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User experiences

Ivan Pedrosa, MD, Chief of MRI and Associate Professor of Radiology.

Takeshi Yokoo, MD, PhD, Assistant Professor of Radiology.

University of Texas Southwestern (UT Southwestern) Medical Center in Dallas, Texas, USA, recently collaborated with Philips to optimize and verify mDIXON Quant, a low flip angle, multi-echo, multi-peak method that enables robust and high quality quantification of fat deposition in the liver. UT Southwestern operates three Philips MR systems clinically; an Achieva 1.5T, Achieva 3.0T TX, and Ingenia 1.5T. Additionally, two Achieva 3.0T systems and a 7.0T system are housed in the Advanced Imaging Research Center.

A healthy liver has about 5%-6% fat content. When the amount of fat in the liver exceeds that amount, the result is fatty liver disease, which affects between 3% and 33% of people worldwide. While classically described in patients with excessive alcohol consumption, fatty liver not related to alcohol, called Non-Alcoholic Fatty Liver Disease (NAFLD), is now considered the most common type of fatty liver disease in the western world. The risk of NAFLD is multifactorial, however it is most often associated with obesity.

Patients with NAFLD are at high risk of steatohepatitis, which can lead to cirrhosis and possibly liver failure. In addition, the exact relationship between NAFLD and other health problems is not completely understood. “There are other entities that are associated with NAFLD, such as diabetes and hypertension, and we are trying to understand if they are a consequence or a cause of the disease,” says Ivan Pedrosa, MD, Chief of MRI and Associate Professor of Radiology at UT Southwestern Medical Center. “There is evidence indicating that patients with NAFLD have a higher risk for liver cancer and cardiovascular events.”

Imaging aids diagnosis

Despite these severe consequences, NAFLD can also be asymptomatic. In those cases, it is often detected when imaging is ordered as a follow-up to an abnormal liver enzyme test that is conducted as part of a routine physical examination. Ultrasound is the most common method to screen for fatty liver disease. However, ultrasound has only
70% sensitivity in detecting abnormal amounts of fat in the liver, and the sensitivity is even lower in obese patients.4

“Liver biopsy, while accurate, is invasive and has a risk of complications that are rare but can be life-threatening. Because of that, patients and referring physicians may be reluctant to use liver biopsy for the initial diagnosis of NAFLD, and even more so for a follow-up,” says Takeshi Yokoo, MD, PhD, Assistant Professor of Radiology. “Patients can’t have a liver biopsy every few months to assess disease progression. In addition, biopsy only assesses a small fraction of the liver, so the sampling error can be significant in patients with heterogeneous fat deposition.”

“Spectroscopy can also quantify fat in the liver, but it requires expertise that is not available everywhere, and like biopsy, only measures a small sample of tissue,” he notes. “In contrast, mDIXON Quant enables quantification of fat in the liver in a way that is non-invasive, fast, robust and provides high quality results.”

Fruitful collaboration
UT Southwestern has been involved in a collaboration with Philips on the development and evaluation of mDIXON Quant for clinical use.

“It is a perfect synergistic effect of combining expertise to work on a technique that is robust and provides the data that we need,” Dr. Pedrosa notes. “We were fortunate to have clinical research at UT Southwestern using spectroscopy to quantify fat in the liver, which provided us with the opportunity to assess mDIXON Quant in human subjects. Being able to correlate data from mDIXON Quant with the spectroscopy data in vivo and to work with Philips scientists to improve the acquisition and reconstruction method using these data allowed us to develop a robust method to quantify fat in the liver.”

“We found that mDIXON Quant provides high quality data for the quantification of fat concentration in the liver when compared to spectroscopy and thus opens the door to investigate many clinical questions,” he adds. “For example, if losing weight is a method to reduce fatty liver, how much weight does one have to lose? At what point does excess fat become a problem? How effective are various therapies? Having a quantitative measure of fat allows us to conduct studies that will provide answers to clinical questions.”

