DUAL-ECHO IN- AND OPPOSED-PHASE MRI FOR THE QUANTIFICATION OF HEPATIC STEATOSIS ON PHANTOMS WITH MR SPECTROSCOPY TO RESOLVE AMBIGUITY OF FAT OR WATER DOMINANCE

J. S. Chang[1], B. Taouli[2], N. Salibi[3], V. S. Lee[2]

[1]New Rochelle Radiology Associates, New Rochelle, NY, United States, [2]Radiology, NYU Medical Center, New York, NY, United States, [3]Magnetic Resonance Division, Siemens Medical Solutions USA,Inc., St. Louis, MO, United States

PURPOSE

To quantify hepatic steatosis on phantoms utilizing an MR method which resolves the ambiguity of fat or water dominance on in- and opposed-phase imaging by use of a qualitative interpretation of single voxel 1H MR spectroscopy (MRS).

Materials and Method

Nine phantoms of various fat fractions (0%, 10%, 20%, ...80% by weight) were produced by homogenizing a mixture of fresh calf liver and vegetable oil. Each phantom was imaged at 1.5T using dual-echo in- and opposed-phase gradient echo sequence (TR/TE/FA 167/2.38 (opposed-phase), 4.76 (in-phase)/80°, acquisition time = 14 sec) and single voxel 1H MRS (PRESS, TR/TE 2000/30, voxel size 2.5 cm, 12 averages, acquisition time=24 sec). Fat fraction (FF) was calculated by the Dixon technique using MRS to resolve the ambiguity of fat or water dominance based on a quick qualitative assessment of the relative sizes of fat and water peaks (qualitative MRS post-processing time<30 sec). If water>fat, then FF=(Si–So)/(2xSi) where Si and So =in-phase and opposed-phase signal intensities, respectively. If fat>water, then FF = 1- (Si–So)/(2x Si). Additionally as an independent method, areas under water and fat peaks on MRS were analyzed quantitatively to predict FF by an investigator blinded to the composition of the phantoms (quantitative MRS post-processing time 10-15 min).

RESULTS

By visual inspection, the 30% and 70% fat fraction phantoms were indistinguishable on in- and opposed-phase images (Fig. 1,2), as were the 40% and 60% phantoms. With qualitative use of MRS to guide analysis of in- and opposed-phase images, the calculated FF (Fig 3) correlated well with the known FF (r = 0.99). The errors in FF ranged from –3% to 6 % with a mean absolute error of 3%. FF determined by quantitative MRS alone also correlated well with known values (r = 0.98) with errors ranging from –5% to 10% and a mean absolute error of 5%.

CONCLUSIONS

The combination of in- and opposed-phase MR sequence with qualitative analysis of single voxel 1H MRS can accurately predict hepatic fat fraction and allow a quick global and regional evaluation of steatosis. This approach, unlike spectroscopic quantification methods, does not require extensive MRS post-processing time or experience.

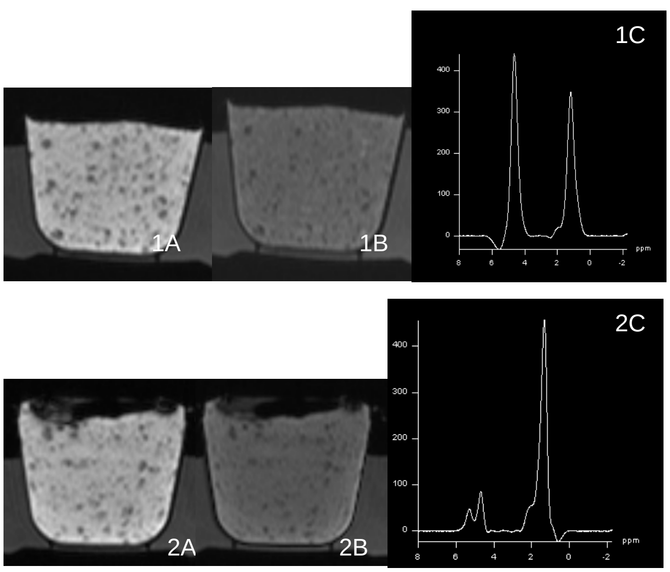

Fig 1 and 2: In- and opposed-phase imaging of two samples placed in water bath. 1: Sample with known fat fraction (FF) of 30%, in-phase (A) and opposed phase (B); 2: Sample with known FF of 70%, in phase (A) and opposed-phase (B). These two samples appear similar and indistinguishable. Without 1H MRS (C) to resolve fat or water dominance, high FF may be misinterpreted as low fat fraction.

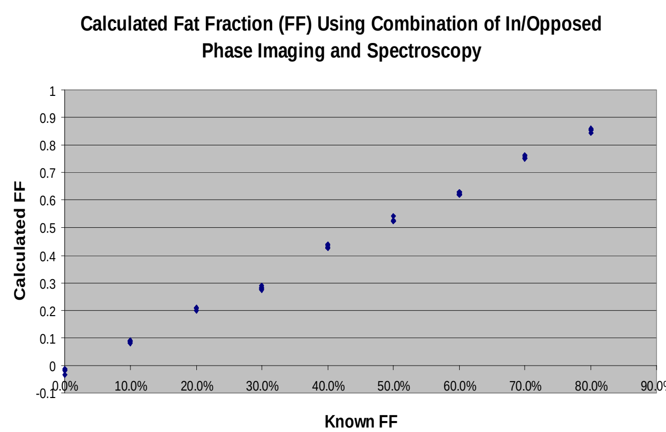

Fig 3: Calculated FF vs. known FF using combination of in/opposed phase imaging and spectroscopy.