

# Novel MR Fine Texture Spectroscopy Technique Enabling Visualization of Fine Structures: Fibrosis detection in chronic Liver Disease

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**Background** Recent progress on understanding the pathogenesis of liver fibrosis (LF) and the growing list of potential drug targets highlights the need for safe and accurate diagnostic tools for quantifying the fine fibrotic structures (textures) present in early chronic liver disease (CLD) [1]. We have developed a novel MR fine texture analysis technique for quantitatively evaluating these fine textures and producing images displaying the distribution of their wavelengths (distance over which the textural pattern repeats). The technique utilizes a modified spin echo sequence to acquire extremely finely sampled data in one dimension from a selectively excited internal volume and applies signal processing methods to extract the fine texture wavelength distribution as a function of location for wavelengths markedly smaller than would be resolvable by standard MRI – to resolve a texture with a 600 micron wavelength by imaging requires isotropic imaging voxels of 300 microns. Sensitivity for fine textural changes is important for early detection of abnormal liver tissue. A fast, non-ionising and non-invasive analysis technique could play a significant role in monitoring disease progression and response to treatment as well as in pharmaceutical development. The current gold standard is liver biopsy, which is invasive, prone to sampling error and carries a small but important risk of morbidity and mortality.

**Purpose:** To evaluate the utility of MR fine texture spectroscopy for identifying the signature wavelength distributions of the fine textures representative of disease stages in CLD.

**Methods** This study was IRB-approved and HIPPA-compliant and included data from normal and diseased liver subjects with a range of disease severity (grades 0 to 4). Fine texture data were gathered using a 1.5T Siemens scanner both pre and post Gd injected contrast; acquisition parameters being - array of 256 points, TE between 12.5 and 17ms, and TRs of 2000ms and 500ms for the pre and post contrast acquisitions respectively. Multiple interleaved selectively-excited internal-volumes of 15x15x70mm oriented left-right were acquired in a single 16 second breath hold providing coverage over a significant portion of the liver. These parameters result in a 1D sampling interval of 270 microns – hence a wavelength resolution limit of 540microns. Analysis and display was performed using in-house developed signal processing and DICOM mapping software to produce colorized images where red green and blue intensities are used to represent the amount of texture in three different ranges of wavelengths. Figure 1 presents four of these maps where the wavelength ranges are: green (0.5 to 1.2mm), blue (1.3 to 2.2mm), and red (2.3 to 4mm). Statistical significance of the data was evaluated by calculating the variance for each k-value across the multiple repetitions in each scan. Clinical grade was determined from reads of the delayed phase axial and coronal VIBE image series, as described [2].

**Results and discussion** Histology predicts there should be a progression to more of the larger wavelength textures with development of fibrosis. Progressive LF leads to fibrous tissue encasing liver lobules, which are ~1.5 to 3mm across. This should become the more dominant texture, corresponding to our findings. Bridging fibrosis between vessels should also progressively obscure the finer textures; normal liver is associated with the repeating pattern of vessel to vessel separation which is in the range of ~0.5mm to 1.5mm. The four examples (Fig 1) show the expected progression from smaller to larger wavelength textures with disease grade i.e., faint green progressing to red/blue. We have found our technique sensitive to the earlier grades of disease which represents the clinically most important and difficult to measure.

**References** [1] RG Wells, Gastroenterology, 2009; 136:387–388. [2] D Martin et al., Liver MRI and Histological Correlates in Chronic Liver Disease On Multi-Phase Gadolinium-enhanced 3D Gradient Echo Imaging. JMIR 2012, in press.

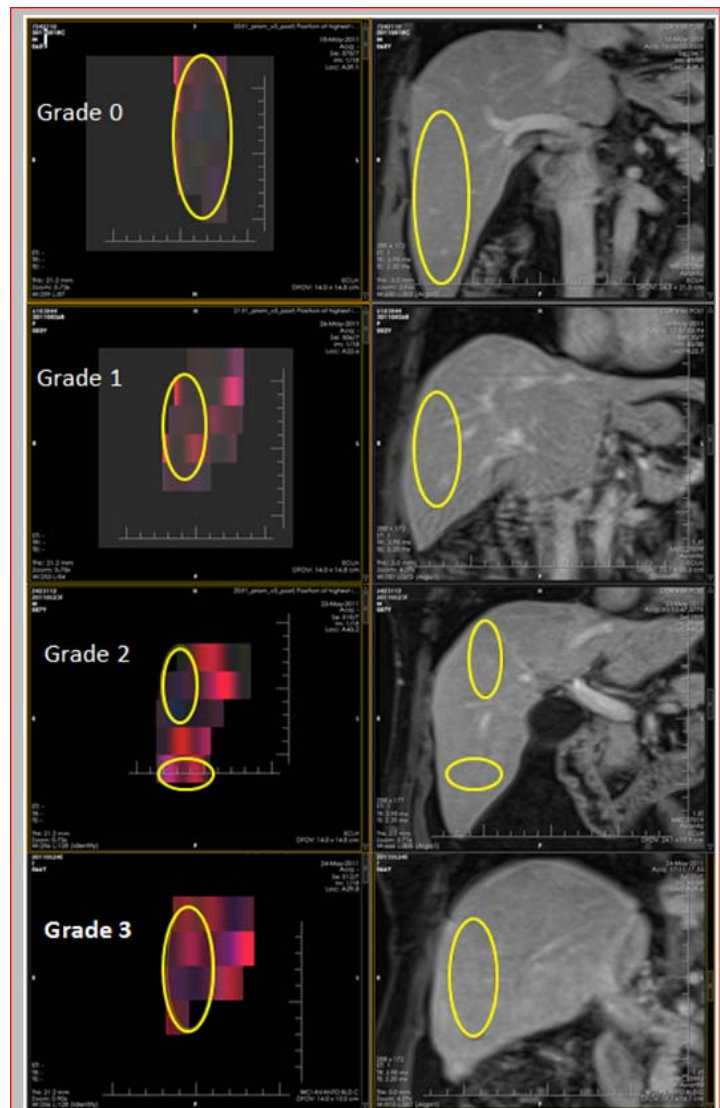


Figure 1 – Four cases with clinical assessment scores of 0 to 3 indicating relatively homogeneous regions of liver tissue avoiding large vessels which appear as coarse textures (red). Note the progression from light green to red/blue where green represents prevalence of 0.5 to 1.2mm wavelength textures typical of vasculature and red indicates prevalence of 2.3 to 4mm wavelength textures.