Assessment of Hepatic Fibrosis in Liver Transplant Patients using MR Elastography - preliminary results

P. Asbach[1], D. Klatt[1], C. Kamphues[2], P. Neuhaus[2], J. Braun[3], and I. Sack[1]

[1]Department of Radiology, Charité University Hospital, Berlin, Germany, [2]Department of General-, Visceral- and Transplantation Surgery, Charité University Hospital, Berlin, Germany, [3]Department of Medical Informatics, Charité University Hospital, Berlin, Germany

Background and Purpose:

Liver transplantation is an ultimate therapeutic option for end-stage liver disease. In the context of liver cirrhosis caused by viral hepatitis, it is known that re-infection of the graft occurs frequently and that progression of fibrosis advances more quickly in the transplanted organ [1]. Therefore, a closer follow-up is necessary including frequent biopsies for grading fibrosis. A non-invasive method of detecting and grading fibrosis in liver transplant patients is therefore of particular interest.

MR elastography (MRE) allows the non-invasive assessment of liver fibrosis based on the response to oscillatory shear stress [2-4]. External mechanical vibrations are introduced into the body and the resulting shear wave propagation in the liver is imaged by motion-sensitive MR sequences. Up to this point, MRE has not been applied to liver transplant patients for detecting fibrosis. Therefore, the aim of this study was to investigate the potential of MRE in detecting liver fibrosis in transplant patients.

Materials and Methods:

Institutional review board approved study, all patients gave written informed consent. MR elastography was performed at 1.5 Tesla using a mutifrequency technique. The excitation signal was a superposition of four driving frequencies (range between 25 Hz and 62.5 Hz) and the corresponding wave images were simultaneously measured. The complex shear modulus was calculated by a 2D-Helmholtz inversion and spatially averaged over the manually segmented liver. Viscoelastic parameters were calculated by fitting the dispersion relations of the rheological springpot model to the experimental data. The springpot model accounts for elastic and viscous properties of tissue with 2 independent parameters: one viscoelastic parameter μ (tissue viscosity η set to 1 Pa s) and one dimensionless structure-geometry index α. This MRE technique was applied to 10 liver transplant patients with biopsy-proven liver fibrosis. All patients were transplanted due to end-stage liver cirrhosis caused by viral hepatitis (HCV). 4 patients had low-grade (stage 1-2) fibrosis and 6 patients had high-grade (stage 3-4) fibrosis according to the Desmet classification.

Results:

Significant differences were found between the viscoelasticity of the liver of low-grade fibrosis patients ($\mu = 3.21 \pm 0.27$; mean $\pm$ SD) and high-grade fibrosis patients ($\mu = 5.19 \pm 1.27$). The structure-geometry index α did not show significant differences between low-grade ($\alpha = 0.27 \pm 0.02$) and high-grade fibrosis ($\alpha = 0.28 \pm 0.02$). Figure 1 shows the modulus dispersion function over drive frequency in one patient with high-grade liver fibrosis (stage 3). The solid lines correspond to the best fit of the springpot model.

Conclusion:

Multifrequency MR elastography has the potential to non-invasively detect liver fibrosis in transplant patients, preliminary results indicate that low-grade fibrosis can be differentiated from high-grade fibrosis, however, further studies with a higher number of patients are necessary.
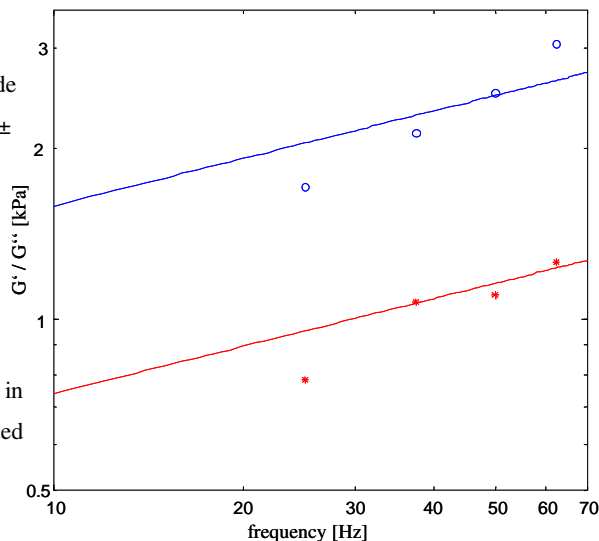
Fig.1: Multifrequency MRE examination on one high-grade fibrosis patient. The real part G' and the imaginary part G'' of the complex modulus are displayed in blue circles and red asterisks, respectively. The solid lines (G': blue; G'': red) correspond to the best fit according to the springpot model with the viscoelastic parameters $\mu = 6.29$ kPa and $\alpha = 0.28$.

References:

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