Non-invasive Diagnosis of Liver Fibrosis: Conventional MR Imaging Findings versus MR Elastography

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Introduction: Liver fibrosis and cirrhosis is currently diagnosed by liver biopsy, an invasive and expensive procedure with a risk of complication and sampling errors. Non-invasive imaging of liver fibrosis would help reduce biopsy related risks and cost and potentially eliminate sampling errors. Development of non-invasive tests to determine disease progression or regression and to predict clinical outcome have become increasingly important. Non-invasive methods include evaluation of serum markers and morphological features of liver on imaging. Classically, imaging evaluation of hepatic fibrosis or cirrhosis includes assessment of hepatic texture alterations, nodularity of liver parenchyma, contour changes and features of portal hypertension -splenomegaly, porto-systemic collaterals and ascites. MRI features for detection of liver fibrosis/cirrhosis have been reported [1-2] and it allows for global assessment of liver. Recently MR Elastography has been shown to accurately estimate the degree of fibrosis by estimating shear stiffness of liver [3]. We undertook a study to compare conventional MR imaging features with MR Elastography for detection of fibrosis/cirrhosis of liver.

Materials and Methods: A retrospective evaluation of MRI and MRE studies of 48 patients was performed. All patients had liver biopsy data available. The MR images were evaluated by a radiologist unaware of the shear stiffness values and liver biopsy results for features of fibrosis. The following features were evaluated: texture analysis for presence or absence of fibrosis; fatty change; surface nodularity; presence or absence of regenerative nodules; contour changes and signs of cirrhosis- enlarged periportal hilar sign, empty gall bladder fossa sign and posterior hepatic notch sign, splenomegaly, porto-systemic collaterals and ascites. The caudate-to-right lobe ratio, modified caudate-to-right lobe ratio and spleen volume index were also calculated. The reading radiologists gave a final overall impression for presence or absence of fibrosis or cirrhosis based on all of the above features. The grading was: 0- No fibrosis; 1-fibrosis probably present, 2-fibrosis present but no cirrhosis, 3-early cirrhosis, 4-advanced cirrhosis, 5-progressive cirrhosis. For comparison all grades ≥ 1 were thought to represent fibrosis.
MR Elastography was performed with a modified phase-contrast, gradient-echo MRE sequence described in literature [3]. The elastograms were generated by an automated process to yield quantitative images of tissue stiffness using multi-scale direct inversion algorithm. Mean shear stiffness of the liver was calculated using a manually specified region of interest by one reader who was unaware of the biopsy results. A shear stiffness value > 2.9kPa [3] was used to identify liver with fibrosis. Liver biopsy results were reported with METAVIR score [F0-F4]. The final scores of MRI features and stiffness values from MRE were compared with the liver biopsy results for detection of fibrosis.

Results: Liver biopsy was normal or showed no fibrosis in 18 patients and fibrosis was present in 30 patients (F1-5, F2-2, F3-10 and F4-13). The F1 and F2 grade fibrosis were grouped as mild fibrosis and F3 and F4 were grouped as severe fibrosis. The MRI features correctly identified fibrosis in 22/30 (73.3%) patients and normal liver in 14/18 (77.8%) patients; whereas MRE with a shear stiffness cut-off value of 2.9kPa identified fibrosis in 29/30(96.7%) patients and all 18 (100%) normal livers as normal [Fig.1]. There was one fibrotic liver (stage F1) which was incorrectly classified as normal with MRE. ROC analysis demonstrated that with a cut off of 2.9kPa, the area under the curve was 0.994 for prediction of fibrosis in liver.
MRI features classified 5 livers with early fibrosis and 3 livers with severe fibrosis incorrectly as normal. An example is shown in fig.1. All individual MRI features were poor predictors of fibrosis. Texture analysis had a sensitivity of 53.3% only. In addition MRI features suggested presence of fibrosis in 4 normal livers.

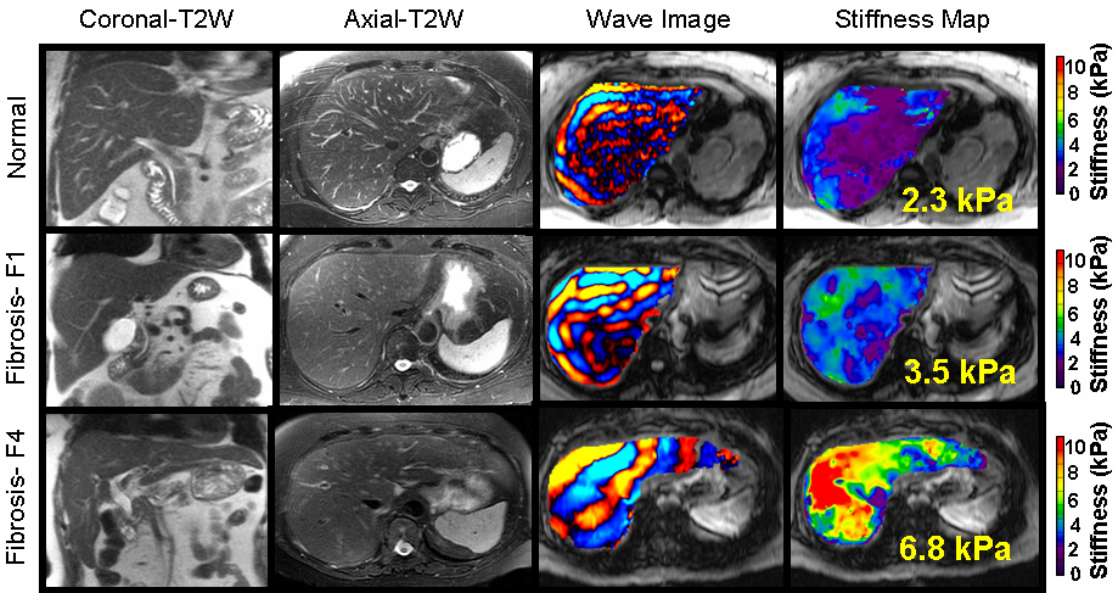

Figure 1. MRI and MRE in patients with normal liver (top row), mild fibrosis (middle row) and severe fibrosis (bottom row). The MRI features correctly classified the normal liver and severe fibrosis liver. In the case of liver with mild fibrosis (middle row), MRI features classified it as normal. MRE detected a shear stiffness of 3.5kPa in this case and therefore correctly predicted mild fibrosis. Note that the spans of the normal and mildly fibrotic livers are similar with no apparent difference on the T2-weighted images. On MRE wave image, the waves are seen to propagate well throughout the liver as against the peripheral part in the normal liver- an indication that liver is fibrotic, which was confirmed on the stiffness maps.

Discussion and Conclusion: MRE elastography is an accurate method for detection of liver fibrosis. Gross morphologic features in conventional MRI can be used to diagnose advanced liver fibrosis and cirrhosis but are not reliable for detecting moderate or early liver fibrosis. The morphological changes of fibrosis that become apparent in more advanced disease are seen as nodularity, textural changes and volumetric changes. MRE provides a way to detect minor changes in hepatic stiffness that reliably indicates the presence of fibrosis. Therefore MR Elastography can be a valuable complimentary technique to routine MRI studies. In addition to its emerging role in the diagnosis of hepatic fibrosis, the capability of MRE to allow detection of minor degrees of fibrosis may potentially be useful for assessment of treatment response.

References:

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