

Optimization of the fat fraction and T2* measurements in mice at 4.7T with the IDEAL algorithm

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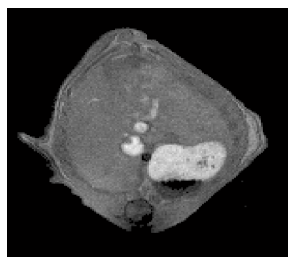


Fig. 1: MR image of a mouse, acquired in axial direction

Introduction: Fat fraction (FF) and T2* relaxation time are important biomarkers in a number of pathologies (metabolic syndrome, hemochromatosis, etc.). The IDEAL approach developed by Reeder et al. (IDEAL, Iterative Decomposition with Echo Asymmetry and Least squares estimation) allows the joint estimation of both FF and T2*. A parameter of this algorithm is the number of echoes to be acquired for an optimal reconstruction of the outputs (FF and T2*). According to Hines et al.², there exists an excellent correlation between fat fraction calculated with 6-echo and 15-echo reconstructions in mice at 3T.

The aim of the current work is to compare the fat fraction as well as T2* values calculated with the 6-echo and 15-echo reconstruction on mice at 4.7T.

Materials and methods: Four mice L-PK/c-myc were anesthetized with 2% isoflurane-oxygen (v/v). MRI measurements were performed at 4.7T (47/40 Bruker

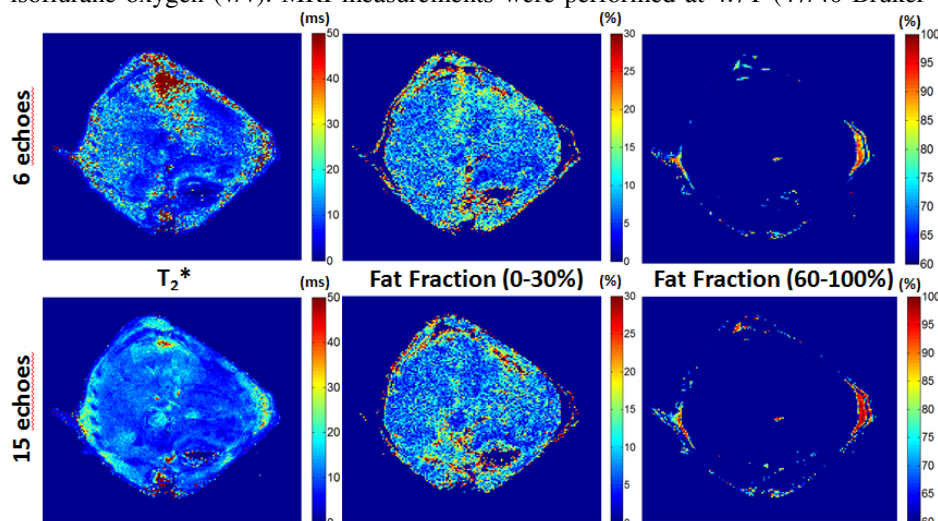


Fig. 2: T2* and fat fraction maps obtained in mice with IDEAL using the first 6 echoes (Top) and 15 echoes (Bottom) of the interleaved sequences. For a better visualization, fat fraction maps are presented in two images ranging from 0% to 30% (center) and from 60% to 100% (right).

reconstructions are shown in **Tab. 1**. With respect to the fat fraction, in accord with Hines et al.², good agreement was achieved between 6-echo and 15-echo reconstruction. It is pointed out that there is an agreement between the results of T2* at both reconstruction as well. Nevertheless, the standard deviations of the values relative to the 6-echo reconstruction are higher than the ones relative to the 15-echo reconstruction. **Fig. 2**, presents the outputs of IDEAL for the two reconstructions obtained in the slice shown **Fig. 1**. In the T2* maps, the values over 50ms were set as maximum. While the fat fraction maps are both well reconstructed, the quality of the T2* map is higher in the 15-echo reconstruction than in 6-echo reconstruction, which presents more aberrant values and more noise. This is in agreement with the results obtained in the ROIs: the red zone on top gives 1/T2* = 0.

Conclusion: In the current work, the results relative to the fat fraction and T2*, reconstructed with IDEAL, were compared using 6 and 15 echoes. Good agreement was achieved between the fat fraction values as well as T2* values, nevertheless the last parameter was better calculated with the 15-echo reconstruction.

Reference

1. Reeder S B et al. Multicoil Dixon chemical species separation with an iterative least-squares estimation method. *Magn Reson Med*. 2004; 51(1):35-45.
2. Hines C D G et al. "Quantification of hepatic steatosis with 3-T MR imaging: validation in ob/ob mice. *Radiology*. 2010;254(1):119-28.

	Fat Fraction values (%)		T2* values (ms)	
	6 Echoes	15 Echoes	6 Echoes	15 Echoes
L	7,3 ± 3,4	5,9 ± 3,9	14,2 ± 6,1	9,9 ± 1,8
L	8,2 ± 3,1	7,2 ± 3,2	13,9 ± 4,5	10,4 ± 1,5
L	6,9 ± 4,0	8,4 ± 3,2	12,9 ± 4,5	10,6 ± 1,3
L	7,7 ± 3,1	8,1 ± 4,2	16,8 ± 14,7	10,6 ± 2,5
M	8,7 ± 3,8	7,9 ± 4,1	13,9 ± 5,9	12,7 ± 1,8
M	15,1 ± 3,9	8,9 ± 3,4	35,1 ± 27,6	14,4 ± 2,0
M	14,5 ± 4,7	9,9 ± 4,5	12,8 ± 4,9	21,5 ± 6,9
M	7,2 ± 3,4	6,4 ± 2,4	21,0 ± 17,7	13,7 ± 2,1
S	89,6 ± 3,1	96,5 ± 1,8	33,4 ± 26,0	27,6 ± 7,5
S	90,3 ± 4,3	83,2 ± 9,3	17,4 ± 12,3	12,8 ± 7,3
S	91,9 ± 1,5	96,5 ± 2,2	35,1 ± 26,7	14,3 ± 2,7
S	88,9 ± 5,5	90,9 ± 5,5	7,9 ± 4,9	7,9 ± 2,4

Tab. 1: Fat fraction and T2* ROI measurements obtained on mice on different areas (L = Liver, M = Muscle, S = Subcutaneous fat): mean values and standard deviation are shown for both the reconstruction.

Biospec). Three shifted multi gradient echo (MGE) sequences were used with these parameters: echo spacing = 2.37ms, first echo time = 1.37, 2.16 and 2.79, 12 echoes, repetition time = 380ms, flip angle = 50°, field of view = 3x3cm², slice thickness 1.25mm, 8 slices, interslice distance = 1.5mm, matrix size = 160x160, bandwidth = 2x10⁵ Hz and 4 averages. The three sequences were put together to create a single sequence of 0.79ms echo spacing. All images (**Fig.1**) were processed with a homemade script in MATLAB® which reproduces the IDEAL algorithm. Mean values and standard deviation of fat fraction and T2* were obtained in ROI positioned in the liver, muscle and subcutaneous fat of the mice.

Results: Fat fraction and T2* values obtained on 6-echo and 15-echo