EDITORIAL

The role of magnetic resonance elastography in liver stiffness evaluation

Lorenzo Mannelli¹, Serena Monti¹, Pavel Ogurtsov²

¹ IRCCS SDN, Naples, Italy
² Peoples’ Friendship University of Russia (RUDN University), Moscow, Russian Federation

The correlation of estimated liver stiffness with liver diseases is of great clinical interest.¹⁻⁴ Different pathologic processes in the liver induce liver fibrosis, including viral hepatitis, alcoholic hepatitis, and nonalcoholic steatohepatitis. On the other hand, liver fibrosis results in cirrhosis with increased liver stiffness.¹⁻² Cirrhosis has a high incidence worldwide, with considerable morbidity and mortality rates.³ Liver stiffness was traditionally estimated by palpation on physical examination, but it can also be assessed using imaging techniques such as ultrasound and magnetic resonance (MR).³⁻⁵ Liver fibrosis is the main predictor of patient survival and liver function; therefore, accurate, safe, easily available, and reproducible methods to measure liver stiffness are of clinical interest.³⁻⁶ Liver fibrosis is a heterogeneous process, and a sample size for its assessment has significant implications. Liver biopsy samples about 1/10 000 of the liver parenchyma and offers a unique advantage for studying liver disease at a cellular level, but it may not be representative of the entire liver fibrotic status. Moreover, it is challenging to repeat liver biopsy frequently.¹⁻²,⁷ On the other hand, ultrasound has the advantage of wide availability and a relatively low cost, while MR imaging allows a comprehensive liver study with the assessment of iron and fat content as well as the highest sensitivity and specificity for hepatocellular carcinoma.²⁻⁵,⁷⁻¹ⁱ The main advantage of MR imaging over ultrasound is that it assesses the entire liver, is not operator dependent, and is feasible in patients with a high body mass index (BMI).¹⁻⁵

The most common MR and ultrasound elastography techniques use an excitation pulse applied to the skin surface and examine the shear wave propagation through the liver parenchyma.¹⁻⁵ The conversion of the shear wave velocity into kPa requires several assumptions, which may not apply to pathologic conditions. In MR elastography (MRE) at 1.5T magnet, 60 Hz is the most commonly used frequency for the excitation applied on the body surface; however, it is possible to use different frequencies, and a more accurate conversion to kPa could be achieved by combining the data from excitations obtained with different frequencies.³ However, increasing the number of collected frequency data would increase the imaging time, and the acquisition of data from a single frequency is currently considered adequate for clinical needs. The accuracy of MRE in assessing liver stiffness in multiple liver diseases with a direct correlation with histologic parameters has been established and confirmed by multiple studies, and it has potential to longitudinally monitor hepatic fibrosis. However, data on MRE precision (repeatability and reproducibility) in large cohorts of patients is not available yet. Ultrasound and MRE methods not based on shear wave propagation are available, but they mainly rely on tagged images and tissue deformation analysis. Moreover, they are currently less accessible and have been tested in clinical practice to a limited extent, so they will not be discussed in this editorial.³,¹⁰

Both ultrasound and MRE based on shear wave propagation have some limitations in clinical practice.¹ A high BMI with thick subcutaneous pannus is a considerable challenge for ultrasonography, while severe iron overload decreases the MRE signal and makes it difficult to analyze the shear wave propagation. Quality control of MRE should include evaluation of phase-contrast images that would confirm the propagation of shear waves through the liver. Failure in shear wave propagation through the liver can be due to air interface or suboptimal positioning of the driver generating the superficial excitations.²,⁸ Different sequences and algorithms to study the shear wave propagation with MRE are available, including 2-dimensional versus 3-dimensional sequences and shear wave propagation analysis, end-expiration versus end-inspiration image
acquisition, and 1.5 Tesla versus 3.0 Tesla scanners. Moreover, the MR technique is being constantly developed, with novel and improved sequences that collect signal to be translated into imaging information. This improvement poses a challenge for clinical practice in cases when stiffness needs to be evaluated longitudinally. Finally, the type and positioning of the driver providing the excitation to generate the shear waves and isotropy of liver elastic properties may be an obstacle in detecting mild changes in liver stiffness in patients with liver cirrhosis.

In a study by Obst et al. on a group of healthy volunteers, there was only 1 obese patient with a BMI higher than 30 kg/m²; however, in other larger studies, severe obesity did not limit the use of MRE based on shear wave propagation. The correlation between fibrosis and stiffness is direct, but unfortunately stiffness is affected also by other factors. For example, in patients with chronic liver disease, a fraction of induration (increased stiffness) is also due to edema and inflammation. Other factors include the metabolic status and blood pressure. In their study, Obst et al. reported a 0% failure rate in performing MRE, which is likely due to the fact that they enrolled young healthy volunteers. In a heterogeneous population of 1377 patients at Mayo Clinic, where the MRE technique was developed, the MRE failure rate was reported at 5.6%, with most of the unsuccessful studies being due to severe iron overload and failure of shear wave propagation through the liver. However, it is commonly believed that despite all the potential confounding factors, MRE is an excellent tool for an indirect and noninvasive classification of liver fibrosis stages in the entire liver parenchyma. Multiparametric MR imaging is constantly being developed, and several studies, as quoted by Kennedy et al., have been designed to address the inflammation and water content challenges. With advances in the field of multiparametric liver MR imaging, there is an increasing need for intense collaboration between radiologists and hepatogastroenterologists in order to optimize patient care. As there are multiple multiparametric MR imaging options, the examination needs to be tailored to the individual patient’s needs.

To summarize, in daily clinical practice, a close cooperation between the clinician and the radiologist is needed when evaluating liver stiffness in order to determine the best imaging option for the individual patient. Ultrasound can adequately screen for liver fibrosis and identify steatosis in most patients. When liver fat content and fibrosis require a quantitative measurement, MR imaging offers a more accurate measurement and can provide quantitative data on the entire liver. In patients where ultrasound is technically challenging, MR imaging is almost always capable of providing clinical information. When a single point measurement to screen for increased liver stiffness is needed, the emphasis should be placed on the sensitivity of the MR technique. On the other hand, when longitudinal measurements are planned in patients with known fibrosis, the emphasis should be placed on accuracy and reproducibility. If longitudinal assessments are needed, the use of the same MR scanner, with the same image acquisition strategy and sequence, should be preferred and properly planned.

**REFERENCES**


**DISCLAIMER**

The opinions expressed by the author are not necessarily those of the journal editors, Polish Society of Internal Medicine, or publisher.

**CONFLICT OF INTEREST** None declared.

**OPEN ACCESS** This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License (CC BY-NC-SA 4.0), allowing third parties to copy and redistribute the material in any medium or format and to remix, transform, and build upon the material, provided the original work is properly cited, distributed under the same license, and used for noncommercial purposes only. For commercial use, please contact the journal office at pamw@mp.pl.