Magnetic Resonance Elastography: Feasibility of liver stiffness measurements in healthy volunteers at 3Tesla.

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Introduction
Currently all conventional imaging techniques are unable to detect early fibrosis and distinguish the fibrosis grades used by histopathologists. Several chronic liver diseases progress to liver fibrosis and cirrhosis at a variable rate which can be influenced by treatment. Several biomarkers have been proposed as an alternative to liver biopsy for the staging of liver fibrosis, including serum blood markers and ultrasound or MR based stiffness measurements. Magnetic Resonance Elastography (MRE) is a promising recently developed technique for evaluating liver stiffness in chronic liver disease patients [1-4]. The current MRE literature is based on measurements performed at 1.5T [1-4]. The technique relies upon the demonstration of waves within the liver using a phase contrast type gradient echo based sequence. This is limited by the attenuation of the waves and the overall signal to noise ratio (SNR) of the measurements. In theory the SNR could be improved by using a higher field MRI system but this also brings the problems of increased artefacts related to susceptibility and variable B1 problems. This has been addressed by using a second harmonic analysis of the basic MRE technique [5]. The aim of this work is to demonstrate the feasibility of obtaining MRE results from normal healthy volunteers using the same technique that has been successfully applied at 1.5T [6].

Methods
Eight healthy volunteers (6 male, 2 females, mean age 37 ± 9 years ranging from 28 to 56 years) with no history of GI, hepatobiliary or cardiovascular disease and not receiving any regular medication were recruited. They were fasted prior to an MRI examination using a whole body 3T MRI system (Signa HDx, GE Healthcare, Milwaukee, USA) with an 8 channel cardiac receive coil. Following initial localiser an MRE acquisition was performed centred on the liver during repeat breath-holding with a pneumatic driver in a right anterior abdominal wall position with the following parameters: FOV 36cm, flip angle 30, two axial sections 10mm thick and 10mm apart, 60Hz excitation, gradient echo based MRE sequence. The MRE images were processed using an LFE inversion algorithm that has been previously developed and described [2, 3]. Adequate image quality was assessed subjectively by demonstrating the presence of visible propagating waves within the liver parenchyma underlying the driver location (Figure1). Liver stiffness values were obtained using manually placed regions of interest (ROI) outlining the liver margins on the gradient echo wave images which were then mapped onto the corresponding MRE inversion image and the mean of the results for both sections obtained.

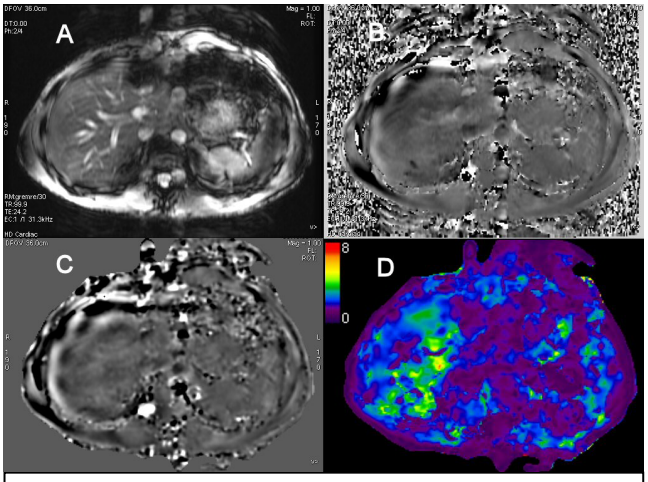

Figure 1: MRE acquisition: (A) Magnitude image, (B) Raw wave image, (C) Unwrapped wave image demonstrating propagating waves in the liver , (D) Elastogram following LFE inversion.

Results
Figure 1 demonstrates typical MRE images in one volunteer. The quality of the MRE images was adequate in all the volunteers, with propagating waves well visualized within the liver parenchyma in all subjects. The mean liver stiffness for the group was 2198 ± 323 pascal (ranging from 1712 to 2691 pascal). These liver stiffness values are in the range of the values reported for normal subjects at 1.5T. [1-4, 6].

Conclusion
This preliminary work using MR elastography at 3T in healthy volunteers demonstrates the feasibility of liver stiffness evaluation at 3T without modification of the approach used at 1.5T. Adequate image quality and normal MRE values were obtained in all volunteers. The obtained stiffness values were in the range of those reported for healthy volunteers in previous studies at 1.5T as expected. A more formal evaluation of the benefits of 3T MRE is required and a direct comparison of volunteer examinations at both 1.5T and 3T is planned.

References
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