

Figures 1a and 1b.



Figures 3a and 3b.

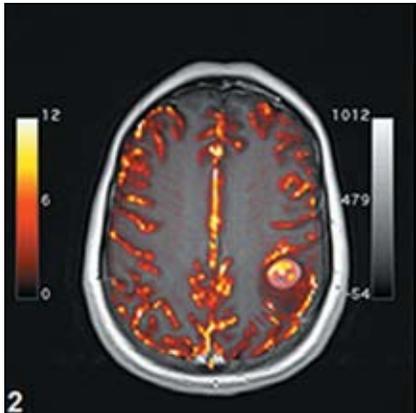


Figure 2.

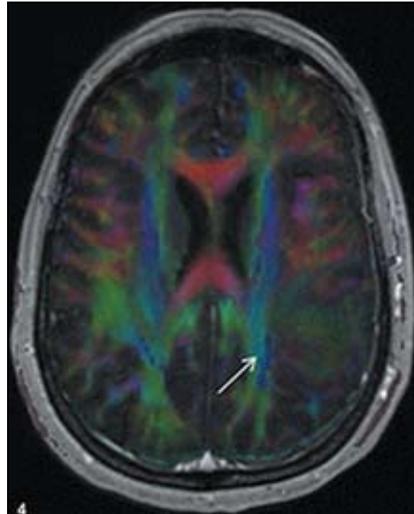


Figure 4.

motor functions: validation with intraoperative electrocortical mapping. *Radiology*. August 2008; 248: 579-589.

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The authors and/or their spouses/significant others have no financial interests to disclose.

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## Focal Nodular Hyperplasia on MRI Using a Hepatocyte-Specific Contrast Agent at 1.5 Tesla vs. 3.0 Tesla Field Strength

*Kevin J. Chang, MD*

**A TWENTY-NINE YEAR-OLD FEMALE WITH AN** implantable contraceptive presented with right upper quadrant and right pleuritic chest pain. A right upper quadrant ultrasound showed no evidence for cholelithiasis or acute cholecystitis but showed a nine cm hypoechoic central liver mass (Figure 1). A CT pulmonary angiogram was then performed to evaluate her chest pain and demonstrated a pulmonary embolism. Images through the upper abdomen also confirmed the nine cm hypervascular central liver mass straddling the right dome and medial left lobes of the liver (Figure 2). Differential considerations at this point for a hypervascular liver mass included a cavernous

hemangioma, focal nodular hyperplasia, hepatic adenoma, or, less likely given the patient's age, a malignancy such as a hypervascular metastasis or hepatocellular carcinoma. A liver MRI using a hepatocyte-specific contrast agent, gadoxetate disodium (Eovist; Bayer Healthcare Pharmaceuticals), was then performed for definitive characterization. This scan performed at a 1.5 Tesla (1.5 T) magnetic field strength showed a background of diffuse

hepatic steatosis and redemonstrated a T1 isointense and mildly T2 hyperintense

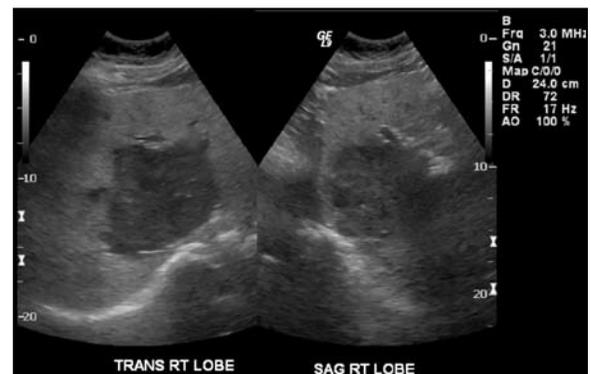


Figure 1. Transverse and sagittal ultrasound images through the right lobe of the liver demonstrates a solid hypoechoic central liver mass.

liver mass in the central liver (Figures 3a, 3b, 4, 5a, and 5e). Following contrast administration, the mass showed avid diffuse arterial phase enhancement which gradually washed out to become mildly hyperintense to background liver parenchyma.

