Feasibility of MR Elastography of the Liver in Obese Patients at Risk for NAFLD

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Target audience: Researchers and clinicians interested in MR elastography of obese subjects and liver disease.

Introduction: Chronic liver disease complications resulting from liver fibrosis present a substantial health care burden. The current reference standard for assessment of fibrosis is biopsy, an invasive procedure with high sampling variability and cost, as well as possible adverse effects. Non-invasive biomarkers of liver fibrosis are desirable, for which MR elastography (MRE) has been proposed (1,2). The ***purpose of this study was to demonstrate the feasibility of hepatic MRE in obese patients***.

Methods: 54 patients (mean age: 50±12 years, body mass index [BMI]: 45±6 kg/m^2, weight=121±19 kg) underwent IRB-approved research MRI exams at 1.5T or 3T (Signa HDx and MR750, GE Healthcare, Waukesha, WI) ≤2 days prior to bariatric surgery done for clinical care. 2D GRE MRE (1.5T/3T) was performed with TR=50ms, TE=22/19ms, in-plane resolution range= 1.9x3.1mm – 3.8x5.0mm, slice thickness=5-10cm, mechanical frequency=60Hz. Chemical shift encoded fat quantification (3) was performed (1.5T/3T) with TR=13.4/8.6ms, ΔTE=2.0/1.0ms, echoes=6, flip angle=5°/3°, resolution=1.7x2.8x8 /1.7x3.4x8mm. Intraoperative biopsies were obtained for research and assessed by an experienced pathologist for steatosis, inflammation and fibrosis using the NASH CRN histologic scoring system (4). MRE stiffness measurements were made in regions of liver with observable wave propagation, avoiding liver edges. Technical success was achieved when propagating waves were visible somewhere inside the liver. MRE quality was assessed dichotomously (poor quality= propagating waves not visible in central regions of liver; good quality = propagating waves visible in central regions of liver). A Wilcoxon rank sum test was used to test for statistical differences between poor- and good-quality images with respect to the following acquisition and morphologic properties: subcutaneous adipose tissue thickness (SCAT, distance from MRE driver to liver), BMI, field strength independent signal loss due to R2* decay ($e^{-R2^*\cdot TE}$), voxel size, and fat fraction.

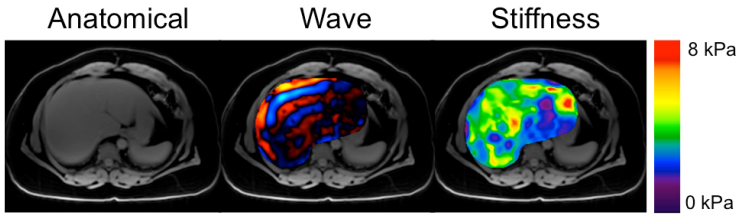

Figure 1: Good-quality MRE. Propagating waves are visible in central regions of liver in obese patient (BMI=39kg/m^2, weight= 100kg, age=41 years) with biopsy confirmed advanced fibrosis.

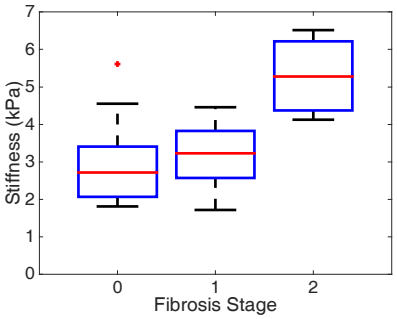

Figure 2: Mean stiffness increases in patients with advanced fibrosis.

	Poor Quality (n=25)	Good Quality (n=29)	*p*-value
SCAT thickness	5.6±1.2cm	4.6±0.9cm	0.025
BMI (kg/m^2)	46±6	42±5	0.072
R2* decay (s^{-1})	48±12%	52±14%	0.579
Voxel size (mm^3)	70±46	104±50	0.004
Fat fraction	15.2±10.5	9.3±7.0	0.034

Table 1: Subcutaneous adipose tissue (SCAT) thickness, voxel size, and fat fraction differed significantly between patients with

Results and Discussion: The technical success rate of MRE (Figure 1) in this group of obese patients was 81% (n=44). While technical success indicates that at least one measurement was possible in the liver, it does not necessary mean that measurements were possible throughout the liver (i.e. good quality). MRE quality (Table 1) was significantly affected by subcutaneous adipose tissue thickness, voxel size, and hepatic fat fraction. Histologically, 44 patients (75%) had steatosis, 5 (9%) suspicious steatohepatitis, and 6 (11%) definite steatohepatis. Mean stiffness values in patients with fibrosis stages 1 and 2 (Figure 2) were consistent with previously reported measurements (1). However, stiffness measurements in patients with no fibrosis were elevated, suggesting that liver stiffness in obese patients more closely resembles that of patients with stage 0 chronic liver disease (1) than that of patients without any liver disease.

Conclusion: MRE is feasible in obese patients as demonstrated by the 81% technical success rate. However, MRE quality is adversely affected by image voxel size as well as some features characteristic of the obese population, namely subcutaneous adipose tissue thickness (which reduces efficiency of wave generation in the liver), and hepatic fat deposition.

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References: 1. Yin et al. Clin. Gastroenterol Hepatol. 2007; 5:1207-1213. 2. Talwalkar et al. Heptatol. 2008;47:332-342. 3. Hines et al. JMRI 2012;35:844-851. 4. Kleiner et al. Heptaol. 2005;41:1312-21