THE ROLE OF NEW MRI TECHNIQUES IN THE DIAGNOSIS OF DIFFUSE LIVER DISEASES

Essay
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Abstract

However, more clinical evidence is needed to determine which method or combination of methods achieves the best accuracy for assessment of fibrosis, fat, and iron deposition. In phase and opposed phase MR imaging allows reliable detection of focal steatosis hepatis owing to the chemical shift cancellation artifact. Areas of steatosis demonstrate signal loss on opposed phase images. In addition, T2* effects allow reliable detection of iron storage diseases related susceptibility artifacts. Areas of iron storage demonstrate pronounced signal loss on the image with the longer echo time. MR spectroscopy has potential tool utility for assessment of metabolic function, particularly with respect to liver fat quantification. It also may provide useful information about other aspects of diffuse liver disease (eg, inflammation and fibrosis). However, in vivo application of MR spectroscopy in the abdomen and pelvis is limited by spectral resolution, SNR, and motion. In summary, MR spectroscopy of the liver is a novel evolving technology with the potential to improve tissue characterization when used in conjunction with other conventional MR sequences.

Key word: DIFFUSE LIVER DISEASES-MRI- *Radiodiagnosi*s- Haemochromatosis- Sarcoidosis- Hepatic steatosis

TO MY

MOTHER, FATHER
MY SISTER
And to my beloved ones

TO WHOM I AM OVERWHELMINGLY INDEBTED TO, THANK YOU AND GOD BLESS YOU

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LIST OF ABBREVIATIONS

ADC: Apparent diffusion coeffecient
AO = aorta
CT = celiac trunk
CNR **:** Contrast to-Noise-Ratio
DA = duodenal artery
DWI: Diffusion weighted imaging
FLASH **:** Fast Low Angle Shot
Fl = falciforme ligament
Gd- DTPA **:** Gadolinium-Diethylene Triamine Penta acetic Acid
HA = hepatic artery
HCV **:** Hepatitis C Virus
IVC **:** Inferior Vena Cave
LGA = left gastric artery
LHV **:** Left Hepatic Vein
LV = ligament venosum
LHA = left hepatic artery
LP **:** Left Portal Vein
MHV **:** Middle Hepatic Vein
MRI **:** Magnetic resonance imaging
MIP: Maximum intensity projection
RHA = right hepatic artery
RHV = right hepatic vein
RPV = right portal vein
SMA = superior mesenteric artery
SA = splenic artery
SMV = superior mesenteric vein
SV = splenic vein
PV **:** Portal Vein
SE **:** Spin Echo
SGE **:** Spoiled gradient echo
SI **:** Signal intensity
SNR **:** Signal to-Noise Ratio
SPIO **:** Super Paramagnetic Iron Oxide
SS **:** Single Shot
STIR **:** Short T1 Inversion Recovery
T **:** Tesla
TE **:** Time of Echo
TR **:** Time of Repetition
Turbo FLASH **:** Turbo fast low-angle shot
USPIO **:** Ultra small superparamagnetic iron oxides
3D-GRE **:** Three Dimensional Gradient Recalled Echo

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INTRODUCTION

Introduction

MRI plays an increasingly important role for assessment of patients with chronic liver disease. MRI has numerous advantages, including lack of ionizing radiation and the possibility of performing multiparametric imaging. With recent advances in technology, advanced MRI methods such as diffusion, chemical shift based fat-water separation and MR spectroscopy can now be applied to liver imaging. ***(Taouli et al, 2009)***

Magnetic resonance (MR) imaging has role in evaluation of diffuse liver disease. Hepatic MR imaging has been proved to be a comprehensive modality for assessing the morphology and functional characteristics of the liver. Concurrent technical improvements as well as implementation of advanced imaging sequence designs permit high-quality examination of the liver with T1-, T2-, and diffusion-weighted pulse sequences. Three basic demands remain if MR imaging is chosen for hepatic imaging: to improve parenchymal contrast, to suppress respiratory motion, and to ensure complete anatomic coverage**. *(Boll and Merkle et al, 2009)***

A T1-weighted gradient-echo in-phase and opposed-phase sequence has become a routine part of every hepatic magnetic resonance (MR) imaging protocol. Although this sequence is primarily used to identify common pathologic conditions, such as diffuse or focal steatosis and focal fatty sparing, it is also helpful in detection of pathologic entities associated with T2* effects owing to the double-echo approach. A complete understanding of both the chemical shift cancellation artifact and the T2* effects of the in-phase and opposed-phase sequence is important for correct interpretation of hepatic MR images. ***(Merkle and Nelson, 2006)***

