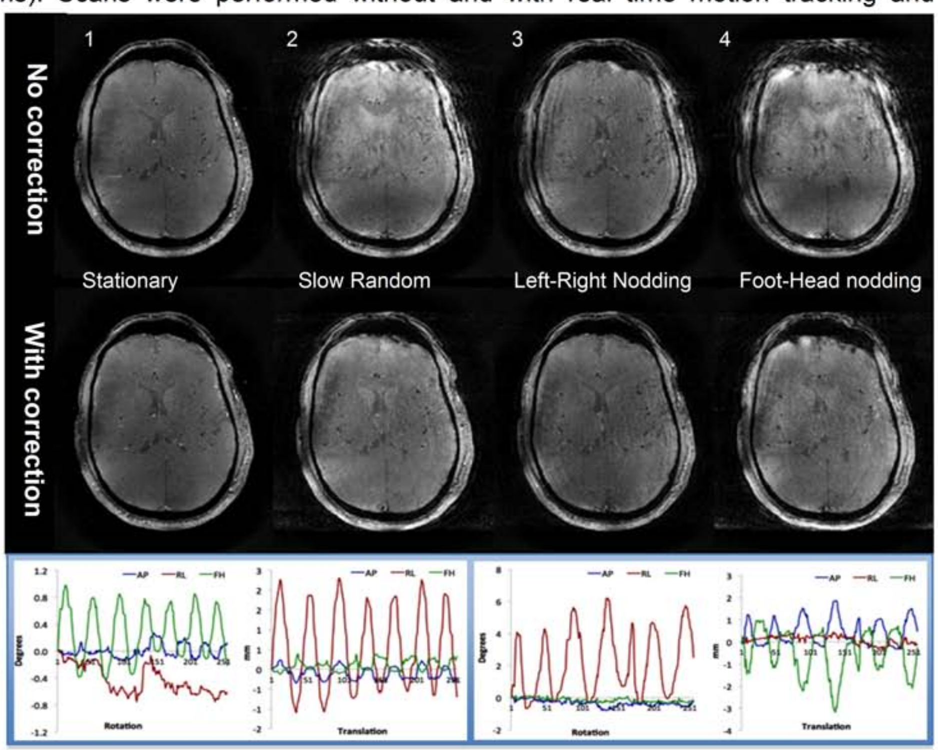

Figure 3. GRE images with and without motion correction and rotation and translation parameters for motion corrected scans 3 (Left-Right nodding) and 4 (Foot-Head nodding).

DISCUSSION

Future work will focus on improvement of system accuracy, precision, robustness and time requirements. Motion correction is being applied to high resolution functional and diffusion experiments at high field and the improvements quantified.

REFERENCES

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