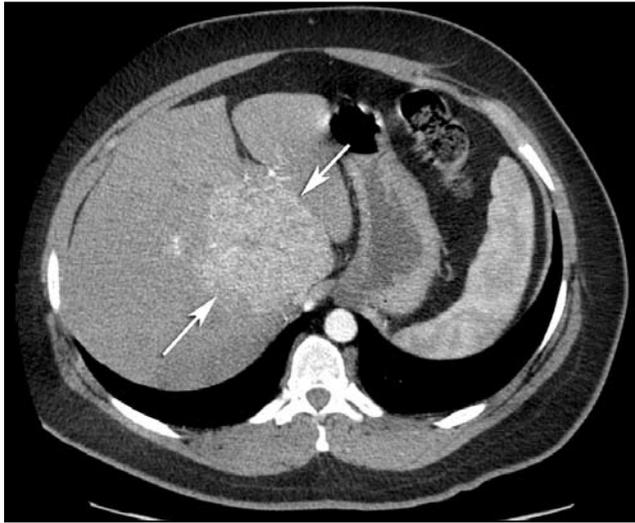
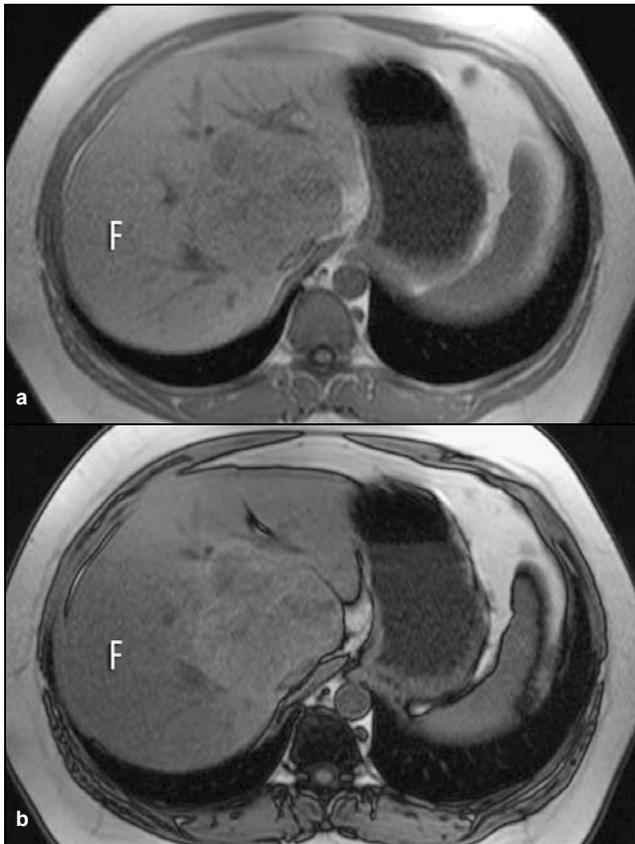


Figure 2. Axial CT image through the upper abdomen included during a CT angiogram of the pulmonary arteries shows a diffusely enhancing liver mass in the central liver (between white arrows).



Figures 3a and 3b. T1 weighted gradient echo in-phase (a) and out-of-phase (b) imaging of the liver at 1.5 T shows diffuse decrease in signal intensity in the background liver parenchyma (F) consistent with hepatic steatosis. The focal liver mass remains mildly T1 hypointense to fatty liver on in-phase imaging but hyperintense to fatty liver on out-of-phase imaging.

Background liver parenchyma likely remained hypointense to the mass on equilibrium phase images due to the underlying hepatic steatosis. 20 minute delayed hepatocyte phase imaging showed retention of contrast in the liver mass, a finding highly specific for a tumor of hepatocyte origin, particularly **focal nodular hyperplasia (FNH)** (Figures 5b-d). A repeat gadoxetate-enhanced liver MRI performed one year later on a newer 3.0 Tesla MRI unit confirmed stability of the FNH as well as demonstrates the higher sensitivity for contrast enhancement and improved signal inherent with imaging at a higher magnetic field strength (Figures 5e-h).

Focal nodular hyperplasia is a benign nonneoplastic liver tumor resulting from a hyperplastic response to a vascular anomaly, typically of developmental origin. FNH is the second most common solid tumor of the liver behind hepatic hemangiomas representing eight percent of all primary hepatic tumors. While oral contraceptives have not been implicated in the pathogenesis of FNH, they may play a trophic role in their growth and development of complications such as hemorrhage or necrosis. However, the vast majority of patients present asymptotically with FNH as an incidental finding and show a clinically silent course. Recognition of the imaging appearance of FNH is crucial to avoid unnecessary biopsy or surgery. No further evaluation or follow-up is necessary, however biopsy or follow-up may be justified when the diagnosis remains equivocal and the patient is acutely symptomatic.

Characterization of many solid liver masses remains limited by ultrasound and single-phase contrast enhanced CT. MRI remains the best imaging modality for the detection, delineation, and characterization of focal liver masses. Hepatocyte specific contrast agents such as mangafodipir trisodium (Teslascan, GE Healthcare, removed from the US market), gadobenate dimeglumine (MultiHance, Bracco), and gadoxetate disodium, are the most useful contrast agents to confirm tumors of hepatocyte origin, particular FNHs. Of these three, gadoxetate disodium is the only combined extracellular and hepatocyte-specific contrast agent to show 50% hepatobiliary uptake and excretion in a time-efficient manner allowing both dynamic phase imaging in the arterial and portal venous phases as well as hepatocyte phase imaging within ten to 20 minutes of contrast injection (and, hence, within the timespan of a single imaging session). FNH shows characteristic homogeneous arterial phase enhancement which



Figure 4. Single-shot T2 weighted image of the liver shows the central liver mass to have mild T2 signal hyperintensity.

