ATTENUATION OF SIGNAL FROM MULTIPLE TISSUE TYPES WITH SINGLESHOT INVERSION RECOVERY RADIAL STEADY STATE IMAGING

Thomas Benkert[1], Martin Blaimer[1], Peter M. Jakob[2], and Felix A. Breuer[1]
[1]*Research Center Magnetic Resonance Bavaria (MRB), Würzburg, Bavaria, Germany,* [2]*Experimental Physics 5, University of Würzburg, Würzburg, Bavaria, Germany*

Target audience: Clinicians and physicists who are interested in the generation of images with tissue types cancelled, steady-state imaging or radial imaging.

Purpose: Inversion recovery (IR) techniques are frequently used in order to suppress one particular species, e.g. CSF fluid in FLAIR imaging [1] or fat in STIR imaging [2]. However, these techniques have their limitation. A single inversion time (TI) has to be chosen prospectively, resulting in only one contrast per IR experiment. The purpose of this work is to present a method, which allows the generation of several images with multiple tissue types attenuated within a single experiment.

Methods: Fig. 1 shows the simulated signal course of an IR measurement of two exemplary species with different relaxation times. By choice of an appropriate reconstruction window around the zero crossing of species 1 and the summation of the corresponding signals (with regard to their signs), species 2 yields high positive signal, while the signal of species 1 is zero. In this way species 1 is cancelled, while species 2 and other species (with different relaxation times) still contribute signal. This simple consideration can be transferred directly to the radial sampling scheme, since all acquired projections travel through the contrast defining k-space center and hence are also summed up. Inserting the signal evolution of the used inversion recovery steady state technique (e.g. [3]) into equation 1 yields the position of the required reconstruction window to cancel a species with defined relaxation times.

Existing solutions to generate different contrasts out of a singleshot measurement usually apply a view-sharing technique like the KWIC-filter [4,5]. However, this special k-space filter has to be implemented and a couple of parameters have to be tuned for each case in order to obtain the best results. In order to compare these two approaches, in vivo measurements were performed on a 3.0 T clinical scanner. 1500 radial projections were acquired using a golden-ratio based IR bSSFP sequence with the following parameters: TR = 4.8 ms, matrix = 256, slice thickness = 5 mm, total scan time = 7.2 s. Standard NUFFT gridding [6] was employed on several reconstruction windows to obtain contrasts with different species cancelled. Corresponding images using the KWIC-filter technique were reconstructed for comparison.

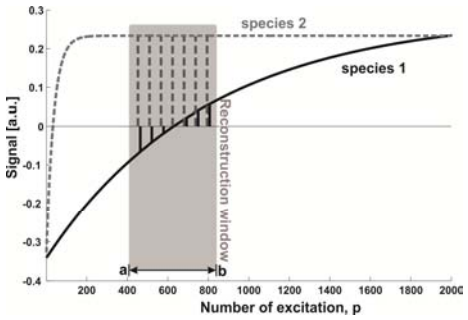

Fig. 1: Simulated signal course for two different species

$$\int_a^b S(p)dp = 0$$

Eq. 1: S(p) is the signal of an inversion recovery experiment after p excitations. a/b is the left/right border of the reconstruction window.

Results: Fig. 2 shows different contrasts obtained with the proposed reconstruction technique as well as with the KWIC-filter technique. Nearly no differences can be seen. In Fig. 3, the CNR between ROIs in white matter and CSF is plotted along the extracted image series, also revealing a similar trend.

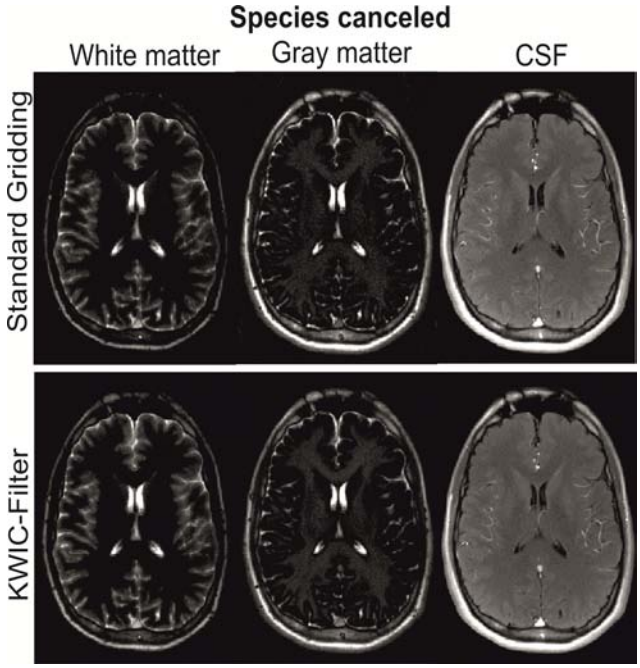

Fig. 2: Different contrasts obtained with conventional gridding and KWIC-filtering

Discussion/Conclusion: We have shown that multiple images with different tissue species cancelled can be extracted out of one singleshot IR experiment by using a common radial sliding window reconstruction scheme. Thus, no fixed TI is necessary and the desired contrasts can be chosen retrospectively. In comparison to filtering techniques, no additional parameters (filterdesign, smoothing,…) have to be tuned. Along with its short scan times of only ~7 seconds per slice this makes this technique a promising candidate for clinical usage.

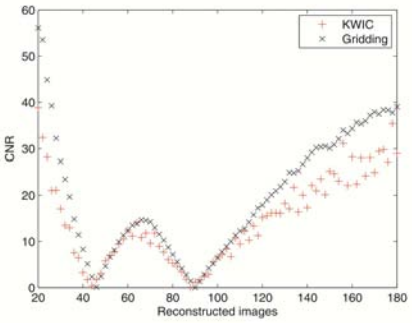

Fig. 3: Calculated CNR along extracted image series between ROIs in white

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