

# The Utility of In-Phase and Opposed-Phase Gradient Recalled Echo Magnetic Resonance Imaging for Detection of Susceptibility In Abdominal Imaging

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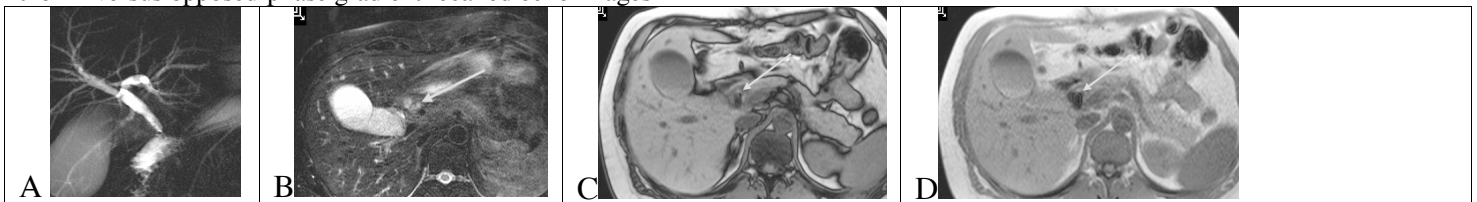
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## Introduction:

In-phase and opposed-phase imaging, which acquires echoes when the precession of fat and water are opposite in phase and again when they are aligned, has been shown to be accurate in the characterization of adrenal lesions and fatty diseases of the liver (1,2). This technique is most commonly applied using a small flip-angle T1-weighted gradient recalled echo and can be performed in a single breath hold. The elongated echo time of the in-phase image can be exploited for the greater T2 and T2\* susceptibility. The concept of "susceptibility-weighted imaging" was introduced relatively recently (3). We present a spectrum of cases where the identification of susceptibility aids in diagnosis.

## Metallic Foreign Bodies and Gas

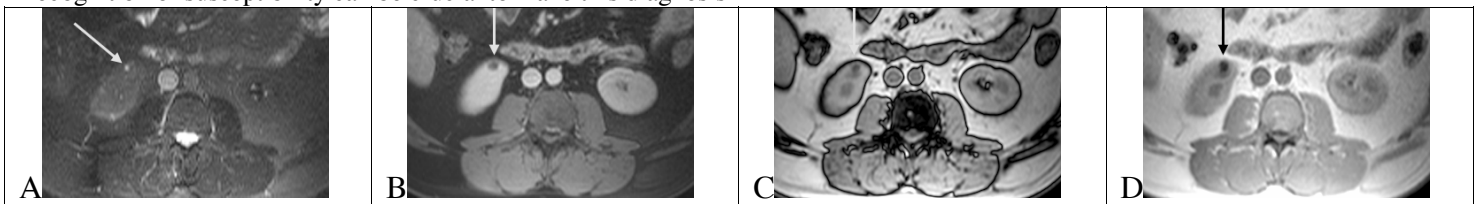
Metals have varying degrees of susceptibility, but most are relatively conspicuous on long-TE gradient recalled echo or steady-state free-precession sequences. Surgical clips, metallic sutures, staples, and traumatic metallic foreign bodies are all more conspicuous on the in- versus opposed-phase gradient recalled echo images.



Dilated common bile duct. A) MR cholangiogram from a thick-section single-shot fast spin-echo T2-weighted image. B) The surgical clip (arrow) which is causing common bile duct dilation is relatively inconspicuous on the fat-suppressed T2-weighted imaging. C) The clip artifact is relatively mild on the opposed-phase image. D) More pronounced susceptibility on the in-phase image.

## Blood Product Deposition

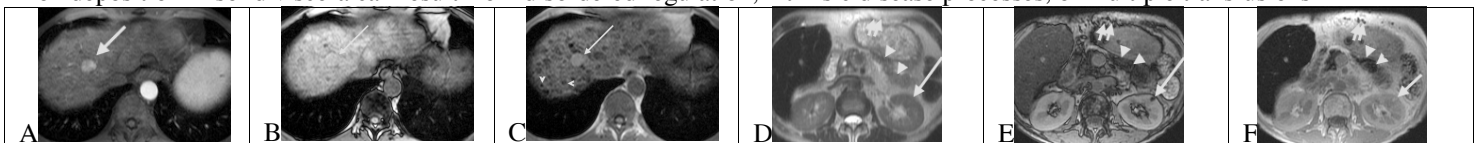
The iron in hemorrhage also results in susceptibility. Because of the variable T1 and T2 signal of hemorrhagic lesions depending on the age of the blood products, characterization can be difficult, and the inherently short T1 can confound evaluation for enhancement. Recognition of susceptibility can be crucial to make this diagnosis.



Lesion of the lower pole of the right kidney. A) Fat-suppressed T2-weighted axial image reveals long T2. B) Contrast-enhanced fat suppressed T1-weighted gradient recalled echo (VIBE) image reveals a low-signal lesion which does not clearly enhance but appears larger than the lesion on T2-weighted imaging. C) The opposed-phase image reveals low signal but no drop-out to suggest angiomyolipoma. D) Susceptibility on the in-phase image confirms a hemorrhagic cyst.

## Iron Deposition: Hemochromatosis and Hemosiderosis

Iron deposition in solid viscera can result from disordered regulation, intrinsic disease processes, or multiple transfusions.



Two cases of iron deposition of the liver. A) Cirrhosis, hepatocellular carcinoma (arrow), contrast-enhanced T1-weighted. B) Opposed- and C) in-phase reveal the lesion better on the latter against a background of siderotic nodules (arrowheads). D) Secondary hemochromatosis is less conspicuous in the pancreas (arrowheads) on this T2-weighted image of a different patient. E & F) Opposed- and in-phase images reveal susceptibility in the liver and pancreas, but drop-out on the former denotes an angiomyolipoma (arrow).

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2. Mitchell DG, et al. Benign adrenocortical masses: diagnosis with chemical shift MR imaging. *Radiology* 1992;185(2):345-351.
3. Haacke EM, Xu Y, Cheng YC, Reichenbach JR. Susceptibility weighted imaging (SWI). *Magn Reson Med* 2004;52(3):612-618.