Precise and simple quantification of liver steatosis by MRI in an animal model and in patients with NAFLD

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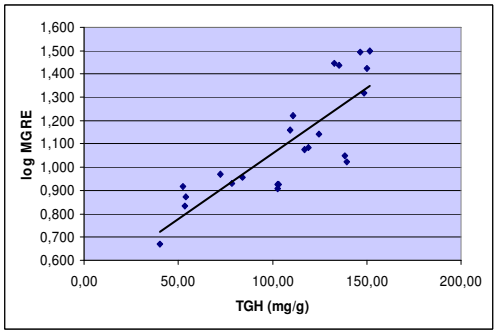
AIMS: to valuate the ability of MRI to quantify liver steatosis, with comparison based on either liver triglycerides content in an animal model, or histological grading and area of steatosis in patients

Methods and results:

•***Animal Study.*** 24 rats underwent a fatty-enriched diet and were explored by MRI and then sacrified.

• 2 MRI sequences were performed: DUAL and MFGRE. The percentage of liver fat by MRI quantification was compared with total liver triglyceride content.

The correlation of a multivariate model including serum ALT and MRI fat content with triglyceride content was high: Rs=0.94 (p<0.001).



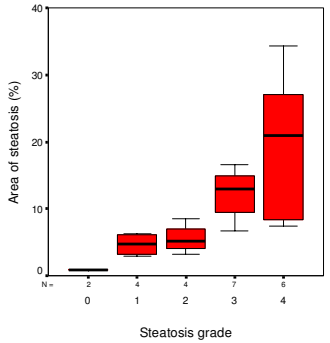
Correlation between MRI liver fat content and triglyceride content was better with MFGRE sequence (Rs=0.85) than with DUAL sequence (Rs=0.47).

•***Human Study***. 23 patients (NAFLD: 21, controls: 2) were included. Steatosis was evaluated using a histological semi-quantitative grading: S0 (absence), S1 (<10% hepatocytes with vacuoles), S2 (10%-30%), S3 (30%-50%) and S4 (>50%).

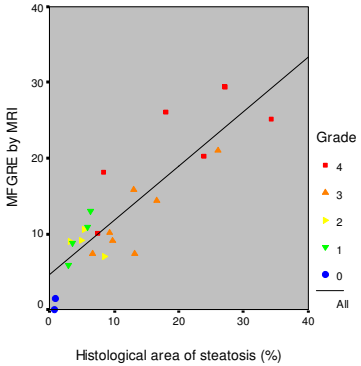
•The area of steatosis (%) was also computed by an automatic image analysis method which measured the area of lipid vacuoles in hepatocytes as a percentage of the whole specimen.

•4 MRI quantitative methods were performed: 2-pts and 3-pts Dixon, DUAL, FSE, and the multi-echo gradient-echo MRI (MFGRE).

•Correlations between MRI sequences and the area of steatosis were: DUAL: Rs=0.71, Ric=0.57; FSE: Rs=0.80, Ric=0.62; 2-point Dixon: Rs=0.71, Ric=0.55; 3-point Dixon: Rs=0.62, Ric=0.28

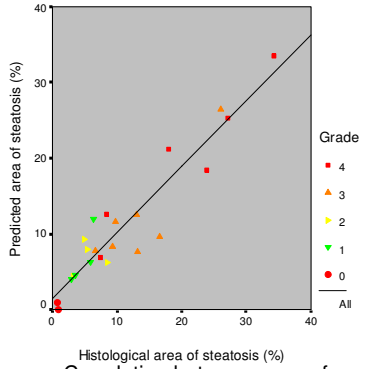


comparison between the area of steatosis and different histological grades
Area of steatosis as a function of grade of steatosis (Kruskal Wallis test: p: 0.003).



Correlation between area of steatosis and steatosis quantification with MFGRE as a function of steatosis grade

Rs: 0.77, Ric=0.85 (p: < 10^{-3}).



Correlation between area of steatosis and predictive model (MFGRE sequence by MRI + ALAT + triglycerides) of area of steatosis (Rs: 0.84) as a function of steatosis grade.

By multiple linear regression, MFGRE was the only MRI variable independently linked to the area of steatosis

Conclusions: MRI, especially MFGRE sequence, is an accurate automatic quantification of steatosis. MFGRE could be used in routine as a noninvasive and simple tool for steatosis evaluation, as a single measurement or in combination with serum markers (ALT and triglycerides).