Diffusion-weighted imaging is an evolving technology with the potential to improve tissue characterization when findings are interpreted in conjunction with findings obtained with other conventional MR imaging sequences. ***(Qayyum, 2009)***

Diffusion weighted echo planar imaging, an adaptation from neuroimaging, is fast becoming a routine part of the MRI liver protocol to improve lesion detection and characterization of liver lesions. ***(Maniam S et al, 2010)***

Magnetic resonance (MR) spectroscopy allows the demonstration of relative tissue metabolite concentrations along a two or three dimensional spectrum based on the chemical shift phenomenon. MR spectroscopy of the liver is an evolving technology with potential for improving the diagnostic accuracy of tissue characterization when spectra are interpreted in conjunction with MR images. ***(Qayyum, 2009)***

The basic pathophysiology of diffuse parenchymal hepatic diseases usually represents a failure of metabolic pathways. Specific parenchymal diseases can be categorized as **storage, vascular, and inflammatory diseases**. ***(Boll and Merkle et al, 2009)***

Noninvasive detection and **quantification of fat** is becoming more and more important clinically. Magnetic resonance (MR) imaging based techniques including chemical shift imaging, frequency-selective imaging, and MR spectroscopy are currently in clinical use for the detection and quantification of fat-water admixtures, with each technique having important advantages, disadvantages, and limitations. These techniques permit the breakdown of the net MR signal into fat and water signal components, allowing the quantification of fat in liver tissue, and are increasingly being used in the diagnosis, treatment, and follow-up of fatty liver disease. ***(Hughes Cassidy et al, 2009)***

Magnetic resonance (MR) imaging is the most sensitive and specific imaging modality in the diagnosis of **hemochromatosis.** The susceptibility effect caused by the accumulation of iron leads to signal loss in the affected tissues, particularly with the T2*-weighted sequences, which makes the diagnosis of iron overload possible. By using MR imaging techniques, it is possible to estimate the hepatic iron concentration in a noninvasive way, thereby avoiding repeated biopsies. (***Queiroz-Andrade et al, 2009)***

Patients with **chronic hepatitis B and hepatitis C virus** infections are at high risk of development of hepatic fibrosis and cirrhosis. In chronic viral hepatitis, evaluation of disease severity and the indications for antiviral therapy usually rely on histologic findings obtained at liver biopsy performed to assess degree of fibrosis. The sensitivity of conventional MRI in the detection of liver fibrosis and early cirrhosis is limited, and noninvasive imaging techniques have not yet been definitely established for the detection of liver fibrosis. With diffusion-weighted MRI (DWI) water diffusion is quantified by calculation of the apparent diffusion coefficient (ADC), which can be used to quantify liver fibrosis in patients with chronic liver disease. ***(Taouli et al, 2007)***

The aim of work

Embracing the role of new MRI techniques as diffusion, chemical shift as well as spectroscopy together with the conventional MRI techniques in tissue characterization, diagnosis and staging of diffuse liver diseases for better impact on the treatment as well as prognosis.

MRI ANATOMY OF THE LIVER

Magnetic resonance (MR) imaging provides comprehensive evaluation of the liver including the parenchyma, biliary system, and vasculature. While computed tomography and sonography are often the initial studies used in evaluating the liver, MR is increasingly relied upon as a primary imaging modality in addition to its problem-solving capacity. MR provides soft tissue characterization unachievable with other imaging modalities. Lack of ionizing radiation and relative lack of operator dependence are additional advantages over computed tomography and ultrasound respectively. Moreover, it enables the radiologist to take axial, sagittal and coronal images when evaluating the liver. Rapid breath-hold pulse sequences have largely replaced older, slower pulse sequences, resulting in shortened examination times. ***(Fisher et al, 2005)***

The major vascular structures are most consistently demonstrated in the axial MR images**.** With spin echo MRI, generally vessels are delineated as areas of signal void. ***(Robinson et al, 2006)***

A wide range of protocols are available due to numerous combinations of field strength, pulse sequence implementation and interdependent sequence parameters, all of which can confluence image quality. ***(Lomas, 2008)***

Segmental anatomy:

