MRI of Diffuse Liver Disease

Diego R. Martin
Department of Radiology
University of Arizona

Richard C. Semelka
Department of Radiology
University of North Carolina at Chapel Hill
Diffuse Liver Diseases

- Fatty Liver
- Iron Deposition
- Acute Hepatitis
- Chronic Liver Disease and Cirrhosis
- Vascular Disease
Fatty Liver / Patterns

- Diffuse
- Patchy
- Focal
Fatty Liver / Causes

- Obesity
- Liver Response to Systemic Disease
- Fatty Liver Related to Focal Liver Disease
- Fatty Liver Related to Therapy
Fatty Liver / Causes

- Non-Alcoholic Fatty Liver Disease NAFLD
- Non-Alcoholic Steatohepatitis NASH
- “Hepatic Steatosis”
- “Steatohepatitis”
Fatty Liver / Imaging Technique

- In-phase and Out-of-phase SGE or 3D GE
- Voxels that contain fat and water lose signal
- Signal loss is maximal when fat content approaches 50%
Fatty Liver
Fatty Liver With Focal Fatty Sparing
Fatty Liver / Imaging Technique

- Fatty liver generally enhances the same as nonfatty liver

- When using fat-suppressed post-contrast imaging (e.g. VIBE/LAVA/THRIVE) it is essential to distinguish enhancement effects from fat-suppression effects.
  - Always examine the in/out-of-phase images for non-uniform fatty liver
Use shortest TE out-of-phase (1st) and in-phase (2nd) echo

To distinguish fat from iron
Fatty Liver / Diagnosis

- Liver drops in signal relative to spleen and muscle
- But muscle is more reliable as spleen may have iron
Diffuse Fatty Liver
Diffuse Fatty Liver / 1.5 T vs 3.0 T
Fatty Liver / Patchy

- Patchy fatty infiltration requires correlation between in-phase/out-of-phase images and the post-gadolinium images when using fat-suppression
Multifocal Fat Infiltration
Fatty Liver / Focal Fat Sparing

- FNH

- Liver metastases (compressed liver around focal lesions is unable to become fatty deposited)
  - results in a bright rim on out-of-phase images.
Background Fatty Liver With FNH
Colon Cancer Metastases

Background Fatty Liver Infiltration
Iron Deposition / Patterns

- Reticulo-Endothelial System
- Organ deposition
- Diffuse
- Heterogeneous
- Focal
Calculated T2 values have been reported to closely relate to tissue iron concentration.

- Semiquantitative approach (T2 single shot/T1 GRE):
  - Mild deposition: dark on T2, no change T1
  - Moderate deposition: dark on T2, gray on T1
  - Severe deposition: dark on T2, dark on T1
HISTO

- High speed T2-corrected liver fat and iron measurement
  - JMRI 2009;29: 629-35
  - Radiology 2009;252:568-576
Reticulo-Endothelial System

- Iron in liver, spleen, bone marrow
- Blood transfusion
- Iron supplements – chronic renal insufficiency
Hemosiderin Deposition From Prior Blood Transfusions
Organ Deposition

- Genetic Hemochromatosis

  - Iron in liver, within hepatocytes
  - Uncommon in spleen

  - Direct deposition occurs in pancreas, myocardium, and leads to cirrhosis and HCC
Primary Hemochromatosis
Primary Hemochromatosis
Primary Hemochromatosis
Iron Accumulation in Cirrhotic Liver / 3.0 T
Congenital Disorders of Erythropoiesis

- Thalassemia

- Combination of
  1- iron deposition in tissues – bone marrow
  2- transfusional siderosis
Congenital Dyserythropoietic Anemia
Coexistent Fat and Iron Deposition / 3.0 T
HISTO – Rapid Concurrent Lipid and Iron Measurement

Lipid%: 15.6% +/- 0.3
R2water: 29.7 s^-1 +/- 0.5
HISTO – Rapid Concurrent Lipid and Iron Measurement
Acute Hepatitis

