

Accuracy of Texture Analysis to Detect Hepatic Fibrosis on T1 Weighted Contrast Enhanced MR

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Target Audience: Abdominal radiologists imaging patients with chronic liver disease

Purpose: Hepatic fibrosis is a reparative process by which the liver reacts to a chronic insult, such as alcohol consumption, hepatitis and fatty liver disease. Early diagnosis and treatment is essential in the prevention of cirrhosis, hepatic failure and death. The current gold standard in the diagnosis of hepatic fibrosis is percutaneous core liver biopsy, which is associated with limitations such as sampling error, patient discomfort, and complications such as bleeding and infection. Such limitations have necessitated a means of noninvasive diagnosis of fibrosis. To date, the serum markers have been equivocal in their ability to diagnose and stage fibrosis. Thus, imaging can be seen as an alternative approach for the staging of fibrosis. The purpose of this study was to diagnose and stage fibrosis by performing texture analysis on post-gadolinium T1 weighted images of the liver parenchyma in the portal venous and equilibrium phases.

Methods: This study was approved by our Institutional Review Board. Patients who had non-targeted liver biopsies performed within 6 months of a 1.5 T MRI examination of the abdomen between December 2005 and April 2013 were included in this study. Histopathologic staging of hepatic fibrosis was performed by a pathologist using the Ishak Fibrosis Staging Scale. Thirty patients were included in this study with hepatic fibrosis scores as follows; 5 patients with a score of 0, 5 patients with a score of 1, 2 patients with a score of 2, 5 patients with a score of 3, 3 patients with a score of 4, 5 patients with a score of 5 and 5 patients with a score of 6. Using a dedicated AW workstation (GE Healthcare, Cleveland, OH), segmentation of hepatic segment VIII was performed on post-gadolinium T1-weighted 3-D GRE images in the portal venous and equilibrium phases. Following segmentation, an in-house developed, MATLAB-based texture analysis program was employed to extract 42 texture features from each segmented volume of liver. The Pearson's correlation ratios were calculated in order to identify the most discriminating features which separate the different fibrosis stages. The texture parameters with the highest correlation coefficients were selected for a linear discriminant analysis (LDA) to calculate sensitivities and specificities on venous and equilibrium phase images. Sensitivities and specificities were calculated for texture parameters: homogeneity versus low gray level run emphasis (LGRE), homogeneity versus short run low gray level emphasis (SRLGE), and LGRE versus SRLGE on venous phase imaging and homogeneity versus mean gradient (MGR), homogeneity versus energy, and energy versus MGR on equilibrium phase imaging

Results: Hepatic fibrosis scales were compared for patients with hepatic fibrosis of 0-4 versus 5-6 and texture parameters on venous phase imaging were compared using a LDA for LGRE versus SRLGE (sensitivity = 44%, specificity = 78%), homogeneity versus LGRE (sensitivity = 47%, specificity = 80%), and homogeneity versus SRLGE (sensitivity = 50%, specificity = 82%) (Table 1). Additionally, hepatic fibrosis scales for patients with fibrosis 0-4 versus 5-6 and texture parameters on equilibrium phase imaging using a LDA for energy versus MGR (sensitivity = 42%, specificity = 72%), homogeneity versus energy (sensitivity = 43%, specificity = 75%), and homogeneity versus MGR (sensitivity = 31%, specificity = 64%) (Table 1).

Discussion: The findings of this study demonstrate specificities of 82% and 72% for discriminating patients with relatively lower levels of hepatic fibrosis from those with advanced fibrosis on portal venous and equilibrium phase images, respectively using a LDA-based approach.

Conclusion: Non-invasive methods of evaluating hepatic fibrosis and the ability to distinguish between lower and higher grades of hepatic fibrosis on imaging is of great clinical importance as it affords repeatable assessments with significantly less risk to the patients compared to current standards which are invasive. Texture-based analyses of contrast-enhanced MRI images offer a potential avenue towards the development of imaging-based assessments of liver fibrosis.

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Venous phase imaging	F0-4 vs F5-6		Equilibrium phase imaging	F0-4 vs F5-6	
	Sensitivity	Specificity		Sensitivity	Specificity
LGRE vs SRLGE	44%	78%	Energy vs MGR	42%	72%
Homogeneity vs LGRE	47%	80%	Homogeneity vs Energy	43%	75%
Homogeneity vs SRLGE	50%	82%	Homogeneity vs MGR	31%	64%

Table 1: Sensitivities and specificities of texture parameters using a linear discriminant analysis (LDA) on both venous phase and equilibrium phase T1-weighted images