Value of dual fast T1 weighted gradient echo MR sequences for quantification of fat liver: Compared to pathologic results

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Introduction

Hepatic steatosis is one of the most commonest morphological abnormalities identified in liver biopsy (1). Unfortunately, fat infiltration is most of time a benign pathology with no clinical or biochemical signs. However, percutaneous liver biopsy can accurately determine the fat fraction, it is an invasive technique with sampling errors. Thus, a non invasive method should be interesting to appreciate the degree of steatosis. Magnetic resonance imaging was already demonstrated to be a non invasive method of quantification in liver iron overload (2). Based on their resonant frequency difference, fast gradient echo technique in a breath hold exam can produce alternating signals in and out of phase for voxels containing fat and water. However, no clinical study has correlated the fraction of fat in human liver biopsy with a commonly available opposed-phase gradient-echo imaging. The objective of this work was to appreciate if the signal intensity variation of the human liver between the in phase (IP) and opposed phase (OP) images reflects the histologic grading of steatosis proved by biopsy.

Methods

We cross-referenced the database of the Department of liver disease with the MR imaging database to identify patients who had undergone liver biopsy and MR imaging in a time frame less than one week. Institutional review board approval was obtained. A total of 25 patients between March 2000 and January 2001 were identified (14 women and 11 men). The average age was 51 years +/- 13,5. Liver biopsy was obtained from the right lobe of the liver and biopsy samples were retrospectively evaluated histologically for grading of fat storage by a single pathologist. Recording items were presence of steatosis, type of steatosis, topography and percentage of hepatocytes with fat infiltration. MR studies were performed at 1.5 T clinical MR imaging system with a phased-array body coil. Transverse dual fast in and out-phase T1-weighted gradient-echo sequences of the upper abdomen (repetition time msec/echo time msec, 202/2.3–4.6; flip angle, 70°; 22 sections acquired in a 23-second breath hold) were performed in 8 mm section thickness. Observer evaluated the MR images for signal intensities by using operator -defined regions of interest (ROIs) placed with a standard software displayed on an independant workstation. Measurement was made at the external part of the right lobe where liver biopsy was performed, avoiding vessels. The signal intensity variation (SIV) between in and out of phase images was calculated for liver as follow : (SIV)liver = [SI liver (in)-SI liver (out) / SI liver (out)]*100. The signal difference/noise ratio between liver and spleen, and between liver and muscle, in phase and in opposed-phase was calculated as follow : (SI liver (in) - SI spleen (in)) / SD (in) and (SI liver (out) - SI spleen (out)) / SD (out). (SI liver (in) - SI muscle (in)) / SD (in) and (SI liver (out) - SI muscle (out)) / SD (out). Fat liver infiltration was correlated with signal intensity variation of the liver parenchyma between in and out-of phase imaging using Pearson's coefficient of correlation. The relation between SIV of the liver and the degree of steatosis was studied with a linear regression. Sensitivity and specificity of dual fast gradient echo imaging for the diagnosis of steatosis were defined by a ROC analysis. Finally, correlation between SIV compared to spleen and muscle with degree of steatosis was assessed with a Pearson correlation coefficient. For all tests, $P < .05$ was considered to indicate a statistically significant difference.

Results

MR images were homogeneous in all cases, with some shading from magnetic field heterogeneity at the bottom or top sections. Histologic specimens demonstrated a fatty liver infiltration in 81 % of patients. Macrovesicular steatosis was present in all cases, associated with microvesicular steatosis in 19 %. Fatty liver infiltration was heterogeneous in 85% of patients. The average percent of fatty hepatocytes was 28 +/- 30. 2 %, with a median of 10 % (min.0 - max. 90%). Distribution of patients according to the degree of hepatic steatosis and the SIV has demonstrated a significant correlation between SIV and fatty liver infiltration ($r = 0.81$, $p < .001$). There is a significant correlation between the signal intensity variation of the liver in opposed-phase with the pathologic grading of steatosis. Because the SIV was a quantitative value, the composite ROC curve has been used to define the threshold between positive and negative results of steatosis. Presence of fat hepatocytes higher than 10 % within the parenchyma of the liver defined steatosis. For this percent of fat, the SIV threshold was 0.16. Thus, the sensibility and the specificity for the diagnosis of hepatic steatosis was respectively 80% and 71%. Pearson correlation coefficients (p) was inferior to 0,6 for the relation between the decrease of hepatic signal relative to spleen or muscle signal with the degree of steatosis. There was no statistical significance between the decrease of hepatic signal relative to spleen or muscle signal with the degree of steatosis.

Conclusion

Comparison of T1-weighted gradient echo in-phase and out of phase images seems to be a practical and useful method of diagnosis liver steatosis with only one short TR series. Image quality is more reproducible than previous series with long TR acquisition. This suggests that this simple technique can be used to grade, and quantify liver steatosis, and further study in a homogeneous group should be done.

References

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