Liver biopsy, MRS and MRI fat fraction quantification in patients presenting fat and iron overload

Elise Bannier[1], Amandine Coum[2,3], Anne Boulic[4], Giulio Gambarota[2,3], and Yves Gandon[4]
[1]*Unité VISAGES U746 INSERM-INRIA, IRISA UMR CNRS 6074, University of Rennes, Rennes, France,* [2]*INSERM, UMR 1099, Rennes, France,* [3]*Université de Rennes 1, LTSI, Rennes, France,* [4]*Radiology Department, University Hospital of Rennes, Rennes, France*

Purpose The purpose of the present study was to assess the ability of MR spectroscopy (MRS) to quantify hepatic liver fat overload, [1,2] in the presence of low to moderate iron overload and compare the results with multi-echo GRE MRI and biopsy. [3] Multi-spectral fat composition and quantification of saturated - no double bound - and unsaturated - 1 or more double bonds - fatty acid ratios were also investigated. [4]

Methods After approval from the IRB, 20 patients referred for biopsy and suspected of presenting hepatic intracellular fat overload (≥30%) and/or iron overload (≥ 36 µmol/g) were included in the study. MR imaging was performed on a 3T MR scanner using a 32-ch surface coil. All acquisitions were performed under 5 to 20s breath hold. The imaging protocol consisted of 1/ ME GRE acquisition with in- and out-of-phase echoes every 1.23ms, 2/ 8 STEAM acquisitions with 4 different TEs (20, 40, 60, 80ms), 30x30x30mm^3 voxel size, 4000ms TR with and without water suppression. The MRS voxel was placed in the right lobe, avoiding large vessels. MRS spectra were analysed using jMRUI/AMARES and LCModel. Signal integrals were quantified for water and lipid (5.3ppm, 2.1ppm, 1.3ppm and 0.9ppm) at each TE. After T2 correction, fat fraction, saturated (FS) and unsaturated (FU) fatty acid ratios were derived. Image processing was performed using ImageJ. T2* decay, liver to muscle ratio and fat fraction were computed.

Results According to biopsy results, patients presented a mean percentage of hepatocytes of 26.8% [0-70], a mean steatosis surface ratio of 8.9% [0.3-24.1] and a mean hepatic iron concentration of 22.8µmol/g [2.9-54.8]. Mean T2* decay was 16.2 [5.7-27.0] and mean LIC 11.0 [0-40]. Fat and water AUCs were quantified in all patients. In 6 patients - 4 of whom with iron overload, the estimated standard deviations were above 10%. The derived T2 relaxation times were calculated to be 23.8±3.7ms and 52.6±14.6ms respectively for the water peak and the methylene peak. Fat fractions obtained via imaging and spectroscopy are presented in Figure 1.

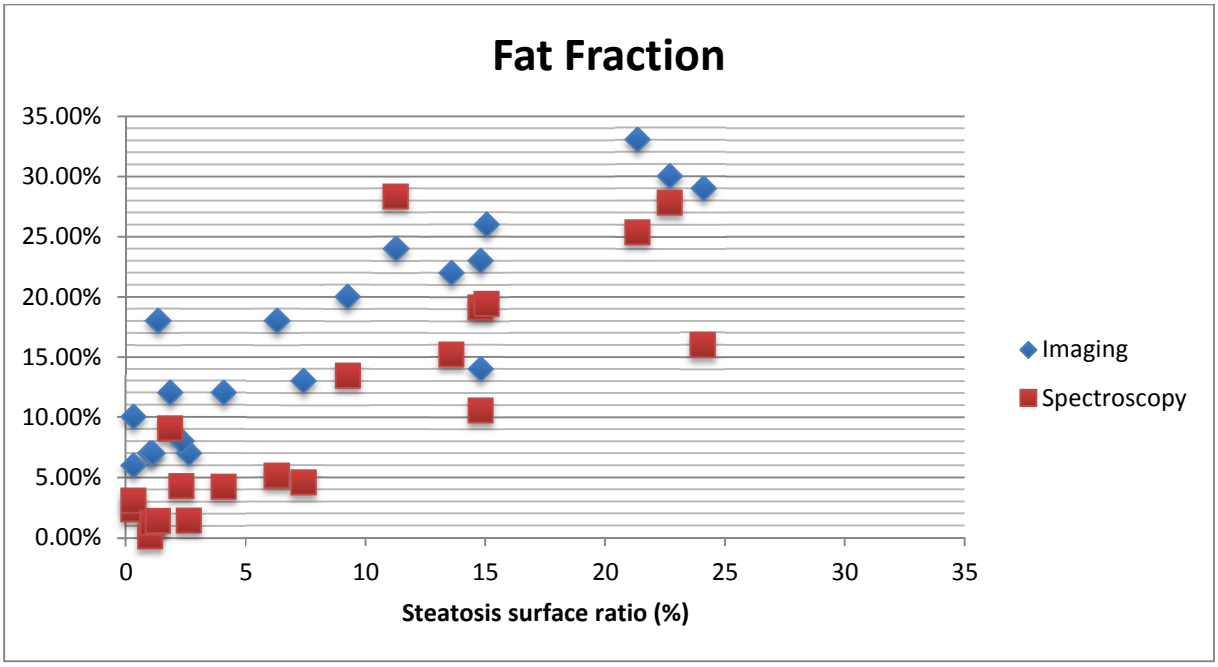

Figure 1 : Fat fraction measured via imaging and spectroscopy versus biopsy results

A correlation coefficient of 0,87 was obtained between fat fraction results obtained via imaging and MRS, 0,87 between MRS and biopsy and 0,91 between imaging and biopsy. Mean FS over FU ratio was 0.6±1.3.

Discussion and Conclusion The present study evaluates the feasibility of MRS in a clinical setting. Water and fat (1.3ppm) T2 values measured are in agreement with the literature. Fat fraction measurements obtained using MRS, imaging and biopsy are well correlated. While ME-GRE MRI allows imaging of the whole liver as well as quantification of both fat and iron, MRS enables quantification of saturated and unsaturated fatty acid ratios. In patients with suspected iron overload, results should be interpreted with caution. Therefore, ME-GRE MRI should be used simultaneously to quantify iron overload.

References [1] Pineda et al, Radiology 2009 [2] Guiu et al, Radiology 2009 [3] Gandon et al, Lancet 2004 [4] Corbin et al, Biochimica et Biophysica Acta 1791 2009