Commentary

Detection of Liver Steatosis by Using MR Imaging Techniques

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ABOUT THE STUDY

Fatty liver disease is the leading cause of chronic liver disease in the United States. Non-invasive detection and quantification of fat has become clinically important, primarily due to the increased prevalence of non-alcoholic fatty liver disease. Fatty disease, an accumulation of lipid vacuoles in hepatocytes, is an important histological feature of fatty liver disease. Liver biopsy, the current reference criterion for assessing steatosis, is invasive, susceptible to sampling errors, and is not suitable in some settings. Several magnetic resonance (MR) imaging-based technologies, including chemical shift imaging, frequency-selective imaging, and MR spectroscopy, are currently clinically used for the detection and quantification of fat and water mixtures. Have important strengths, weaknesses, and limitations. These techniques enable the breakdown of the net MR signal into fat and water signal components, enable the quantification of fat in liver tissue, and are increasingly used in the diagnosis, treatment, and follow-up of fatty liver disease.

Fatty liver disease is the most common cause of chronic liver disease in both children and adults in the United States and is the leading cause of liver transplantation, hepatocellular carcinoma, and liver-related death. Non-alcoholic fatty liver disease alone affects more than 30% of Americans. An important histological feature of fatty liver disease is steatosis, which is the accumulation of lipid vacuoles in hepatocytes. Liver biopsy, the current diagnostic criterion for assessing steatosis, is invasive. There is a sampling error. Not suitable for screening, long-term monitoring, or assessment of treatment response. Accurate detection and quantification of fatty liver is a major unmet need for the diagnosis and treatment of fatty liver disease, as well as large therapeutic clinical trials and epidemiological studies. The adverse effects on the prognosis of fatty liver for live liver donors and patients undergoing liver resection are increasingly recognized, and the need for non-invasive methods to detect and quantify liver fat in these patients. These modalities allow the net MR signal to be broken down into fat and water signal components, and when performed correctly, allow for the quantification of fat in liver tissue. This article describes three MR imaging modalities for detection and quantification of steatosis that can be used clinically: chemical shift imaging, frequency-selective imaging, and MR spectroscopy. For each method, we will review the main concepts and basic physical principles, and explain and explain clinical applications. In addition, it describes the strengths and weaknesses of each technique and provides recommendations for use in fat detection and quantification. It also describes recent technological advances that improve sensitivity and accuracy in this context, such as iterative decomposition and least squares estimation. The focus is on the liver, but to explain important concepts, we will discuss the assessment of extrahepatic tissue as needed.

DETECTION TECHNIQUES

Chemical shifting method

MR imaging technology that utilizes the chemical shift effect is immediately available in clinical practice and is a powerful tool for fat detection. The term chemical shift refers to the difference in generative motion frequency (or resonance frequency) between two proton MR signals, which are expressed as one millionth of the resonance frequency of the static magnetic field B0. Applying a standard non-selective RF pulse to a mixture of fat and water excites both proton species, but the water signal precesses about 3.5 ppm faster than the fat signal.

Frequency selective imaging

In chemical shift imaging, both fat and water protons are excited to generate MR signals. In contrast, frequency-selective imaging can separate the desired signal from water and fat. Two basic approaches are possible: selective saturation of the signal or selective excitation of the signal. This article focuses on fat saturation techniques that are widely used as standard acquisition options in virtually all MR imaging sequences.