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Viscoelastic properties of liver measured by oscillatory rheometry and multifrequency magnetic resonance elastography

Dieter Klatt [a], Christian Friedrich [b], Yasmin Korth [b], Robert Vogt [b],
Jürgen Braun [c] and Ingolf Sack [a,*]
[a] *Department of Radiology, Charité-Universitätsmedizin, Berlin, Germany*
[b] *University of Freiburg, FMF, Freiburg, Germany*
[c] *Institute of Medical Informatics, Charité-Universitätsmedizin, Berlin, Germany*

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Abstract. The mechanical properties of liver can sensitively indicate the progression of hepatic fibrosis. Mechanical tissue characterization involves the analysis of the complex shear modulus measured either by oscillatory rheometry or by *in vivo* elastography. In this study, bovine liver specimens were investigated by oscillatory rheometry and multifrequency magnetic resonance elastography (MRE) in a common frequency range between 25.0 and 62.5 Hz. The results were compared with *in vivo* MRE of human liver. Storage and loss moduli were quantified, and the data were also analyzed employing a springpot model, yielding a stiffness-related parameter of 2.96 ± 0.53 kPa in bovine liver by rheometry and of 2.20 ± 0.45 kPa in human liver by *in vivo* MRE. Furthermore, MRE of excised bovine liver showed that stiffness tended to increase with decreasing sample temperature. In conclusion, mechanical tissue characterization by multifrequency MRE agrees well with oscillatory rheometry, which validates MRE as a method for investigating the rheology of liver tissue.

Keywords: Magnetic resonance elastography, rheometry, liver viscoelasticity, springpot

1. Introduction

One of the most traditional diagnostic methods in medicine, manual palpation, is based on the correlation between pathological conditions of soft tissue and changes in its mechanical properties. In the past, a mechanical characterization of biological tissue was limited to excised samples. For instance, compression tests were performed to determine the grade of hepatic fibrosis from liver stiffness [19]. Dynamic magnetic resonance elastography (MRE) [8,12] and shear-wave based ultrasound elastography (USE) [11,18] are noninvasive techniques capable of measuring tissue mechanical properties inside the human body. Both modalities have been used for noninvasive staging of hepatic fibrosis [2,3,13, 20]. In conventional MRE, mechanical vibrations of a single frequency, the so-called drive frequency, are introduced into the target tissue, which is positioned inside the magnetic resonance (MR) imager.

[*]Address for correspondence: Ingolf Sack, PhD, Department of Radiology, Charité-Universitätsmedizin Berlin, Charitéplatz 1, 10117 Berlin, Germany. E-mail: ingolf.sack@charite.de.