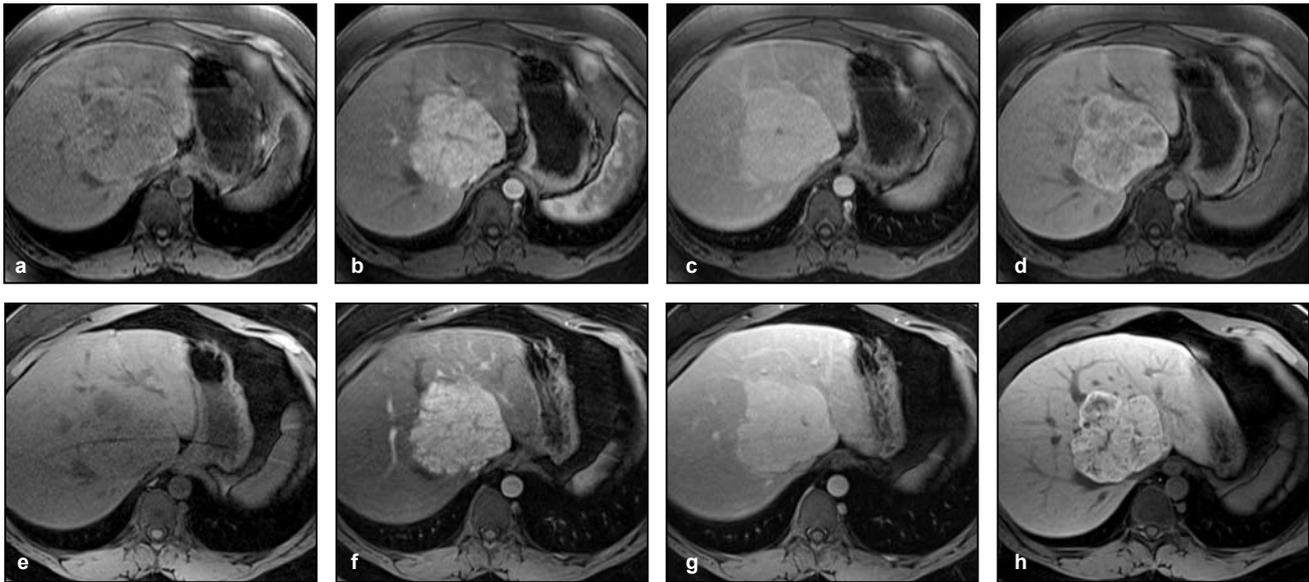


Figure 5a – 5h. T1 gradient-echo fat-saturated dynamic multi-phase gadoxetate disodium enhanced MRI of the liver mass. a. Precontrast at 1.5 T. b. Arterial phase at 1.5 T. c. Portal venous phase at 1.5 T. d. Delayed hepatocyte phase at 1.5 T. e. Precontrast at 3.0 T. f. Arterial phase at 3.0 T. g. Portal venous phase at 3.0 T. h. Delayed hepatocyte phase at 3.0 T. The mass shows avid diffuse arterial phase enhancement (b & f) which gradually washes out to become mildly hyperintense to background liver parenchyma (c & g). Background liver parenchyma likely remains hypointense to the mass on equilibrium phase images due to underlying hepatic steatosis. 20 minute delayed hepatocyte phase images show retention of contrast in the liver mass, a finding highly specific for a tumor of hepatocyte origin, particularly FNH (d & h). Note the improved signal, contrast, and spatial resolution at 3.0 T (e-h) compared to 1.5 T (a-d).

washes out to become more isoenhancing to background liver parenchyma on portal venous and equilibrium phase images. On delayed hepatocyte phase images, FNH retains contrast due to the presence of hepatocytes that are typically not present in other types of tumors (except for the rare exception of well-differentiated hepatocellular carcinomas which would generally have a different appearance on other T1 and T2 weighted pulse sequences).<sup>1,2</sup>

In regards to MR imaging at higher field strengths, an increase in field strength is accompanied by an increase in signal to noise ratio resulting in higher quality images with the possibility of higher spatial resolution, higher temporal resolution, or a combination of the two. When comparing abdominal imaging at 3.0 T to 1.5 T, imaging at 3.0 T shows significantly higher sensitivity to Gadolinium enhancement with an improved contrast to noise ratio compared to 1.5 T. Higher spatial resolution can also be expected.<sup>3</sup> This is evident in the current case when Figure 5d is compared to Figure 5h.

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## Disclosure of Financial Interests

The author and/or his spouse/significant other has no financial interests to disclose.

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