LIPID SUPPRESSION WITH A CRUSHER COIL FOR FAST AND ACCURATE IMAGING

In magnetic resonance imaging (MRI), the presence of lipid signals surrounding the tissue of interest can significantly interfere with image quality and contrast. Lipids produce a bright signal that hampers the visualization of other structures and may contaminate the signals from metabolites in magnetic resonance spectroscopic imaging (MRSI).

To overcome these challenges, lipid suppression techniques are often employed in imaging sequences. Lipid (or fat) suppression enhances contrast and enables accurate assessment of tissue characteristics. However, traditional lipid suppression schemes have drawbacks, such as limited efficiency due to inhomogeneous radio-frequency (RF) field and increased overhead on the scan time. These limitations are further exacerbated at ultra-high field (UHF) strengths where there are more strict specific absorption rate (SAR) limits.

In this white paper, we present a more elegant approach to suppressing skull lipids, namely a hardware solution [1] that shapes magnetic fields in the lipid regions to suppress the signal. This solution can save scan time and efficiently suppress the lipid signal in any imaging sequence.

Innovative Technology

C***arme*** [2] is a novel crusher coil technology designed specifically for effective skull lipid suppression during brain imaging. It consists of two-channel local B0 shim coils driven with real-time amplifiers. By shaping the magnetic field, *Carme* creates a destructive crushing field over the skull lipids during excitation, effectively eliminating their signal during the scan without any modifications to the imaging sequence.

Carme crusher coil helmet insert

The helmet-insert design ensures easy and detachable installation without any modification to RF coil or MRI setup. The two-channel design accommodates different head shapes and sizes, allowing for homogeneous suppression of lipid signals.

No modification to the scanner room's filter panel is needed and the system is synchronized with the scanner using a TTL trigger signal.

Case Study

To evaluate the performance of the *Carme* crusher coil, a case study [3] was conducted with two objectives: (1) to assess the crushing performance of the crusher coil compared to unsuppressed imaging, and (2) to compare the lipid suppression performance of the crusher coil with the traditional fat saturation (FAT-SAT) technique.

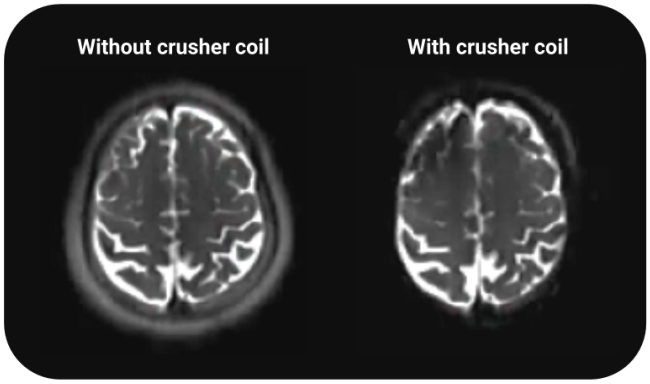
For the first study, a T2-weighted brain imaging sequence was used at a Siemens 3T Prisma scanner [4] , with the 32-channel head-neck RF coil. The sequence parameters were TE/TR = 100/2000ms. Images were acquired once with and once without the use of crusher coil. No lipid suppression scheme was used in the sequence in either case.

The results showed that the Carme crusher coil was able to effectively suppress skull lipids, effectively eliminating their signal from the image.

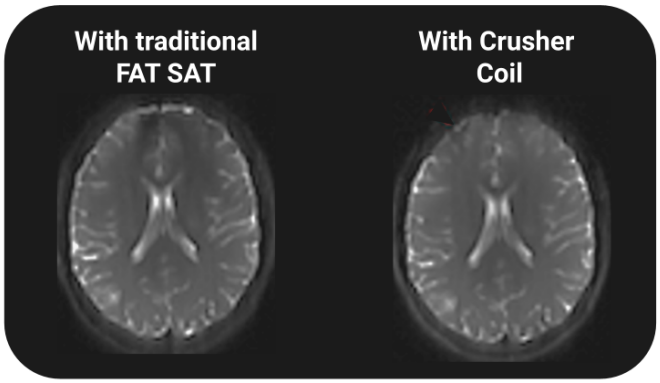
In the second study, a diffusion-weighted imaging (DWI) sequence was employed using the same scanner and RF coil setup. Images were acquired once with a conventional FAT-SAT scheme in the sequence and once with the crusher coil and without any FAT-SAT in the sequence.

The results demonstrated that the performance of lipid suppression using only the *Carme* crusher coil was comparable to that achieved with the conventional FAT-SAT scheme. This finding suggests that the lengthy and SAR intense sequence-based fat suppression can be effectively replaced by the crusher coil, simplifying the imaging process and shortening the scan time.

By reducing the burden on the imaging sequence, the crusher coil can save significant scan time and SAR consumption while efficiently nulling the lipid signal



T2-weighted imaging with and without the crusher coil showcasing efficient suppression of lipid



DWI images showing the efficiency of crusher coil is comparable to traditional FAT-SAT and can replace it efficiently

Conclusion

By providing an efficient hardware solution for skull lipid suppression, the Carme crusher coil technology eliminates the need for additional scan time or modifications to the existing imaging protocols. It offers a significant advantage for various brain imaging sequences, including functional MRI (fMRI), DWI, echo-planar imaging (EPI), arterial spin labeling (ASL), quantitative susceptibility mapping (QSM), and spectroscopy. This technology can be seamlessly integrated into the existing MRI setup at any field strength, enabling researchers to obtain clearer and more accurate data by effectively suppressing the interfering lipid signal.

[1] Boer VO et al, "Lipid suppression for brain MRI and MRSI by means of a dedicated crusher coil." Magn Reson Med. 2015 Jun;73(6):2062-8. doi: 10.1002/mrm.25331. Epub 2014 Jun 19. PMID: 24947343.

*[2] **CAUTION**: Not a medical device. Limited by Federal (or United States) law to investigational use.*

[3] Conducted at Donders Institute for Brain, Cognition, and Behaviour

[4] All product and company names are the registered trademarks of their original owners. The use of any trade name or trademark is for identification and reference purposes only.

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