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Elastography determines the stiffness, or elasticity, of tissue, using either ultrasound or MR to measure mechanically generated vibrations. MR Elastography has been evaluated for a number of years in breast applications for the characterization of focal lesions. Recent developments have drawn attention to the use of MR elastography to help define the stages of liver fibrosis. Liver fibrosis refers to the accumulation of connective scar tissue in the liver.

Professor Bernard E. Van Beers, M.D., Ph.D. of the Saint-Luc University Hospital (Brussels, Belgium), has been evaluating non-invasive MR elastography to image liver fibrosis and determine stages of hardness in the liver. Prof. Van Beers recently completed a study comparing MR elastography to other methods of diagnosing and staging liver fibrosis, which will be published in an upcoming issue of Radiology. The study involved 88 patients, who were followed for 19 months between September 2004 and April 2006.

“We have a long history of scientific and clinical collaboration with Philips,” Prof. Van Beers says. “For years, we have been working on the non-invasive diagnosis of liver fibrosis and portal hypertension with functional MRI. MR elastography was a quite natural choice for a next study.”

MR elastography samples large volume

Liver fibrosis and the later stage of cirrhosis are typically diagnosed using histopathological analysis of biopsy samples. Because liver fibrosis is often heterogeneous, sampling variability is a limitation with this invasive modality. “In the case of biopsy, if you sample in one region only, you might have a different stage of fibrosis one or two centimeters outside that region,” says Prof. Van Beers.

Doppler ultrasound and blood tests are used as surrogate markers of liver fibrosis. However, these methods often detect only the late stages of the disease, such as liver cirrhosis. Elastography emerges as a non-invasive, potential alternative to liver biopsy for diagnosing liver fibrosis. While ultrasound elastography currently is a one-dimensional method, MR elastography images several slices within the liver, providing a more representative sample of the liver, and the number of slices can be increased to sample the entire liver.

“With MRI, elastography becomes three-dimensional. The mathematical model used to calculate the stiffness based on the propagation of waves is a more complete, more accurate method,” says Prof. Van Beers.

Prof. Van Beers continues to use more refined mathematical models for liver elastography. “The theory behind the propagation of the waves in tissues is relatively complex,” he says. “It would be easier in a homogeneous medium, but the liver is heterogeneous.”

MR elastography may help to determine stage of fibrosis

MR elastography provides the potential to quantify the stages of liver hardening, which figures significantly into treatment options. “Liver disease can be treated with medication in its early stages,” Prof. Van Beers says. “During this treatment, the physician will want to monitor the patient’s progress.”
Patients are often reluctant to accept liver biopsy, because of the discomfort and risk of complications, and it’s even more difficult when we have to perform multiple biopsies,” he says. “MR elastography is non-invasive and can be performed repeatedly in patients who require frequent monitoring during treatment. Our study also shows good reproducibility.”

MR elastography can be combined with other imaging sequences during liver exams, giving a more comprehensive exam. It can also be used to complement ultrasound imaging, says Prof. Van Beers. “Ultrasound is fast, it’s cheap, it can be performed by a clinician, but our results so far show a better assessment with MRI, so when we need a more detailed assessment – for example, before treating fibrosis – we prefer to use MRI.”

**Transducer and software generate precise elasticity maps**

“In liver imaging with MR elastography, the difference in contrast is based on the visco-elastic properties of the tissue,” explains Philips clinical scientist Leon ter Beek, Ph.D. Using the Philips Intera 1.5T, a small, removable transducer which vibrates at 65 Hertz, is added within the magnet to create mechanical waves within the liver. With the patient in a supine position, the transducer is placed under the back, pushing upwards in the A-P direction. The four-element SENSE Body coil is used to measure amplitude and phase information of the spins in the tissue. The scan used is a spin-echo based sequence in which a magnetic field gradient is alternated in polarity to phase encode moving spins. The acquisition time is about 20 minutes. Motion compensation with navigator gating is used, but Prof. Van Beers is currently validating an EPI based sequence that can be performed with breath holding, which reduces scan time significantly. Post-processing software completes the configuration, to calculate quantitative elasticity and viscosity maps of the liver.

**Results are promising**

While biopsy remains the gold standard and MR elastography is still in the validation stage, Prof. Van Beers expects that MR elastography will be increasingly used not only for liver fibrosis, but also for lesions in the liver and in other organs. “It may help to characterize these lesions and to assess their response to treatment by showing not only their visco-elastic parameters, but also possibly the architecture of the underlying microstructure.” Ter Beek adds: “Our results have been very promising, and the prospect of potentially being reliably diagnosed and monitored without biopsies is very good news for liver patients.”

**References**
