Real-time Compensation for B0 Field Drift in Proton Echo Planar Spectroscopic Imaging Improves Water Suppression Efficiency

T. Li[1], P. Mullins[1], S. Posse[1]

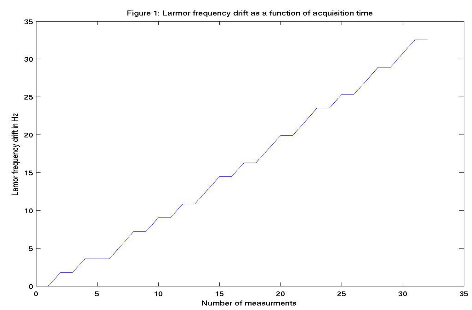
[1]MIND Imaging Center, Albuquerque, NM, United States

Introduction:

The acquisition times for spectroscopic imaging are typically long (1) and in prolonged acquisitions the B_0 field experiences significant drifts due to shim coil heating and other factors (2,3). This problem is even more pronounced in Proton-Echo-Planar Spectroscopic Imaging (PEPSI) due to rapid gradient switching (4). By implementing an automatic frequency shift method for the PEPSI sequence, matching the measured drifts in B_0, we show improved and consistent water suppression *in vivo* in long PEPSI acquisitions at 4T.

Methods:

Measurements were performed on healthy volunteers using a 4 Tesla Bruker MedSpec scanner, equipped with TEM head coil and Sonata gradients. PEPSI data were acquired from a para-axial slice at the upper edge of the ventricles with TR 2 s and short TE (20 ms), using 32x32 or 64x64 spatial matrix, minimum pixel size of 3 mm and 8-step phase cycle. A 3-pulse CHESS water suppression module with Gaussian RF pulses (60 Hz bandwidth) was used. Complete 8-slice outer volume suppression was applied along the perimeter of the brain. Saturation pulse flip angles were optimized to minimize lipid contamination. Individual averages were stored separately. Even- and odd-echo data were reconstructed separately using a water reference scan for automatic phasing and frequency shift correction as described in (4). To characterize the B_0 drift, multiple experiments were performed on both a phantom and human subjects using a total measurement time of 38 mins. Frequency shift of the water peak over time was monitored and a consistent pattern was found. We then applied automatic frequency correction using a look-up table, correcting the water suppression frequency with each measurement within the PEPSI sequence to account for this drift.



Results:

Typical examples of the field drifts in Hz in a scan with 6mm spatial resolution as a function of acquisition time are shown in figure 1. Maximum frequency drifts were in excess of approximately 1 Hz per minute. Figure 2 shows the residual water peak in a representative voxel at different stages of the acquisition in an *in vivo* study, demonstrating the reduction of water suppression efficiency due to a 31Hz of field drift over 38 minutes. Residual water increased 6-fold during this measurement. Figure 3 shows the variation of the much reduced residual water signal of the same voxel in the same subject with real-time frequency drift correction. Since water suppression efficiency is maintained across all measurements, a marked improvement of water suppression in the final averaged spectrum was obtained.

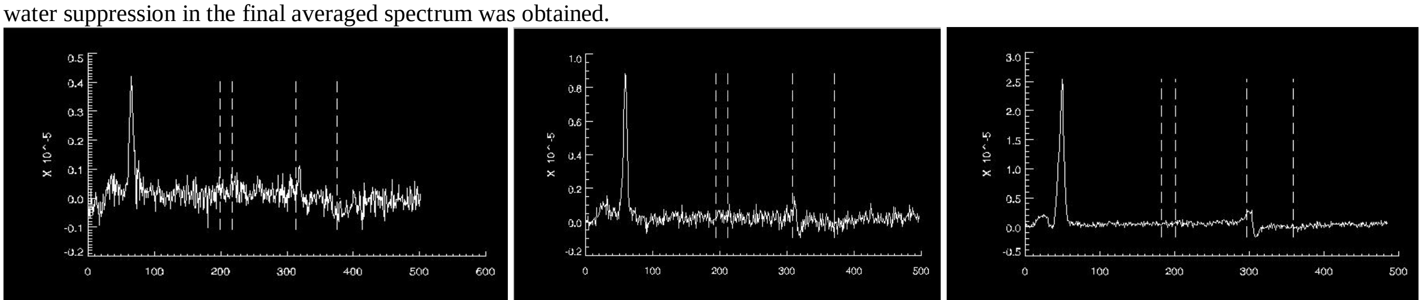


Figure 2. Residual water peak at the 1st, 16th and 32nd measurements with 6 mm spatial resolution *in vivo*

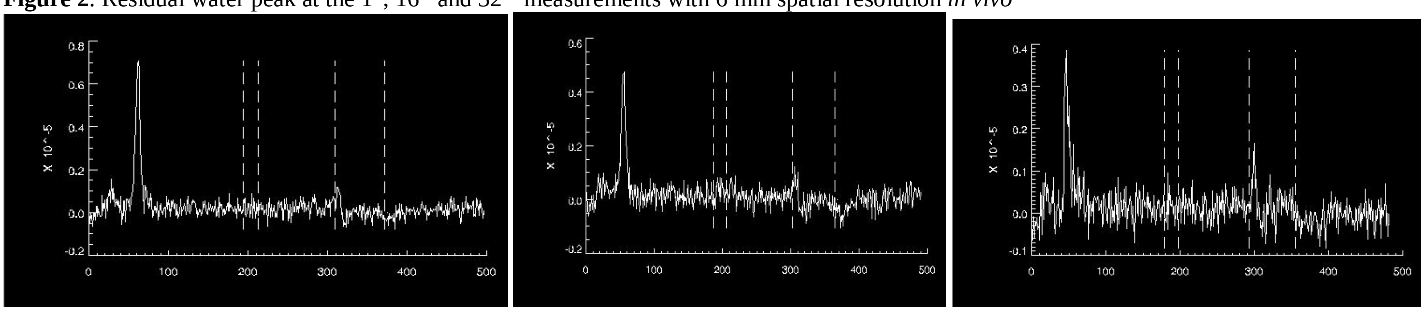


Figure 3. Residual water peak after using frequency correction at the same time points in acquisition as shown in figure 1.

Discussion:

Multiple *in vivo* and *in vitro* experiments show that the B_0 field drift introduces significant water artifacts in long acquisitions, and that our compensation method can considerably reduce residual water artifacts over time. To make the compensation more robust, we plan to insert interleaved navigator scans into the PEPSI acquisition, allowing online measurement of B_0 drifts and hence even more precise real time compensation of field drifts due to shim heating or other causes.

References: (1) Thiel T, *et al*. Magn Reson Med. 2002 Jun; 47(6):1077-1082. (2) Henry PG, *et al*. Magn Reson Med 1999; 42(4):636-642. (3) Tkac I, *et al*. Magn Reson Med 1999 Sep; 42(6): 997-1003. (4) Posse S, *et al*. Magn Reson Med 1995; 33: 34-40.

Supported by NIDA 1 R01 DA14178-0 and the MIND Institute