Increased signal-to-noise in high field localized spectroscopy of the temporal lobe using new deformable high-dielectric materials

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Introduction. Localized spectroscopy in human brain has been shown to benefit greatly from increases in static magnetic field. Spectra in the occipital lobe, for example, allow quantification of up to 20 metabolites [1-3]. In many neurodegenerative diseases, especially Alzheimers, it is highly desirable to obtain spectra from areas of the brain such as the temporal lobe. However, using commercial volume resonators, these areas are known to give very poor S/N due to destructive interference of the B_1^+ transmit fields [4]. If the temporal lobe alone were of interest, then a small transmit/receive surface coil could be used to overcome the low sensitivity. In practise, most clinical exams require spectra to be obtained also from structures deep within the brain, e.g., the basal ganglia. In this study we investigate the use of new high dielectric constant materials [5] placed next to the head to increase the S/N in the temporal lobe.

Methods. All experiments were performed on a 7 Tesla whole-body magnet (Philips Achieva). A dielectric pad was prepared using a slurry of 40% v/v calcium titanate in de-ionized water, to give a deformable mixture with a dielectric constant of ~110 with a short T2 of ~12 ms. B_1 maps were acquired using a double-TR method. Localized spectra were acquired with and without the bag placed on the side of the head. RF pulses were calibrated separately for both cases using volume-selective power optimization [6]. For localized spectroscopy, a STEAM sequence was used with TR/TM/TE values 2000/28/17 ms, 128 averages, BW 3 kHz, 2048 complex data points, total acquisition time per spectrum 4:32 minutes.

Results and Discussion. Figure 1(a) shows an axial slice of a T_1 weighted sequence at the level of the temporal lobe with the bag visible on the right side of the head (radiological convention). The increase in signal intensity, as well as increased gray matter/white matter contrast indicating a greater tip angle, is evident. The values of the B_1^+ in the temporal lobes were 11 μT and 6 μT (1500 Watt input power), with and without the bag, respectively. The S/N of the spectrum was increased by a factor-of-three on the right side of the brain compared with the same-sized volume placed on the contralateral temporal lobe, as illustrated in Figures 1(b) and (c). The acquired B_1 maps also showed that the transmit field in the centre of the brain was reduced by less than 5% by using this dielectric pad, and therefore spectra from other regions of the brain do not suffer a significant sensitivity loss due to its presence. The use of this high dielectric material, therefore, means a clinically highly significant reduction in the required data acquisition time for localized spectroscopy of the temporal lobe.

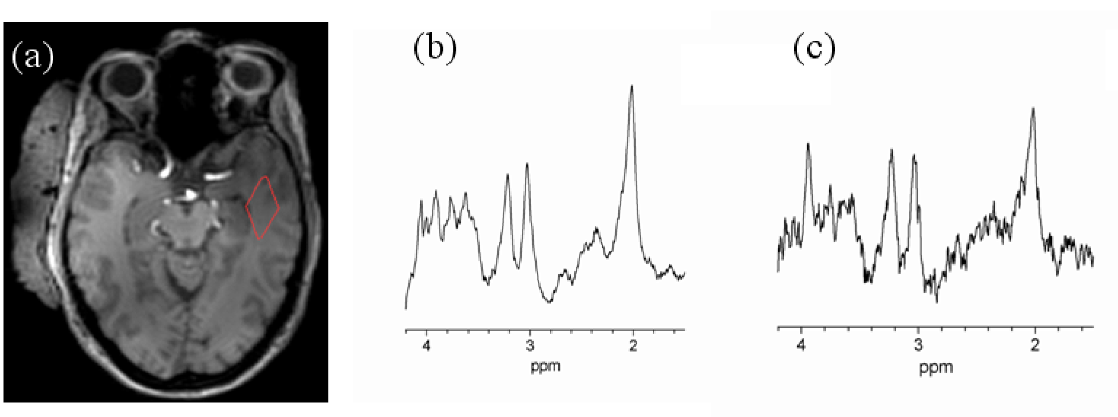

Figure 1. (a) Scout axial slice through the temporal lobe regions. The dielectric bag appears isointense to the brain matter on the short echo time scan. The dielectric bag on the left increases the B_1^+ magnitude by a factor-of-two compared to the identical region on the other side. The red diamond indicates the location of the voxel used for STEAM spectroscopy. (b) Localized spectrum obtained from the temporal lobe adjacent to the dielectric bag. (c) Corresponding localized spectrum on the contralateral side of the brain.

References. [1] I.Tkac et al. Magn.Reson.Med. 46, 1279, 2001. [2] I.Tkac et al. Magn.Reson.Med. 62, 868, 2009. [3] R.Mekle et al. Magn.Reson.Med. 61, 1279, 2009. [4} C.M.Collins et al. J.Magn.Reson.Imag, 21, 192, 2005. [5] K.Haines et al. J.Magn.Reson. 200, 349, 2009. [6] M.J.Versluis et al. Magn.Reson.Med. in press, 2009.