Quantitative measurement of fibrosis by morphological features

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Abstract—The shape and elasticity of the liver are two important features for computer-aided diagnosis (CAD) of hepatic fibrosis, which can be measured by morphology changes from the hepatic contours on Gd-EOB-DTPA-enhanced hepatocyte-phase MR Images and the stiffness of liver on MR tagging images, respectively. Morphological features calculated in both spatial and frequency domains were used for predicting hepatic fibrosis stages quantitatively. The promising results indicate the potential classification ability of our CAD system and it is expected that our method for non-invasive assessment of liver fibrosis may be an alternative to traditional liver biopsy.

I. INTRODUCTION

Cirrhosis of liver may cause structural distortion of entire liver by fibrosis and parenchymal nodules, in which the image findings on MR/CT images can be interpreted by shape, texture, volume, elasticity analysis and so on [1]. To ease the workload of radiologists from interpretation of the numerous medical images, CAD system on liver has been developing for quantifying the diagnosis of fibrosis. Technologies for morphologic measurement regarding image processing and pattern recognition are introduced in this study.

II. CAD SCHEME DESCRIPTIONS

MR images used in this study are scanned using a 3-T superconducting system (Intera Achieva Quasar Dual; Philips Medical Systems, Netherlands) with a six-channel torso array coil. MR-tagging images obtained by a modified SPAMM sequence with a train of non-selective radiofrequency (RF) pulses was employed. 9 images conducted 16-mm stripe spacings of cine-tagging grids are scanned separately in sagittal imaging planes. A healthy liver (F0) at the maximal inspiratory (frame1, Fig. 1 (a) phase and the maximal expiratory (frame 9, Fig. 1 (b) phase is shown in Fig. 1. The grid is deformed during 1 second of forced exhalation, and the elasticity analysis is employed by the bending energy (BE) in spatial domain vs. the difference of the power spectral (DPS) values in frequency domain.

Gadolinium ethoxybenzyl diethylene-triamine-pentaacetic acid -enhanced hepatocyte-phase (EOB) MR imaging yields excellent signal enhancement in the liver parenchyma with uptake rate of about 50%. The delineation of hepatic excellent signal enhancement in the liver parenchyma with a contour (red lines) morphology shown in Fig. 1(c) is associated with fibrotic changes in the liver. Shape analysis is based on the power spectrum of the profile of the hepatic contour [2].

III. RESULTS AND CONCLUSIONS

Figure 1(d) demonstrates that the deformation of the healthy liver is greater than that of the cirrhotic liver with higher BE and DPS values, which reflects the firmness of the parenchyma. Scatterplots for SD at each fibrosis stage are shown in Fig. 1(e). The mean SD was significantly higher in patients with > F3 than with < F2. It is concluded that the computer-aided analysis of hepatic contour and elasticity are highly accurate in diagnosing hepatic fibrosis stages F3 and F4 and may be a useful imaging biomarker for staging hepatic fibrosis.

REFERENCES