Accuracy of Hepatic Fibrosis Staging Using T2-WI and Texture Analysis

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Target Audience: Clinical radiologists and gastroenterologists serving a patient population with chronic liver disease and the need for improved non-invasive assessment of fibrosis staging.

Purpose: The prevalence of chronic liver disease is increasing worldwide as the sequela of multiple etiologies including viral hepatitis, alcohol use, and fatty liver disease. Irrespective of the initial inciting hepatic insult, the response to chronic liver injury proceeds through a common pathway characterized by hepatic fibrosis which alters the hepatic parenchyma leading to cirrhosis, hepatic functional impairment, and, eventually, death[1-3]. These comorbidities are associated with significant healthcare costs[1-3]. The early diagnosis of hepatic fibrosis is imperative for treatment and management to halt these chronic inflammatory changes that ultimately lead to cirrhosis and hepatic failure[1-8]. The purpose of this study was to evaluate the use of texture analysis of T2-weighted images of the hepatic parenchyma to noninvasively quantify degrees of hepatic fibrosis.

Methods: Following IRB approval, 27 patients with a non-targeted liver biopsy performed within 60 days of 1.5-T MRI exam of the abdomen between July 2006 and August 2013 were included in this study. Histopathologic scoring of hepatic fibrosis was performed by a pathologist who subjectively graded hepatic fibrosis on a scale from 0-6 with grade 0 representing no fibrosis and grade 6 representing cirrhosis. Segmentation of hepatic segment 8 of the liver was performed on T2-weighted TSE (TE = 80ms) MRI images using a dedicated AW workstation (GE Healthcare, Cleveland, OH) with a semi-automated graphical-user-interface (GUI). 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. Pearson's correlation coefficients were calculated between hepatic fibrosis scores and the three texture features with the highest Pearson's correlation ratios: Gray-Level Co-occurrence Matrices (GLCM) entropy, contrast, and energy. The sensitivity and specificity of predicting hepatic fibrosis was calculated using a linear discriminant analysis (LDA) applied to these three texture features by evaluating contrast versus energy, entropy versus contrast, and entropy versus energy.

Results: Of the 27 patients included in this study, the range of hepatic fibrosis included 7 patients with grade 0 fibrosis, 4 patients with grade 1 fibrosis, 4 patients with grade 2 fibrosis, 4 patients with grade 3 fibrosis, 2 patients with grade 5 fibrosis, and 6 patients with grade 6 fibrosis. Pearson's correlation coefficients for the T2 texture analyses revealed a correlation between hepatic fibrosis with GLCM entropy of -0.56 ($P < 0.0001$), contrast of -0.48 ($P < 0.0001$), and energy of 0.53 ($P < 0.0001$). Hepatic fibrosis scales were compared for patients with hepatic fibrosis of 0-3 versus 5-6 using an LDA algorithm for contrast versus energy (sensitivity = 71%, specificity = 60%), GLCM entropy versus contrast (sensitivity = 71%, specificity = 65%), and the GLCM entropy versus energy (sensitivity = 86%, specificity = 70%) (**Table 1**). Additionally, hepatic fibrosis scales for patients with fibrosis 0-2 versus 3-6 were compared using contrast versus energy (sensitivity = 89%, specificity = 83%), GLCM entropy versus contrast (sensitivity = 88%, specificity = 79%), and the GLCM entropy versus energy (sensitivity = 90%, specificity = 88%) (**Table 1**).

Discussion: Our study demonstrates the use of T2-weighted images and texture analysis for the noninvasive, quantitative assessment of hepatic fibrosis in a cohort of 27 patients with biopsy specimens as a reference standard. Increases in hepatic fibrosis moderately correlated with an increase in GLCM entropy and energy and a decrease in contrast. High sensitivities and specificities were achieved, discriminating patients with more severe hepatic fibrosis by comparing the GLCM entropy with contrast.

Conclusion: The development of accurate, non-invasive methods for the assessment and staging of liver fibrosis is crucial given a growing global impact of chronic liver disease and fibrosis. The application of texture analysis tools using T2-weighted images, possibly as part of a multi-parametric approach, affords the possibility of developing an accurate, noninvasive assessment of hepatic fibrosis.

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	F0-3 versus F5-6		F0-2 versus F3-6	
	Sensitivity	Specificity	Sensitivity	Specificity
Contrast vs Energy	71%	60%	89%	83%
GLCM Entropy vs Contrast	71%	65%	88%	79%
GLCM Entropy vs Energy	86%	70%	90%	88%

Table 1: Sensitivities and specificities using a linear discriminant analysis (LDA) for hepatic fibrosis scales using texture features.