Evaluation of novel multi echo MRS and MRI sequences for iron and fat overload quantification at 3T in one breath-hold

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Purpose The purpose of the present study was to assess at 3T the ability of both multi echo (ME) spectroscopy (SVS) and 3D gradient-echo (GRE) imaging to quantify hepatic liver fat overload[1-4], in the presence of low to moderate iron overload and compare the results with reconstructions based on 2D ME GRE MRI[5,6].

Methods After approval from the IRB, 63 patients (58±12y.o, 48 males, 27±3 BMI) suspected of presenting hepatic intracellular fat and/or iron overload were included in the study. MR imaging was performed on a 3T MR scanner (MAGNETOM Verio, Siemens Healthcare, Erlangen, Germany, VB17) with body and 32-ch surface coils. All acquisitions were performed under breath hold.

The protocol consisted of 1/ 2D ME GRE acquisition with 11 in- and out-of-phase echoes every 1.23ms, 3.2x3.2x7mm^3 voxel size, 5 slices, 20° FA and 120ms TR. Fat percentage and Liver Iron Concentration (LIC) were assessed using the IronByMR ImageJ plugin previously validated, on this same MR scanner, against 105 biopsies[6] 2/ prototype 3D ME (VIBE) with 8 in- and out-of-phase echoes every 1.23ms, 1.9x1.6x4mm^3 voxel size, 5° FA and 11.7ms TR, 36 slices. Water and fat images as well as R2*, water and fat percentage maps were computed using a prototype advanced multi-step adaptive fitting approach[3]; however, there was no correction for magnitude noise effects caused by long TE and short T_2* / high liver iron concentration (LIC). For both MRI acquisitions, the MRI ROIs were placed in the anterior (1), middle (2) and posterior (3) right liver as well as in the spleen and muscle. 3/ prototype ME STEAM single-breath-hold, single voxel spectroscopy (SVS), without water suppression, with 12ms, 24ms, 36ms, 48ms and 72ms TEs, 30x30x30mm^3 voxel size, 3000ms TR. The MRS voxel was placed in the right lobe, avoiding large vessels and hepatic lesions. R_2 of water and fat, and T_2 corrected fat percentage were computed[1] using a prototype software implementation.

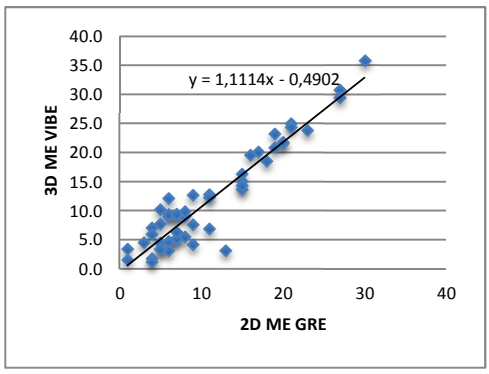

Fig 1: Fat fraction (%) measured with 3D ME VIBE and 2D ME GRE

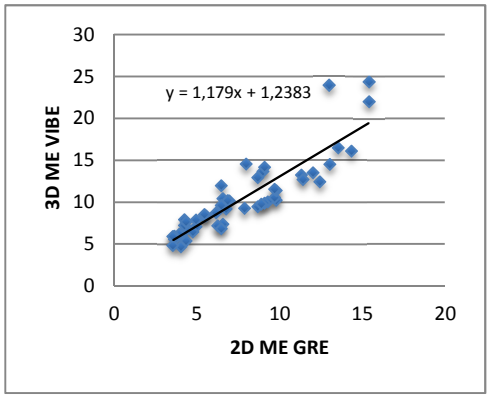

Fig 2: T2*(ms) measured with ME SVS and 2D ME GRE

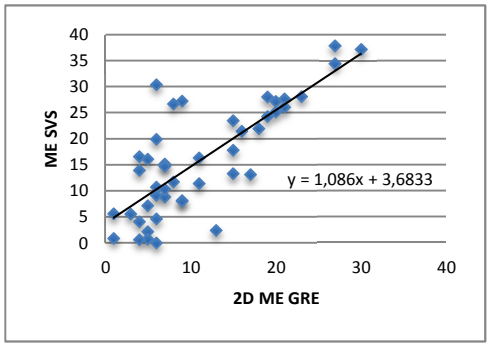

Fig 3: Fat fraction (%) measured with ME SVS and 2D ME GRE

Results According to 2D ME GRE results, mean T2* decay was 7±4ms, mean LIC was 65±49µmol/g and mean fat fraction was 9.4±8.9%. According to 3D ME VIBE results, mean T2* decay was 9.9±4.3ms and mean fat fraction was 11.6±9.2%. Over all patients, correlation coefficient of 0.67 and 0.78 were obtained for fat fraction and T2* respectively. Excluding patients with a high LIC (>120 µmol/g) according to 2D ME GRE, excellent correlation coefficients were found for fat fraction (0.94) and T2* (0.89) as presented in Figures 1 to 3. According to the ME SVS results, mean water T2 was 20±4ms, mean lipid T2 was 45±15ms and mean fat percentage was 15.9±10.5%. Correlation coefficients of 0.86 and 0.78 were obtained for fat percentage compared with ME VIBE and ME GRE respectively.

Discussion and Conclusion The present study evaluates spectroscopy and imaging sequences for fat and iron overload quantification at 3T. Fat fraction values measured with 3 techniques in patients with moderate LIC were well correlated. In patients with high iron overload, the correction of noise floor effect is important.

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