Short TR, Elongated Echo time Spectroscopy (STREETS) of Muscle at 3 T.

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Introduction

There has been a growing interest in non-invasive quantitation of intramyocellular lipids (IMCL) in the field of lipid metabolism, diabetes and obesity [1]. The measurement of IMCL is hampered by the fact that IMCL resonances overlap with the much larger resonances of extramyocellular lipids (EMCL). In order to overcome this limitation, a number of studies have proposed long echo time (TE) MRS as a method that would allow for a better discrimination of IMCL from EMCL [2, 3]. However, at very long TE (e.g. 270ms) the sensitivity of MRS suffers from the lower signal-to-noise ratio (SNR). Since lipids' T1 is relatively short [4, 5], we hypothesized that, it could be possible to substantially increase the lipid SNR in MRS of muscle at 3T by choosing a TR shorter than those typically employed (≥ 2s).,

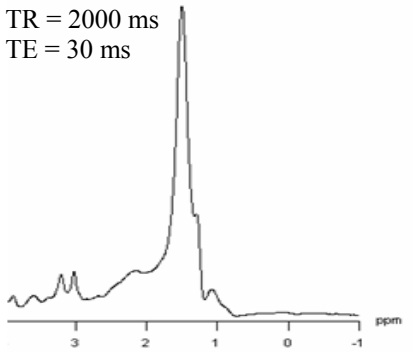

***Fig.1**. Long-TR, short-TE spectrum of soleus muscle. The IMCL resonances are overlapped by the larger signals of EMCL.*

Materials and Methods

The IMCL SNR per unit time was calculated according to Ernst and Anderson [6], for a 90° excitation, using published values of IMCL CH_2 T1 [4, 5]. MRS experiments were performed on a 3 T Tim Trio (Siemens Healthcare, Erlangen, Germany) using a PRESS sequence. Spectra at different TR (600-4000 ms) (2kHz BW, 512 complex points) were acquired from an 8 ml VOI in the soleus muscle in 4 healthy subjects.

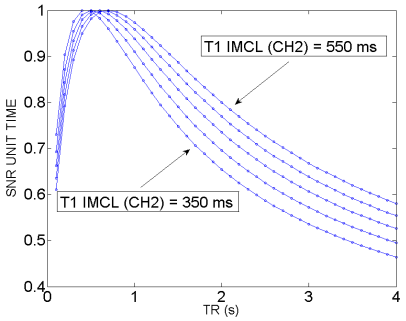

Fig.2. *SNR per unit time as a function of TR, calculated for IMCL T1 ranging from 350 ms [4] to 550 ms [5] (50 ms steps). Greatest SNR is at 500-700 ms TR.*

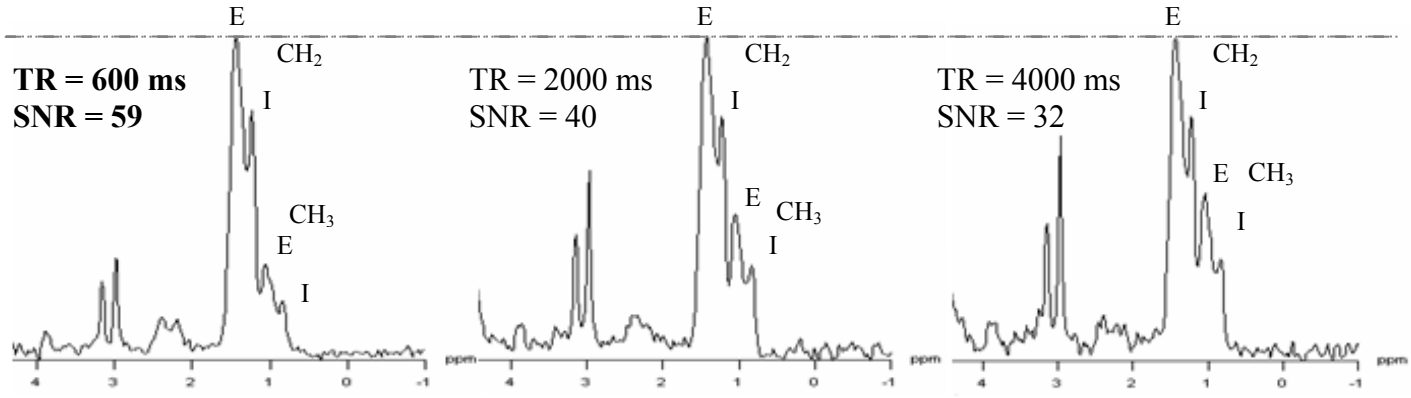

***Fig.3**. Short-TR, long-TE (**270ms**) spectrum (**left**) and long-TR, long-TE (**270ms**) spectra (**center and right**) of a VOI in soleus (scan time 30 s, same VOI location as in Fig.1). Note the increase of SNR (e.g., **noise level ~ 0 ppm**) of the I- & E-MCL CH_2 resonances as TR decreases. At short TR (**left**), note the partial saturation of creatine, choline and I- & E-MCL CH_3 resonances.*

Results/Discussion

The short-TE spectrum yielded a poor discrimination of IMCL from EMCL resonances (**Fig.1**). The simulated SNR of ICML CH_2 resonances indicates a maximum around 600 ms (**Fig.2**). Long-TE spectra (**Fig.3**) provide a better discrimination of the IMCL CH_2 (0.9ppm) and CH_3 (1.3ppm) from EMCL CH_2 (1.1ppm) and CH_3 (1.5ppm) resonances. The SNR of the IMCL&EMCL CH_2 resonances increases at shorter TR. At TR=600ms, a ~ 50% improvement in SNR (compared to TR=2s) is observed (**Table**). In order to normalize fat ratios, correction for partial T1 recovery must be applied. As these corrections are commonly applied in long TR spectra as well, this method does not additionally burden the analysis. Short-TR lipid spectroscopy could be of particular interest in chemical shift imaging, where the small size of VOIs exacerbates the low SNR of long-TE spectra. We conclude that it is possible to substantially improve the SNR of long-TE lipid spectra, by using a short TR at 3T.

TR (s)	SNR
0.6	59 ± 2
0.8	51 ± 4
1.2	48 ± 4
2.0	40 ± 3
4.0	32 ± 3

References [1] Boesch C, et al., NMR Biomed. 2006;19:968-88. [2] Skoch A, et al., J Magn Reson Imaging. 2006;23:728-35. [3] Ren J, et al., Proc. Intl. Soc. Mag. Reson. Med 2009,17:684. [4] Krssák M, et al., MAGMA. 2004;16:155-9. [5] Wang L, et al., J Magn Reson Imaging. 2009;29:1457-64. [**6**] Ernst, RR, Anderson, WA, Rev Sci Instrum. 1966;37:93-102.