FAT QUANTIFICATION IN CHRONIC LIVER DISEASE PATIENTS WITH 3D MULTI-ECHO GRE DIXON AT 1.5 T: COMPARISON WITH T2 CORRECTED SPECTROSCOPY

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Purpose: Magnetic resonance imaging (MRI) has been a highly accurate alternative in the detection and quantification of fat in the liver, in replacement of an invasive biopsy procedure. Specific sequences are used to visually assess and quantify the presence of these liver abnormalities. Among them, spectroscopy has been shown to be a good methodology to accurately access and monitor liver steatosis (1) in the past two decades. The problems with long acquisitions times of multiples frames for T2 correction was solved with the development of the high speed T2 corrected multi echo (HISTO) sequence (2), allowing data acquisition in one single breath-hold. Another approach is to use multi-echo gradient-echo (GRE) sequences to evaluate the whole liver, avoid T1 and T2* bias effects and also the confound factor of iron overload, when this disease coexists with steatosis (3-7).Recently, a multi-echo GRE. sequence with an inline reconstructions of fat fraction (including correction for T1 bias and T2* decay, and multipeak fat spectrum) and R2* mapping was proposed (7). This new sequence (ADVANCED DIXON) uses a hybrid magnitude/complex data algorithm (3), and has been validated with the HISTO sequence as a reference at 3 T, but not at 1.5 T yet (7).The aim of this study was to validate this new ADVANCED DIXON sequence against the HISTO spectroscopy sequence at a clinical wide-bore 1.5 T system.

Materials and Methods: A total of 119 data sets from patients with chronic liver disease who had been waiting for hepatic transplantation and undergone abdominal MRI were analyzed retrospectively. The study was approved by local institutional review board. All MRI exams were performed on a 1.5 T scanner (MAGNETOM Espree, Siemens Medical Solutions, Erlangen, Germany) using the six-channel body matrix coil in combination with the table-mounted spine matrix coil. HISTO spectroscopy sequences was performed with 3 cm cubic voxel placed in the right lobe of the liver. Other parameters were: TR=3000 ms, five TEs between 12 and 72 ms, FA 90 degrees and BW1200 Hz/px. The ADVANCED DIXON sequence was performed is based on a 3D 6-echo GRE acquisition, with TR=11,5 ms. The first two echos were acquired at TE=2.39 ms and TE= 4,78 ms. The remaining echoes were set to be minimal TEs between 6.06 and 9.90 ms. Other parameters were: Thickness=4mm, FOV=420 mm, matrix 141x224. The water, fat, proton density fat fraction (PDFF) and R2* map were calculated and generated inline (7). The quantitative PDFF data was gathered directly from HISTO inline report (figure 1-A and B) and from a region of interest (ROI) placed at the same location as the spectroscopy voxel in the PDFF map generated by the ADVANCED DIXON sequence inline (figure 1-C and D). The PDFF threshold for steatosis was 5,6%. RStudio was used for statistical analysis.

Figure 1: HISTO inline result showing the fat percentage (A) and the fat peak (B, in red, above the arrow). C show the HISTO voxel localization that guides the ROI localization for measures in fat percentage image at advanced DIXON (D).

Results: Among the initial 119 examinations, 69 were used in statistical analysis (exclusion motives: 14 experienced technical difficulties in the new sequence, 3 experienced incomplete protocol, 16 had bad voxel positioning in HISTO and 17 motion artifacts). The results are shown in Figure 2 and the intraclass correlation coefficient between (ICC) both sequences for fat quantification was 0,830 (CI95%=0,737 to 0,891). The two methods had disagreement for 7 cases (5 considered as normal by HISTO and steatosis by the new sequence and 2 considered as steatosis by HISTO and normal by the new sequence). It should be noted that most of those disagreements occured in the near PDFF threshold for steatosis (between 5-6%), with small absolute erros which could be considered as either normal or steatosis in practice.

Discussion: Patients with chronic liver disease usually present a disregulation in the fat-iron liver mechanism, which may cause a common deposition of both substances in their livers. The new sequence tested in this study was able to correct the iron-induced R2* effect, and generated the fat percentage maps as fat quantification measurements. The correlation for the studied patient group with chronic liver disease was good in comparison to the already validated spectroscopy-based HISTO sequence.

Conclusion: The new ADVANCED DIXON sequence, with multipeak fat spectral modeling and six-echo chemical shift encoding, has a good correlation with HISTO spectroscopy in the PDFF for chronic liver disease patients at 1,5T.
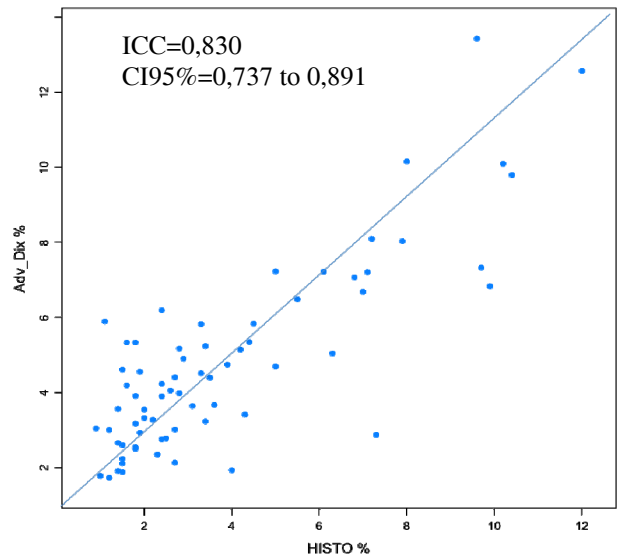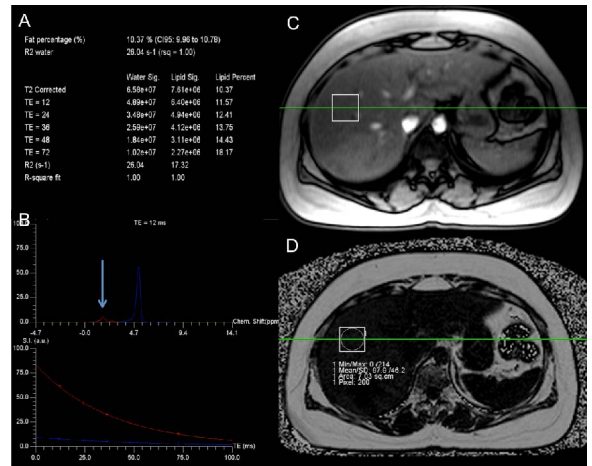

Figure 2: Dispersion graphic showing the correlation between the fat percentage of the new sequence (Adv_Dix) and HISTO. The intraclass correlation coefficient was 0,829.

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