Interplatform Variability of Liver and Spleen MR Elastography

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Target audience: Clinical scientists and physicists interested in MRE.

Introduction: MR Elastography (MRE) is a phase contrast based imaging method that captures the mechanical harmonic wave propagating through the body and converts that information into stiffness related maps. Since its introduction in 1995[1], the clinical use of MRE has significantly increased. Ideally, MRE should be independent of the host scanner, however, there is limited knowledge of inter-platform variability in quantitative MRE, particularly for the abdomen[2]. The objective of our study was to quantify variability in liver stiffness (LS) and spleen stiffness (SS) measurement between two different systems (1.5T and 3.0T) from different vendors in the same subjects.

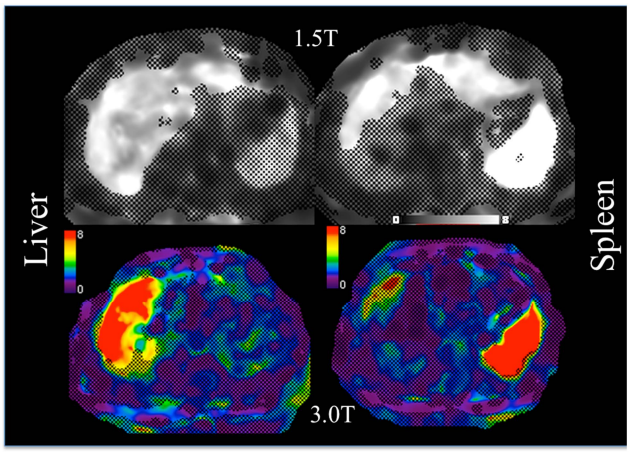

Fig. 1: MRE stiffness maps of liver and spleen acquired in a 56 y old patient with HCV cirrhosis obtained at 1.5T (top) and 3.0T (bottom) using 2D-GRE sequence. Stiffness values (in kPa) were LS=6.4 and SS=14.6 at 1.5T; and LS= 6.2 and SS=11.4 at 3.0T.

Methods: Six initial subjects (2 healthy volunteers and 4 patients with liver disease, M/F 5/1, mean age 35 y) were enrolled in this ongoing IRB approved prospective study. Etiology of liver disease included HCV (n=1), primary sclerosing cholangitis (n=1), NASH (n=1), and alcohol intoxication (n=1). Subjects were scanned with two different MRI systems (1.5T and 3.0T) using a breath-hold 2D GRE sequence with passive drivers placed on the right and left sides to measure LS and SS. Parameters were for 1.5T (Aera, Siemens): TR/TE 50/25, 256x90, 4 slices, 7 mm thickness, 60Hz mechanical motion, 60 MEG frequency, GRAPPA 3. For 3.0T (MR750, GE): TR/TE 50/20, 256x80, 4 slices, 10 mm thickness, 60Hz mechanical motion, ASSET 2. LS and SS values were measured by a single observer using ROIs as large as possible within the limits of confidence maps in all 4 slices. Mean LS and SS values for each patient were compared between 1.5T and 3.0T using Pearson correlation, coefficient of variability (CV) and Bland-Altman limits of agreement. An invitro experiment involved scanning a gelatin phantom to estimate complex shear modulus using a modified method as described in[3] using same scanning parameters as above.

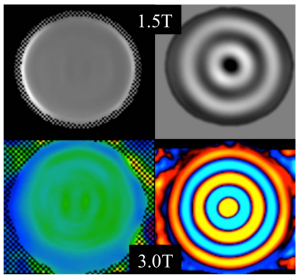

Fig. 2: MRE stiffness maps and corresponding wave images of water based gelatin phantom obtained at 1.5T (top) and 3.0T (bottom) using 2D-GRE sequence. Stiffness values (kPa) were 3.4 at 1.5T and 3.2 at 3.0T.

Results: The failure rate in subjects was equivalent in both systems: on liver in 1 patient at 3T and on spleen in another patient at 1.5T. In the remaining 5 subjects, there was acceptable variability in LS and SS measurements, with excellent correlation **(Table, Fig. 1).** In-vitro MRE scans on two systems demonstrate highly concordant stiffness measurements **(Fig. 2).**

	1.5T	3.0T	CV (range)	r	p	CR
LS	3.3±2.1	3.4±1.8	9.8% (2%-20%)	0.97	<0.001	32%
SS	8.5±4.1	10.7±3.5	12.0% (0.5%-21%)	0.96	<0.002	26%

Table: LS and SS (in kPa) obtained at 1.5T and 3T in 5 subjects, with CV, correlation coefficient (r) and Bland-Altman coefficient of reproducibility (CR) between the two systems.

Discussion and Conclusion: Liver and spleen shear stiffness measurements were compared between 2 systems with different field strengths from different vendors, although using the same 2D-GRE sequences with quite similar parameters in 5 subjects. This initial data demonstrates acceptable reproducibility for LS and SS, with slightly better concordance for LS. Variability between systems relate to different factors such as the placement of passive driver, positioning of the patient in relation to isocenter, different RF coil/field strength and slightly different ROI placement. SS estimations presented higher variability than LS estimations. This could be explained by the frequency (60 Hz) chosen specifically for liver viscoelastic properties. It is possible that higher excitation frequencies would provide more consistent results across different platforms for SS. Effects of different frequencies on spleen was demonstrated previously[4] and concluded that wave propagation at lower frequencies (longer wavelengths) was dominated by the boundaries of the organ. In-vitro experiments can be further expanded for various phantoms of wider range of viscoelastic properties in order to assess the inversion algorithms used in different systems. We demonstrated acceptable inter-platform differences in liver and spleen stiffness using a 2D-GRE sequence using different systems. Further work needs to assess inter-platform differences using different sequences.

References
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