The eight liver segments are numbered clockwise based on frontal view of the liver, beginning with the postero-superior segment of the left paramedian sector, which corresponds to the caudate lobe, and ending with segment VIII which is consistent with the postero-superior segment of the right paramedian sector **(Fig.1)**. ***(Schneider, 2006)***

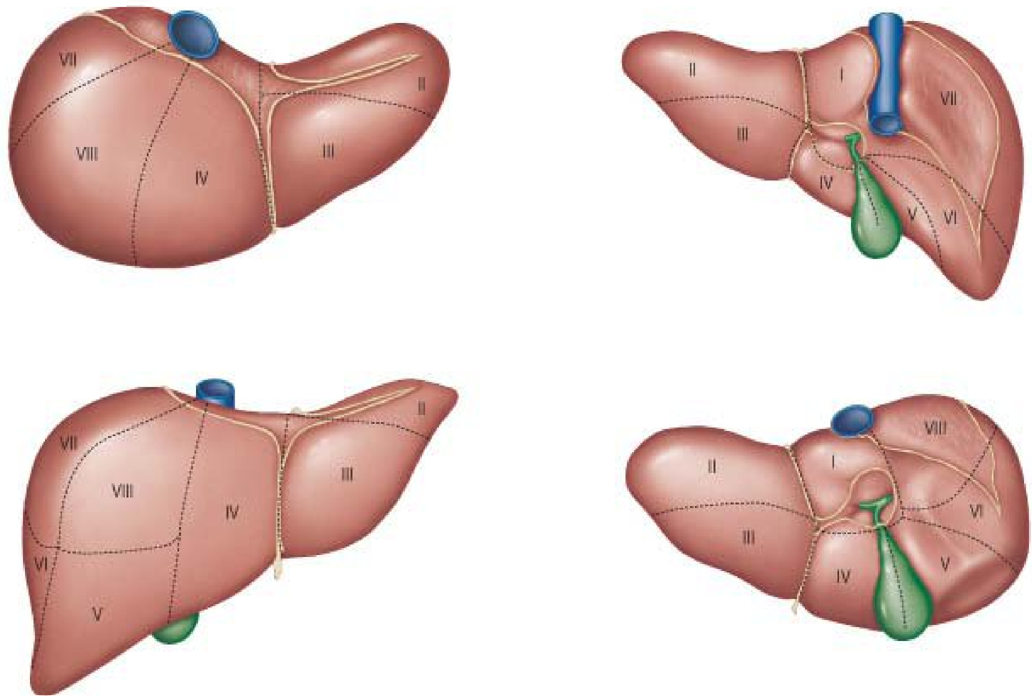

Fig.1: Showing Segmentation of the liver. ***(Standring et al, 2005)***

Anatomically, the borders of the liver segments are well-defined, but show a wavy shaped course. However, in clinical routine, segmentation of the liver in cross sectional MR imaging is sharply demarcated and usually based on certain landmarks that define the underlying borders. ***(Lee et al, 2007)***

Based on these landmarks, the IVC is considered the center point for liver segmentation. A line from the IVC to the middle hepatic vein and the gall bladder separates the left and right hemi liver and the corresponding liver segments V/VIII and I/IV (a & b) respectively. Whereas the axis between the IVC and right hepatic vein corresponds to the border between liver segments VI/VII and V/VIII, the line between the IVC and left hepatic vein and the falciform ligament separates liver segments IV a and IV b from segments II and III. ***(Schneider, 2006)***

Whereas liver segments VII, VIII, I, IV a and II are located at the posterior aspect of the imaged abdominal situs and above the level of the left and right main portal vein, segments VI, V , IVb and III are located inferior to the level of main portal veins at the anterior aspect of the liver. Segment I corresponds to the caudate lobe as shown in **(Fig.2)**. ***(Shahid, 2007)***