- Infection
- Diffuse systemic disease
- Toxins
Acute Hepatitis / Imaging Features

- Hepatomegaly
- Hepatic Edema (Diffuse - Periportal)
- Fatty Infiltration
- Transient Increased Patchy Enhancement
Acute Hepatitis
Acute Hepatitis 3T
Chronic Liver Disease and Fibrosis

Imaging Findings

- Changes of liver morphology
- Presence of fibrosis
- Active-on-chronic disease
- Portal hypertension
Cirrhosis Morphology

Macronodular

Micronodular
Cirrhosis Morphology

- Right lobe atrophy
- Caudate lobe hypertrophy
- Left lateral segment hypertrophy
Central Liver Regeneration
Primary Sclerosing Cholangitis
The most consistent morphological feature on MRI of chronic liver disease is the demonstration of fibrous tissue, that appears as a reticular network of linear stroma of varying thickness that accumulates contrast on delayed phase T1W images.
Fibrosis – Imaging Features

- Low signal on T1
- Varies from high to low signal on T2
- Negligible enhancement on immediate postgadolinium images
- Increased enhancement on interstitial phase images
Hepatic Fibrosis
Fibrosis is best shown on

- In-phase TE T1-weighted images
- Out-of-phase images (TE=2ms)
- Interstitial phase fat-suppressed post-gadolinium images
Hepatitis C
Autoimmune Hepatitis
Autoimmune Hepatitis 3T
Fibrosis

Imaging Patterns

- Reticular
- Confluent
- Both reticular and confluent
**Reticular Fibrosis**

Appears as a network of linear tissue

- **Mild ( < 2mm in thickness)** – No surface irregularity
- **Moderate (between 2-5 mm)** – Surface irregularity
- **Severe (> 5 mm)**
Mild Reticular Fibrosis
T1 Contrast Resolution / Reticular Fibrosis / 1.5 T vs 3.0 T
Moderate Reticular Fibrosis

T2

Arterial

2.2ms

Delayed

A157
Severe Reticular Fibrosis

T2

2.2ms

Arterial

Delayed
Confluent Fibrosis

- Regions of amorphous fibrosis
- > 2 cm in diameter
- Shows the same pre and post-gadolinium MR characteristics as reticular fibrosis
- Enhancement pattern may be homogeneous or patchy on immediate post-gadolinium images
Confluent Fibrosis

T2

Pre

Arterial

Delayed
Fatty Infiltration in Cirrhotic Liver
Acute inflammation superimposed on chronic disease

Always present at histology, in more substantial inflammation early patchy increased enhancement is shown

Increased enhancement is transient and becomes isointense over time (unlike diffuse HCC which washes out).
Active-on-Chronic Hepatitis
Active-on-Chronic Hepatitis
Active-on-chronic Hepatitis
Diffuse and Confluent Fibrosis
Portal Hypertension

- Varices
- Splenomegaly
- Ascites
- Bowel wall edema
- Gallbladder wall thickening
- Portal vein thrombosis
Portal Hypertension / Gastric and Esophageal Varices
Portal Hypertension – Spleno-renal Shunt / Splenomegaly
Portal Hypertension – Abdominal wall varices 3T
Gallbladder Wall Edema
Portal Vein Thrombosis
Portal Vein Thrombosis
Portal Cavernous Transformation / 3.0 T
Vascular Liver Diseases

- Portal vein
- Hepatic vein
- Hepatic artery
Sub-Acute Budd Chiari
Late Sub-Acute Budd Chiari
Right hepatic lobe infarction and hemorrhage
CONCLUSION

- MRI IS HIGHLY ACCURATE FOR LIVER TUMOR AND FOR DIFFUSE LIVER DISEASE DETECTION AND CHARACTERIZATION
  - FAT
  - IRON
  - INFLAMMATION
  - FIBROSIS
  - VASCULAR DISEASE
  - (BILE DUCTS)