Extending the Sensitivity Volume of Surface Coils for Spectroscopy at 7T by Using Deuterium Water Bags

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INTRODUCTION

Ultra-high field spectroscopy poses new challenges caused by dielectric effects in samples with size comparable to the frequency of sampling. Highly inhomogeneous B_1 patterns can be seen even in homogeneous phantoms and despite the use of volume coils. These patterns are even more pronounced when surface coils are used. Still, the high sensitivity of surface coils makes them a valuable tool for spectroscopic sampling of nearby regions. While the idea of using dielectric pads for B_1 shimming for imaging is well known (1-6), their use in spectroscopy has not been evaluated. Moreover, the published data are on the use of water pads. Here we demonstrate the effectiveness of utilizing D_2O bags in *directed extending* the sensitivity volume of surface coils to improve SNR in proton spectroscopy at 7.0T. This study was necessitated by our attempts to perform MRS on human tibialis anterior, which is an important muscle in metabolic studies, and on tibial bone marrow, with the use of a surface coil, while keeping the subject in a comfortable supine position.

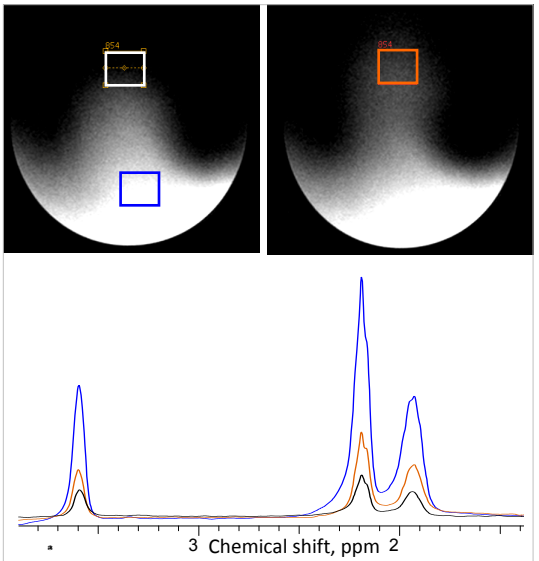

Fig.1. Images and MRS of a phantom either without (left) or with (right) D_2O bag placed on top of the phantom. The D_2O bag is seen to "pull" the RF field up. MRS compares SNR from a voxel close to the RF coil (blue) vs. far from the coil (black) vs. with the D_2O bag (orange).

MATERIALS AND METHODS

All spectra were acquired on a whole-body 7T scanner (Achieva, Philips Medical Systems, Cleveland, USA) using a partial volume (7-cm radius half cylinder) quadrature surface coil. The coil had two partially overlapping 12 x12 cm loops. All human volunteers were scanned according to the local IRB protocol. Volunteers (n = 4) laid on their back and the coil was placed under the left calf .The intensity distribution of T2 Fast Spin Echo (FSE) and the SNR of STEAM spectroscopy of human tibial bone marrow were compared in three cases: 1.) With the placement of a 1L sterile water bag on top of the leg, 2.) With 1L D_2O (99%) bag, and 3.) with no water bag. Spectroscopic sampling of the tibial bone marrow was chosen due to its increased distance from the coil and the inability to perform spectroscopy on it using the surface coil and conventional methods. To show directed extending of sensitive volume, phantom data was also collected placing the sterile H_20 and D_20 bags at different locations anterior to a 1L bottle filled with 200 mM glutamate.

RESULTS AND DISCUSSION

Figure 1 shows that placing a D_2O bag on top of the phantom extends the sensitivity volume of the surface coil. There was a 2-fold increase in the SNR of STEAM spectra from identical voxels. Figure 3 shows similar results *in vivo*, from the tibial bone marrow where there was a 4-fold increase in SNR with the use of the bag. Figure 2 shows the ability to selectively "pull" the RF field preferentially, depending on the position of the bags. Although in Figs.2. and 3 we used H_2O bags for illustrative purposes, the use of D_2O bags is preferred as they will not introduce extraouneous signal that may cause folding artifacts or hamper image windowing / leveling.

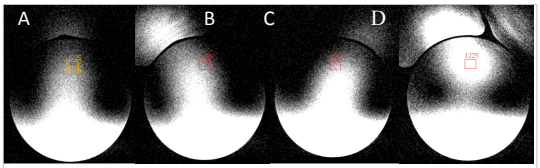

Fig. 2. Directing the RF by using a H_20 bag on top (A), top-left (B), top-right (C), or with two bags (D).

In conclusion, in this abstract we demonstrate in phantoms and *in vivo*, that SNR can be dramatically improved in MRS at 7.0T, by using a D_2O bag.

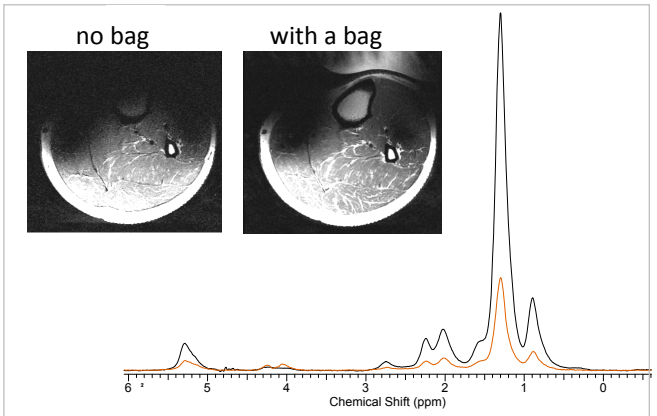

Fig.3. Increasing the SNR of a surface coil both in MRI and MRS with the use of dielectric bags. For illustrative purposes a sterile water bag was used. The SNR from a voxel in the bone marrow increased 4-fold in MRS (black line) vs. when no bag was used (brown line).

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