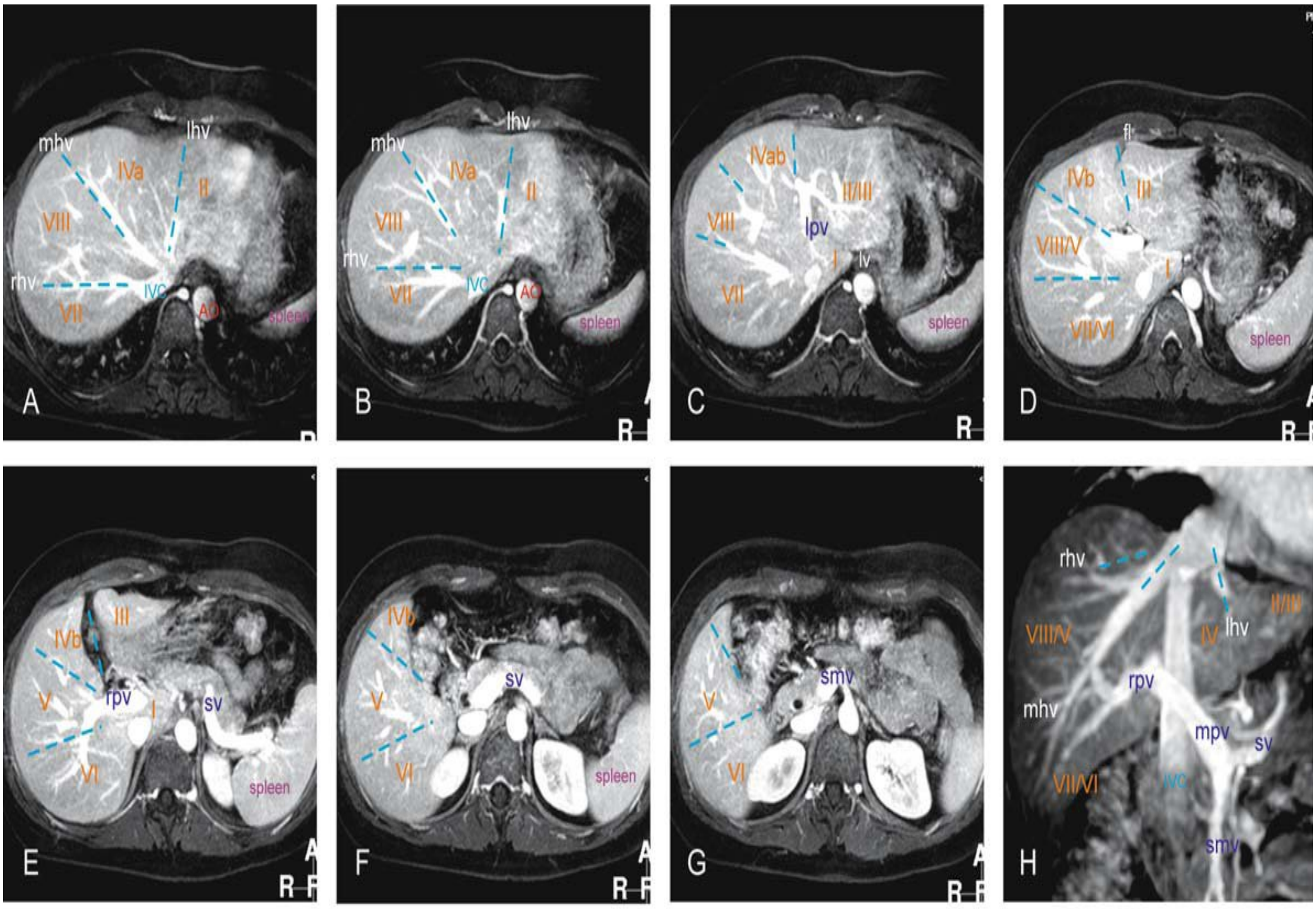

Fig.2: A–G Axial maximum intensity projection (MIP) based on the three-dimensional (3D) gadolinium-enhanced delayed phase gradient echo images at various levels shows the hepatic segments (I–VIII), three hepatic veins, portal vein, and ligaments. **H.** Coronal reformat shows the relationship among the hepatic segments, three hepatic veins, portal vein (formed by the splenic and superior mesenteric veins), and inferior vena cava. ***(Shahid, 2007)***

Vascular anatomy:

Normal hepatic arterial supply occurs only in a small majority of subjects. In 55%of cases, the common hepatic artery (CHA) gives rise to the right hepatic artery (RHA), middle hepatic artery (MHA), and left hepatic artery (LHA) (114.1J); in 11%, the RHA originates from the superior mesenteric artery (SMA); in 10%, a replaced LHA is present; in 8% the RHA, MHA, and LHA arise from the CHA with an accessory LHA from the left gastric artery (LGA); in 7%, the RHA, MHA, and LHA arise from the cha with an accessory RHA from the LGA; and in 4.5%, the entire CHA