Quantitation of Hepatic Steatosis in Oncologic Patients Using a Fast Dual-echo Dixon Technique

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Introduction: Hepatic steatosis is associated with a variety of liver disorders, including obesity, diabetes, hepatitis, and drug toxicities. Quantitation of hepatic fat content is often of interest in patients with hepatic malignancies prior to the partial hepatic resection. A fast, noninvasive imaging technique that can accurately quantitate hepatic steatosis would be useful in the preoperative assessment of morbidly obese patients submitted to gastric bypass or in evaluation of living donors prior to liver transplantation. Conventional chemical shift or in- and out-of phase MRI techniques have been proposed to quantitate hepatic fat fraction. However, these techniques are not directly quantitative and interpretation of the imaging results can be ambiguous [1]. We recently developed a fast dual echo Dixon technique that can generate automatically and unambiguously high-quality water-only (WO) and fat-only (FO) images of an entire abdomen in a single breath-hold [2]. The purposes of this study are 1) to validate this technique in a phantom for quantitative fat measurement and 2) to establish the radiologic-histopathologic correlation for hepatic steatosis quantitation in patients with hepatic metastases prior to the hepatic resection.

Materials and Methods: 1) A phantom with pixels containing known relative concentrations of water and fat was first imaged with the fast dual-echo 2PD technique. 2) In vivo study: 8 patients with hepatic metastases were scanned prior to hepatic resections using the same technique with the following scan parameters: TR 150 ms, TE 2.2 ms for out-of-phase, and TE 4.7 ms for in-phase, flip angle 85°, slice thickness/gap 5-7/0-2 mm, matrix size 256x192, and the total scan time 20 seconds in a single breath-hold. The images were post- processed to generate a WO and a FO image for each slice automatically. A total of 9 regions-of-interests (8 from surgical sites, 1 from biopsy site) were selected at a workstation to measure the signal intensity on FO images (SI_{FO}) and corresponding WO images (SI_{WO}), retrospectively. In addition, the SI of spleen (SI_{sp}) at the mid-section level was measured as a reference and for quality control.
Bivariate analyses was performed using % fat fraction (FF) calculated as $SI_{FO}/SI_{FO}+SI_{WO}$ and ratios (L/S) of SI_{FO}/SI_{sp}. Each variable was also graded by an experienced body radiologist using a 10-point grading system and results were compared with the % fat fraction (FF) on histopathologic specimen measured subjectivity by a pathologist. Pearson correlation coefficients (r) between the measurements from MR images and histopathologic specimen were calculated.

Results: 1) The phantom study demonstrated excellent correlation between the measured fat from MR images and the actual fat concentration (Fig 1). 2) In clinical study, %FF and L/S ratio from MR images were highly correlated with %FF from histopathologic specimen [r = 0.89 (Fig 2) and 0.93, respectively]. Using the 10-point grading system, the %FF and L/S ratio from MR images were also found to correlate well with the histopathologic findings [r = 0.85 and 0.92 (Fig 3), respectively].

Figure 1. Phantom Study
Measurement = fat fraction measured
Expectation = actual fat percentage

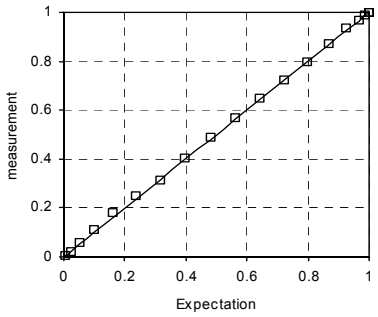


Figure 2. % Fat Fraction on MRI vs. % Fat Fraction on Pathology
N=9

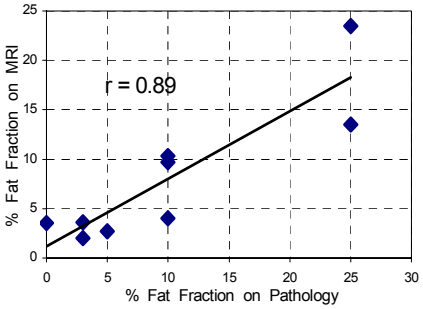
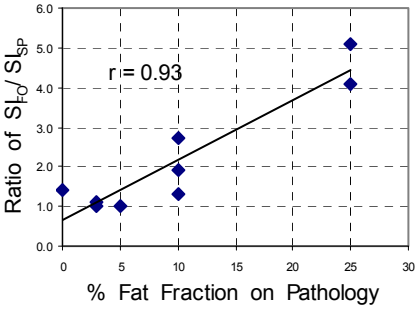


Figure 3. L/S ratio on MRI vs. % Fat Fraction on Pathology
N=9



Conclusions: Hepatic fat measured using the fast, single breath-hold, dual echo Dixon technique was highly correlated with % fat fraction measured from liver histopathologic specimen. Limitation of this study is possible sampling error. Further evaluation is underway using a larger group of patients with a wide range of hepatic steatosis.

References: [1] Hussain HK, et. al., Hepatic fat fraction: MR Imaging for quantitative measurement and display – early experience. *Radiology*, 2005 (in press). [2] Ma, J. Breath-hold water and fat imaging using a dual-echo two-point Dixon technique with an efficient and robust phase-correction algorithm. *Magnetic Resonance in Medicine* 2004; 52: 415- 419.