Standardization key to clinical relevance
“While different MR system vendors measure fat content in the liver in different ways, it is the reproducibility of the results across all vendors and field strengths1 that is the strength of MR fat quantification in the liver,” Dr. Yokoo says. “Fat quantification in the liver now has the potential to become like blood pressure or hemoglobin level. The measurement is reliable,4 so it can be used to make patient management decisions. Patients can go to different centers, or different MR systems at the same center, and the results can be compared with confidence.”

Important health factor
Both Dr. Pedrosa and Dr. Yokoo expect mDIXON Quant to become a standard part of liver protocols, given that in the United States alone, 20-30 million people have NAFLD.

“Many radiologists are not cognizant of reporting fatty liver as a significant finding, and I think that needs to change,” Dr. Yokoo says. “If we believe that hypertension and high cholesterol are important biomarkers to predict future development of coronary disease or poor outcome, liver fat is just as important. So if you think hypertension should be reported, then liver fat should be reported as well.”
Liver in obese patient with type II diabetes
A 50-year-old Caucasian female with obesity, type II diabetes, and abnormal liver enzymes. A non-alcoholic fatty liver is suspected.

High resolution, single shot axial T2W TSE BH and fat saturated (SPAIR) images show no gross abnormality. Axial dual echo T1 2D FFE demonstrates diffuse loss of liver parenchymal signal on the out-of-phase image, compatible with diffuse fatty liver. A blooming susceptibility artifact in the gall bladder fossa, more pronounced on the long TE (in-phase) image, is compatible with metallic cholecystectomy clip(s). The respiratory triggered axial EPI DWI images are within normal limits.

mDIXON Quant fat fraction maps show diffuse fatty liver, slightly heterogeneous across the liver. Fat fraction values ranging from 13-22%, compatible with grade 1-2 steatosis at histology (Tang, et al, Radiology 2013, PMID: 23382291).

The dynamic 3D T1 FFE mDIXON contrast-enhanced series (water only) shows decreased liver parenchymal signal on the pre-contrast image in keeping with fatty liver. Minimal patchy heterogeneity of the arterial enhancement may be related to underlying liver disease. Portal and delayed venous phase images are within normal limits. On other images in the exam (not shown) no definite morphological evidence was seen for cirrhosis or portal hypertension.

Philips Achieva 3.0T TX with SENSE Torso XL coil. 3D T1 FFE mDIXON Quant: TR 6.2 ms, 6 echoes TE1/DTE 1.05/0.8 ms, flip 2 deg, BH 18 sec, matrix 188 x 194, 26 slices of 10 mm. Fat fraction tool allows for color display of fat fraction measurement.
Multi-echo, multi-peak mDIXON Quant method delivers robust, high quality fat quantification

mDIXON Quant balances accuracy and efficiency in acquiring the data needed for fat quantification in the liver non-invasively, in a single breathhold.

A simple in-phase and out-of-phase acquisition may be used for a qualitative assessment of fat. However, mDIXON Quant uses a 6-echo acquisition for robust and high quality fat quantification. Using a higher number of echoes has the advantage of allowing quantitative assessment, accommodating fat molecules’ multiple spectral peaks and enabling T2* correction. T2* correction is necessary because T2* signal decay between echoes influences the relative signal intensity of the fat peaks.

Freely selectable echo time
mDIXON Quant differs from other MR fat quantification methods because its algorithm maintains freedom for the user in selecting echo times. This also provides flexibility in choosing other parameters, such as resolution and field of view.

The 7-peak reconstruction enables robust water/fat separation, which delivers better modeling of heterogeneous fat distribution in the liver.

Convenient color maps
mDIXON Quant results can be displayed in a color fat fraction map that visually conveys the amount of fat in the liver, and enables convenient comparison of images acquired at different times.

Another benefit of the mDIXON Quant technique is the possibility to create a T2* map. When paired with fat quantification, this provides a more complete picture of liver health.

**References**