Detection of lipids in various tissues in calf in one measurement by 2D CSI with FID and long echo time acquisition at 7T

Ivica Just Kukurová[1,2], Ladislav Valkovic[1,3], Martin Gajdošík[1], Martin Krššák[4], Stephan Gruber[1], Tibor Liptaj[2], Siegfried Trattnig[1], and Marek Chmelík[1]

[1]MR Centre of Excellence, Department of Radiology, Medical University of Vienna, Vienna, Austria, [2]Department of NMR and MS, Faculty of Chemical and Food Technology, Slovak University of Technology, Bratislava, Slovakia, [3]Department of Imaging Methods, Institute of Measurement Science, Slovak Academy of Sciences, Bratislava, Slovakia, [4]Department of Internal Medicine III, Medical University of Vienna, Vienna, Austria

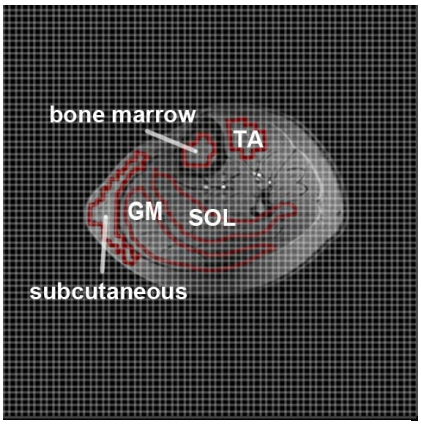

Fig. 1 Localizer image overlaid with the CSI matrix and depicted different tissues analyzed.

Introduction: Adipose tissue composition and level of unsaturation of fatty acids can be connected to various diseases and their predisposition [1]. Usually single voxel spectroscopy is the main method for noninvasive detection of spectra from fatty acids. If fat content of various compartments/tissues/organs is of interest multivoxel acquisition may be preferable. It was recently shown that 2D CSI sequence with high spatial resolution, no fat suppression and simultaneous FID and long echo acquisition is suitable for detecting IMCLs in skeletal muscles in the calf [2]. The same sequence can be used for simultaneous detection of lipids also in other areas of the calf at the same time.

The aim of this study was to assess the composition of fatty acids from the extramyocellular lipids, bone marrow and subcutaneous adipose tissue in the calf at 7T and analyze their saturation profiles.

Methods: Right calf of four young healthy volunteers was scanned at 7T Magnetom, Siemens, using 1H birdcage coil from the scanner manufacturer. 2D CSI sequence with FID and long echo time acquisition [2] was used with following parameters: TR=0.8s, TE=280ms, FOV 200x200mm, 48x48 matrix interpolated to 64x64, no WS and OVS applied, total measurement time ~23 min. Three regions were examined: subcutaneous fat (SUB), bone marrow (BM) and the calf muscles – soleus (SOL) gastrocnemius (GM) and tibialis anterior (TA) (Fig.1). Voxels with separated lipid peaks were selected, phased and summed and then fitted in AMARES, jMRUI. Amplitudes were corrected for relaxation times [1]. The relaxation times of the lipid peak at 5.5ppm were taken from the breast measurements [3], because there are no 7T data from the skeletal muscle available. Ratios of unsaturated fatty acids (CH=CH) (UFA) to CH3 group, polyunsaturated fatty acids (=CH-CH2-CH=) (PUFA) to CH3 group, and PUFA to UFA+PUFA [4] were calculated.

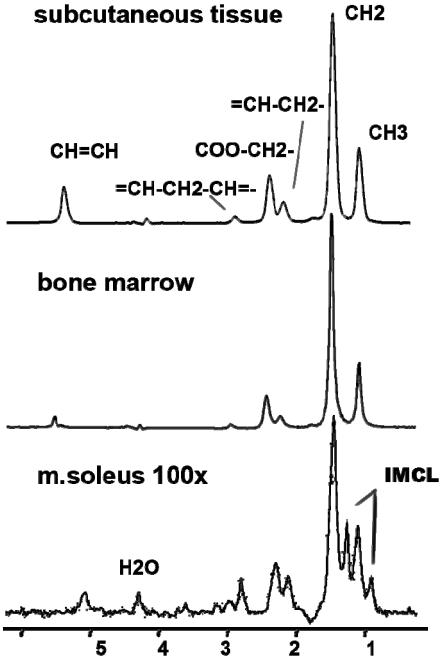

Fig. 2 Sample 1H spectra acquired with the long echo time, from the SUB (top), BM (middle) and SOL (bottom). The m.soleus spectrum is zoomed 100 times for better visual comparison.

Results and discussion: In the measured spectra, we were able to fit 7 EMCL peaks for all tissues – 1.1ppm, 1.5ppm, 1.8ppm, 2.47ppm, 2.97ppm, 5.5ppm (Fig.2) Calculated results show slight differences in composition of individual adipose tissue compartments with quite high SEM as the number of volunteers (n=4) is relatively low (Fig.3). Even though the total fat content is much lower in the skeletal muscle groups than in the SUB or BM, the saturation profile seems to be comparable in the GM and BM and in the SOL, TA and SUB. The PUFA to CH3 ratio was found to be higher in SUB than in BM, what is in agreement with previously published data [5]. For the absolute comparison of the measured data an exact knowledge of the relaxation times of all lipid groups in all tissue types would be needed, what is the limitation of the current study.

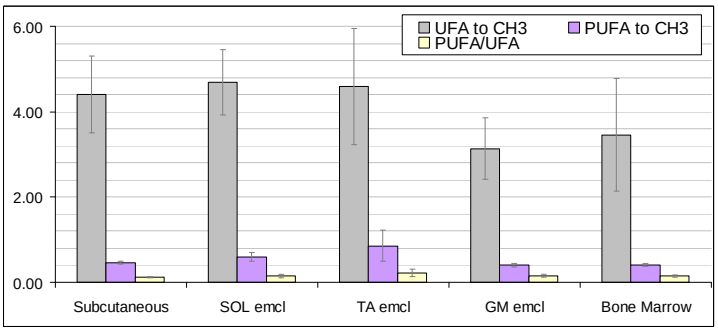

Fig. 3 Graph is showing average values of UFA to CH3 group, PUFA to CH3 group and PUGA to UFA groups in various tissues.

Conclusion: The new 2D-CSI sequence was found suitable also for detecting lipids in various tissues for consecutive analysis of their composition with no extra time needed.

References:

[1] Ren J, et al. 2008, J Lip Res
[2] Just Kukurova I, et al. 2012, ESMRMB
[3] Dimitrov I.E, et al. 2011, Magn Res Med
[4] Machann J, et al. 2012, NMR Biomed
[5] Machann J, et al. 2012, ESMRMB

Acknowledgements:

The grant support from the OeNB Jubilaeumsfond #13629 is gratefully acknowledged.