# High Resolution MR-Elastography to diagnose Liver Fibrosis and Hepatic Steatosis in Rats

**N. Salameh[1], B. E. Van Beers[1], B. Larrat[2], I. Leclercq[3], M. Pernot[4], J. Abarca[1], and R. Sinkus[2]**

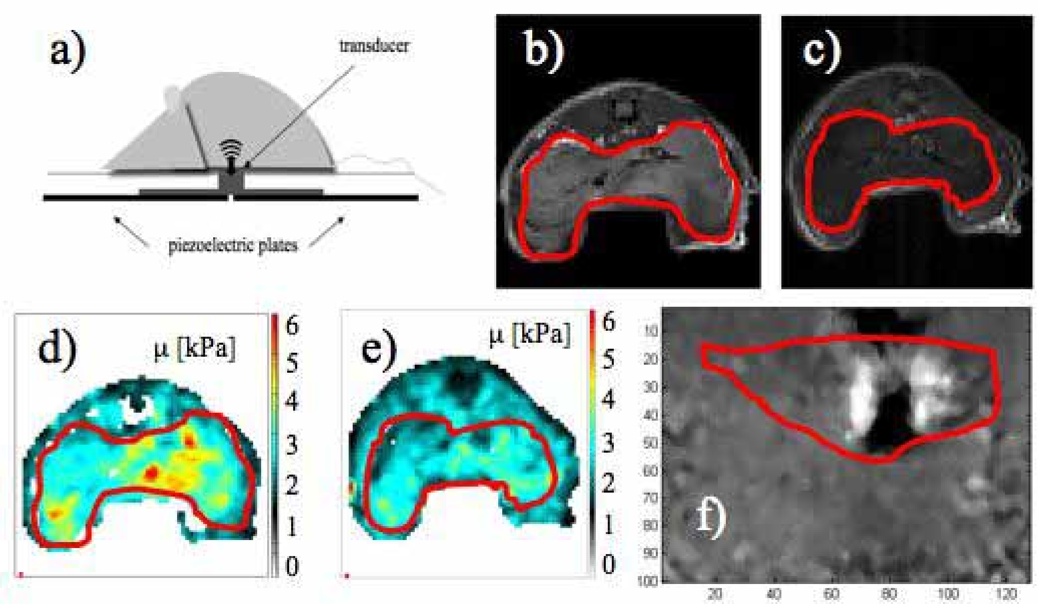
[1]Diagnostic Radiology Unit, Université Catholique de Louvain, Brussels, Belgium, [2]Laboratoire Ondes et Acoustique, ESPCI, Paris, France, [3]Gastroenterology Unit, Université Catholique de Louvain, Brussels, Belgium, [4]Supersonic Imagine, Aix-en-Provence, France

## Introduction

MR elastography is a non-invasive method to evaluate liver fibrosis by measuring the visco-elastic parameters of the liver [1]. The aim of the present study is to diagnose in vivo liver fibrosis combined with hepatic steatosis using this technique. In fact, the presence of fat in the liver can affect the visco-elastic properties of the tissues [2] and therefore lead to misdiagnosis and thus insufficient treatment for the patients. We investigate within a longitudinal study the effect of artificially induced steatosis within sprague-dawley rats fed with a choline-deficient diet [3]. Initial results from a rat after two weeks of diet are compared to a healthy rat. Moreover results are compared to those obtained via transient ultrasound elastography [4].

## Material and methods

Low-frequency (300 Hz) longitudinal mechanical waves were generated by a transducer consisting of two piezoelectric plates driven by a programmable pulse generator (Fig. a). Images were obtained on a 7 T Bruker Pharmascan animal imager. The propagation of the waves was imaged with a modified spin-echo sequence as described in [5]. Eight transverse slices (SL=830 μm) through the liver were acquired. The FOV was 53 mm, matrix size $64^2$ leading to an isotropic voxel size of 830×830×830 $\mu m^3$. The sinusoidal motion was sampled with four dynamics. Sequence parameters were: TE = 13.3 ms, TR = 350 ms and NSA = 4, leading to an acquisition time of 6 min for each spatial direction.




Respiratory motion was compensated via a sensor monitoring the abdominal motion externally. The MRE-sequence switched automatically between data acquisition mode and dummy scans depending on whether the respiratory position was within the requested gating window. Thereby the steady state condition for the mechanical wave was maintained. After the MRE experiment, another technique, based on ultrasound, was used for the non-invasive assessment of the elastic properties of the liver. Using the acoustic radiation force, elastic shear waves can be created in soft tissues by focusing an ultrasound beam at a given location. The following propagation of the generated shear wave is imaged by the same ultrasound system, which generated the radiation force. The visco-elastic maps of the medium were then recovered by applying the inverse problem algorithm. Fig. f shows the transient shear wave propagating to the left and to the right within the liver (red boundary).

## Results and Discussion

The magnitude images of the diseased rat and the normal one are shown in Fig. b and c, respectively. Those images already indicate a significant change in contrast for the steatotic liver (b) due to the accumulation of fat. The corresponding images of the shear modulus (d and e) show firstly a very good correlation to the expected anatomy. Secondly, the shear modulus of the diseased liver is significantly enhanced (μ = 2.7 kPa) when compared to the normal liver with S = 1.9 kPa. Moreover, the corresponding values for the loss modulus also indicate a significant change (from 0.69 kPa for the normal liver to 0.97 kPa for the diseased liver). Interestingly, the ratio of the loss modulus over the dynamic modulus stays the same for both cases (Gl/Gd ~ 0.36). The origin for this invariance is currently under investigation. The results obtained from the ultrasonic elastography approach agree rather well with the values calculated with MR elastography. The ability of MRE to differentiate between these two cases, given the early stage of the steatosis, indicates the important diagnostic potential of this technique. It should be noted that trying to diagnose steatosis via biopsy is difficult because it requires a specimen representing an intact piece of the liver. It is foreseen to measure in this study 40 rats with different degrees of steatosis and fibrosis. MRE results, ultrasound elastography results and histology will be used in conjunction to explore the diagnostic potential of elasticity imaging.

## References

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