The spurious echo artefact in 1H-MRS and PRESS

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Introduction

The spurious echo artifact (Fig.1) is often encountered in *in vivo* magnetic resonance spectroscopy (MRS). It originates from signals excited in regions outside the selected volume that refocus into an echo during the signal acquisition (1). The artifact is once again actualized, with application of MRS in more susceptibility influenced regions where a decreased size of the selected volume often results in larger shim gradients. **Aim:** To describe, verify and characterise the spurious echo artefact using k-space formalism and *in vitro* measurements.

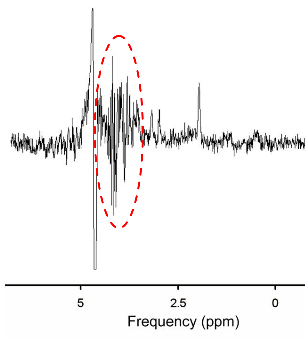

Fig.1. An example of an *in vivo* spurious echo artifact in a brain spectrum.

Material & Method

K-space formalism was used as a new approach to analyze the spurious signals in the PRESS sequence (Fig.2). By *in vitro* studies the spurious echoes from the magnetic coherences of the PRESS sequence were verified and characterised. Measurements were set up so that the only signal giving material, a small sphere (Ø 4 cm, EEC-solution), was kept outside the VOI but crossing chosen slice/slices of the sequence (Fig. 2B). Ideally the spectra should then only contain noise. Using a linear shim gradient the different coherences were refocused into spurious echoes. All phase cycling was turned off.

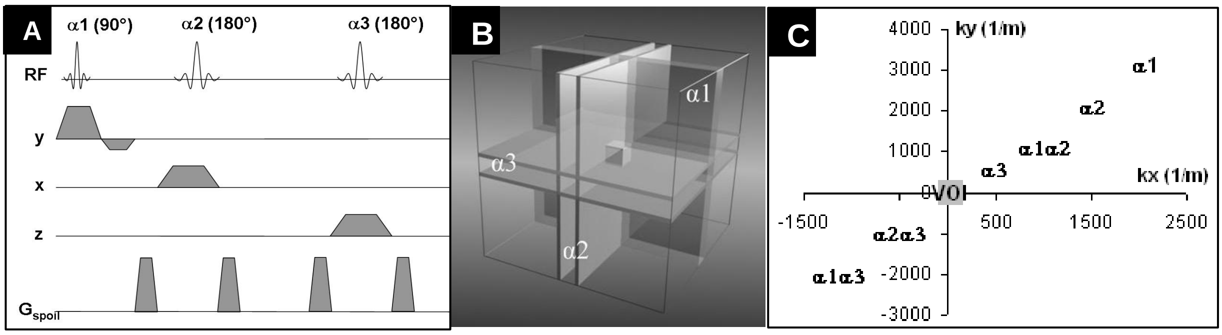

Fig.2. A) A PRESS sequence with the RF-pulses, slice selection and spoiling gradients. B) The corresponding excitation slice regions and C) approximate k-space coordinates (1/m) for the PRESS coherences before the start of acquisition.

Results & Discussion

The k-space formalism facilitates a good geometrical view of the problem, and is also well suited for studying gradient spoiling and refocusing effects. The spurious echo artifact was verified and characterized by measurements. The coherences of the PRESS sequence were separately refocused by linear magnetic field gradients and the artifact appeared as a complex, spectrally demarcated structure at various positions. The free induction decay of the second 180 degree pulse (the α3-pulse) was the most probable to cause an artifact and also caused the most pronounced artifacts (Fig.3). All other partitions are less likely to cause an artifact during an *in vivo*-measurement with *in-vivo* shim gradients (data not shown).

The times when the maximal amplitudes in the time domain signals were found and the calculated times for refocusing, i.e. time for passing through origo of k-space, agreed very well.

The spurious echo artifact can be minimized in several ways, e.g. by adapting the orientation of the VOI so that the α3-slice does not cross regions where the phase cycling is probable to fail, e.g. motions, or by adapting the spoiling gradient direction to the actual shim gradient direction.

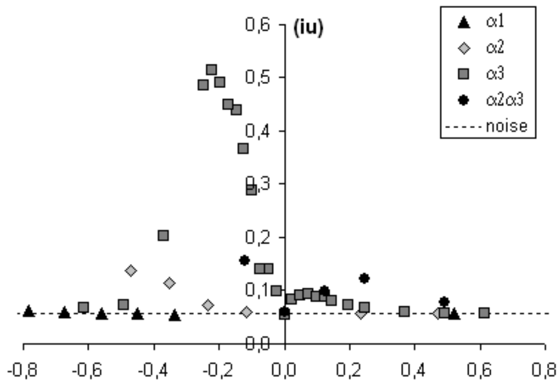

Fig.3. The integral of the time domain signal (institutional units) at different gradient strengths (mT/m) for the α1 (▲), α2 (♦), α3 (■) and α2α3-artifacts (●) and a mean noise level (---). The x-axis shows the gradient strength, i.e the velocity through k-space. The gradient direction was always towards or from origo of k-space. For α1, α2 and α3 negative values show velocity towards origo and for α2α3 it is the opposite, i.e. positive values are towards origo.

Reference

1. Ernst, T.*et al.* Magn Reson Med, 1996. **36**(3): p. 462-8.