Evaluation of fat in the liver; Comparative study with MR Spectroscopy, MEDAL, and CT

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Introduction; The abnormalities of metabolic conditions may cause diabetes mellitus, atherosclerosis, or high blood pressure and incidence of fatty liver might increase. So far several techniques have been reported for the quantitative evaluation of fat in the liver. One of the approaches was the calculation of fat fraction using dual echo gradient echo technique such as multi-echo with 2-point Dixon reconstruction for decomposition aqua/lipid (MEDAL, GE, Japan). Another technique is the use of proton MR spectroscopy. Accordingly, purposes of the current study were to evaluate the feasibility of fat measurements in the liver using MEDAL and proton MR Spectroscopy in comparison of CT measurements and to assess the reproducibility of MR technique between two fat measurements with an interval of a week.

Materials and Methods: *Population*: 32 volunteers (22 men and 10 women, mean age 35years) were included. The institutional review board approved the study. *MR and CT;* Initially, they underwent both MR and CT within 30 minutes after 6-hour fasting. With more than one week interval, MR scan was repeated. *[MR]* MR was performed on a 1.5 T Magnet (HDe, GEYMS, Hino, Japan) with an 8 channel phased array multicoils. After localization, Breath-hold axial 3D gradient echo sequence (MEDAL) was obtained covering the entire liver with following parameters; TR/TE/Flip angle/FOV/slice thickness/matrix: 7.3/2.3, 4.6ms/12 deg/35cm/5mm/256x224, 1NEX and reduction factor (RF) 2. Imaging time was 26 seconds. After obtaining dual echo data, fat and water only images were generated, respectively. Sequentially, breath-hold and respiratory triggered single voxel proton MR spectroscopy was obtained with placing voxel of interest (VOI) sizing 1.5x1.5x1.5cm on the posterior aspect of the hepatic parenchyma with exclusion of vasculatures and bile ducts. Utilized sequence was Point Resolved Spectroscopy (PRESS) with the following parameters; 1500ms/27ms/2NEX /8 acquisition, 2048 data points with spectra width of 2500Hz. Imaging time was 21 seconds for breath-hold. For respiratory triggering, parameters were the same except TR 2000 ms/8NEX, 16 acquisition and imaging time was and 2.5 to 4min. *[CT:]* CT was performed on a 64 multidetector row scanner (Lightspeed VCT, GE) for covering abdomen and pelvis with the following parameters; slice thickness 5mm, exp time 400, 120KVP with auto MA. Imaging time was 3 seconds with breath holding . *Data analysis: [MR]* MEDAL: Imaging data obtained with MEDAL were processed with voxel-base calculation using equation of signal intensity (SI) of fat image /SI of in-phase image. And 3D complete data sets were generated on an off-line computer. The VOI sizing 1.5x1.5x1.5cm was placed on the posterior aspect of the liver, which was corresponding to that for MR spectroscopic measurements and the fat fraction of the liver was obtained. Proton MR spectroscopy: Obtained data was analyzed with SAGE (version 7.6, GE). After fast Fourier transformation, spectral data were obtained with automatic phase correction. Peak areas, resonance frequencies, and line width for water protons were calculated by fitting the spectra to a Lorenzian curve using a Marquardt algorithm. CT: The corresponding imaging slice was selected and the region of the interest (ROI) was placed on the corresponding area to there on MEDAL. And attenuation value of the liver was measured and additionally, as reference, that of the spleen was measured. Contrast of the liver attenuation against the spleen was calculated. Statistics: Reproducibility of the obtained data between two different MEDAL acquisitions and MR spectroscopy with breath-hold or respiratory triggering and correlation of data obtained with MEDAL and MR spectroscopy was evaluated by linear regression analysis, respectively. The correlation of the data from MR measurements and CT was also evaluated as well. **Results**: The reproducibility between two measurements of MEDAL and proton MR spectroscopy was obtained, respectively (MEDAL, MR spectroscopy: R^2=0.967, R^2=0.894, p<0.001)(Fig1,2). Close correlation of the data from breath-hold and respiratory triggered MR spectroscopy was also demonstrated (R^2=0.945, P<0.001) and correlation of the data from MEDAL and breath-hold MR spectroscopy was acceptable (R^2=0.654, p<0.001)(Fig 3). There was least correlation between the value of liver/spleen attenuation from CT and that with MR measurements (R^2=0.329).

Summary and Conclusions: Reproducibility of MR measurements is observed. Semiquantitative fat measurements of the liver can be performed with MR in a short period time. It takes 21 seconds for breath-hold MR spectroscopy, and 26 seconds for MEDAL. With different mechanism of the fat measurements with MEDAL and MR spectroscopy, but acceptable correlation was obtained. MR acquisitions can be used for noninvasive semiquantitative evaluation of fat in the liver, which might be good for medical check ups.