Liver Fibrosis: Review of Current Imaging and MRI Quantification Techniques

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Liver fibrosis is characterized by the accumulation of extracellular matrix proteins such as collagen in the liver interstitial space. All causes of chronic liver disease may lead to fibrosis and cirrhosis. The severity of liver fibrosis influences the decision to treat or the need to monitor hepatic or extrahepatic complications. The traditional reference standard for diagnosis of liver fibrosis is liver biopsy. However, this technique is invasive, associated with a risk of sampling error, and has low patient acceptance. Imaging techniques offer the potential for noninvasive diagnosis, staging, and monitoring of liver fibrosis. Recently, several of these have been implemented on ultrasound (US), computed tomography, or magnetic resonance imaging (MRI). Techniques that assess changes in liver morphology, texture, or perfusion that accompany liver fibrosis have been implemented on all three imaging modalities. Elastography, which measures changes in mechanical properties associated with liver fibrosis—such as strain, stiffness, or viscoelasticity—is available on US and MRI. Some techniques assessing liver shear stiffness have been adopted clinically, whereas others assessing strain or viscoelasticity remain investigational. Further, some techniques are only available on MRI—such as spin-lattice relaxation time in the rotating frame ($T_1\rho$), diffusion of water molecules, and hepatocellular function based on the uptake of a liver-specific contrast agent—remain investigational in the setting of liver fibrosis staging. In this review, we summarize the key concepts, advantages and limitations, and diagnostic performance of each technique. The use of multiparametric MRI techniques offers the potential for comprehensive assessment of chronic liver disease severity.
Level of Evidence: 5

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Liver fibrosis is characterized by the accumulation of extracellular matrix proteins as a result of repeated injury to the tissue due to chronic liver disease.[1] All causes of chronic liver disease—including viral hepatitis, metabolic, and cholestatic disease—may lead to fibrosis.[2]

Liver biopsy is the current reference standard for the diagnosis and staging of fibrosis. However, it is associated with the limitation of sampling error, as it only examines a small liver sample, has low patient acceptance, and low intra- and interobserver repeatability.[3,4] In recent years, efforts have been made to migrate toward noninvasive techniques for assessing liver fibrosis.

Several imaging techniques have been developed for the diagnosis and staging of liver fibrosis. Historically, clinicians and radiologists have relied on the assessment of morphological changes associated with liver fibrosis. Other techniques rely on changes in physical properties that can be assessed quantitatively with imaging methods. These include texture, mechanical properties, $T_1\rho$ lengthening, diffusion, perfusion, and hepatocellular function. Elastographic techniques implemented on commercial ultrasound (US) and magnetic resonance imaging (MRI) systems have gained the widest clinical acceptance in the context of liver fibrosis imaging. The others are mainly restricted to an investigational setting.

The most widely validated and used liver fibrosis staging techniques are US-based elastography techniques. These techniques have improved the management of liver diseases by providing an alternative to liver biopsy. Moreover, many MRI techniques for imaging of liver fibrosis are being

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