MULTI-CHANNEL B0 CRUSHER COIL FOR LIPID SUPPRESSION IN MRI AND MRSI

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Introduction: Proton MR spectroscopic imaging (MRSI) provides spatially resolved metabolic information mapped of the human brain. Spatial resolution in MRSI is limited by the relatively low SNR, due to the relatively low concentrations as well as the long TR of most MRSI sequences. Moreover, one needs to exclude signals from the skull that contain high intensity lipid signal in a poorly shimmed environment, causing corruption of the spectra in the brain due to point-spread and ghosting. To mitigate these effects, practically all MRSI sequences applied to the human brain use either volume preselection boxes (i.e. STEAM, PRESS, sLASER) and/or outer volume suppression (OVS). As a consequence, repetition times (TR) will be long hence the sampling duty-cycle in MRSI are typically very low (i.e. < 10%), and especially at high field, this leads to suboptimal SNR per unit of time. As a solution, an B_0 crusher coil [1] can be employed to dephase extracranial signals [Boer MRM 2014] and relieve the need for RF based lipid suppression. So far, the crusher coils were limited to a single channel, where the spoiling depth can only be regulated by changing the driving current. Here we show the results with a multi-channel crusher coil, to adapt the crusher field to the shape of the brain, and the slice of interest.

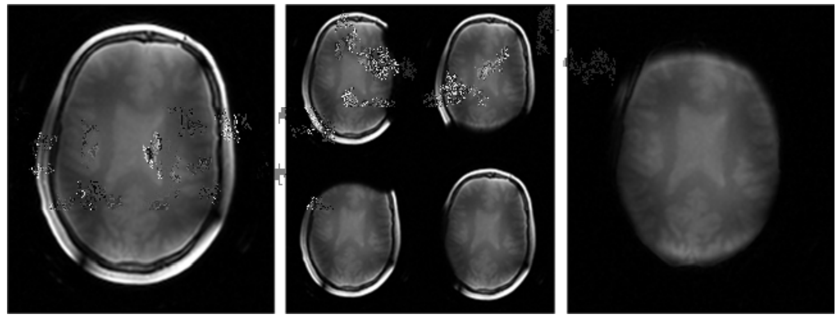

Figure 1. Anatomical reference (left), the four independent channels of the crusher coil (middle) and the combined effect (right) at 7T.

Methods: A four-channel crusher coil was developed (MR Coils BV) and used in a 16-channel (Nova Medical, USA) receiver array. The crusher coil was interfaced to four of the B_0-shim amplifiers (10A max) of the 7T system (Philips, Cleveland) and controlled via a commercially available dynamic shim update unit (Resonance Research Inc, USA) to switch on between the RF pulse and signal detection. Both imaging and fast slice selective pulse-acquire MRSI (TE/TR=2.5/200ms, 1cc voxels, 3:28min acquisition time, SPOKES-water suppression [3]) were performed with application of the crusher coil for lipid suppression.

Results: Effective steering of signal crushing can be obtained with the use of a multi-channel inserted crusher coil. By adapting the driving currents of the four coil-parts, the crushing field can be adapted to fit the shape of the brain (figure 1). Since the crushing does not require any additional RF power deposition, fast and SNR optimized MRSI is feasible as indicated by the high spatial resolution and effective suppression of signals from the skull (Fig 2).

Discussion: High resolution MRSI is feasible by replacing SAR demanding localization and outer volume suppression techniques with a local crusher coil. As head shapes and sizes vary, it is essential to be able to adapt the crushing field to the anatomy of interest. Although several versions could be created to fit varying head sizes, we show here it is also possible to shape the crushing field using a multi-channel crusher coil. With a shaped crushing field, optimal lipid suppression can be performed in MRI and MRSI.

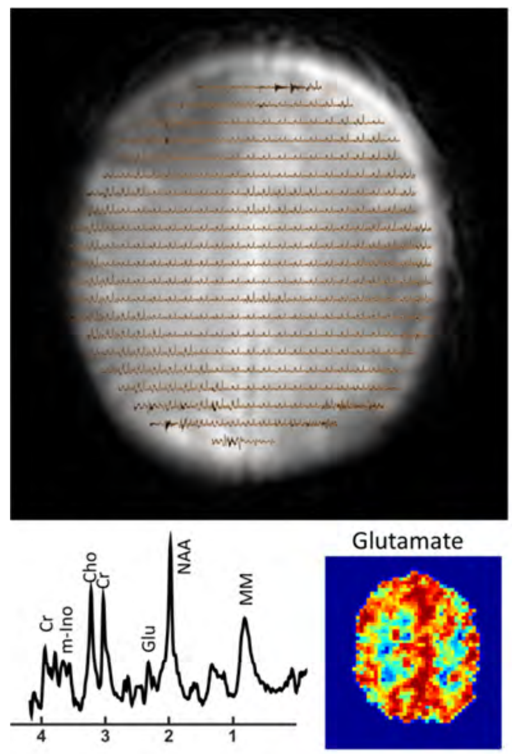

Figure 2; example of a pulse-acquire MRSI dataset, acquired in 3.5 minutes (1cc voxels), acquired with lipid suppression by the crusher coil. Excellent spectral quality is seen in 95% of the voxels.

References

1. Poole, Concepts Magn Reson B 2007.
2. Boer MRM 2014
3. vd Lindt, ISMRM 2013