MR Elastography of the Liver: Observations from a Review of 1,377 Exams

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Introduction:
Multiple studies have reported on developments of hepatic MR Elastography (MRE) to quantitatively assess hepatic fibrosis by measuring the viscoelastic properties of the liver (1-3). Recent studies have shown that other factors, such as dynamic perfusion effects, should be taken into account as potential causes of variability of hepatic stiffness (4,5). The purpose of this study was to perform a retrospective study of patients with MRE-assessed liver stiffness to assess the rates of technical success and to investigate whether there are any other pathophysiological factors that may correlate with the mechanical properties of the liver in select patients with histological and physiological data available.

Methods and Materials:
Our institution has performed over 1,500 hepatic MRE exams on clinical patients since 2007 and we reviewed 1,377 researchable exams in this study which was approved by our institutional review board. The stiffness distribution for this population and causes of technical failures were analyzed, including the impact of body mass index (BMI). Patients with liver biopsies performed less than 1 year from the date of their MRE exam were selected to analyze the effect of varying inflammatory grade on liver stiffness at different stages of fibrosis. A subset of these patients was selected to assess the relation between stiffness and other histologic and physiologic parameters. These patients were selected based on the additional criteria that 1) the patients had chronic liver disease only, 2) were not treated at the time of MRE, and 3) had blood work ≤ 30 days from the date of MRE. Regressions were performed between liver stiffness and fibrosis extent in those patients with NAFLD (nonalcoholic fatty liver disease) and HCV (chronic hepatitis C). Contour profiles were used to investigate the interdependence of stiffness and other parameters including mean blood pressure, ALT (alanine aminotransferase), TB (total bilirubin), and Alb (albumin).

Results:

Fig.1
Hepatic Stiffness in 1,377 Patients

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<tr>
<th>Histogram Analysis</th>
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<tr>
<td>Total</td>
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<td>Std Dev</td>
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<td>Median</td>
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Fig.2
Effect of BMI & Technical Failure Causes

Fig.3
Effect of Inflammation

Fig.4
Mean Stiffness

Fig.5
Liver Stiffness

From the 1,377 patient records examined, Fig.1 shows that the MRE-assessed liver stiffness from 1,300 successful examinations has a broad left-skewed distribution with a mean value of 4.12 ± 2.22 kPa (range: 1.1 to 18.8 kPa). 77 (5.6%) of the 1,377 cases had technical failures with various causes. 55 (4.0%) of these 77 exams suffered from inadequate SNR due to iron overload. The mean blood pressure obtained within 30 days of the date of MRE examination and causes of technical failure were used to determine the effect of the liver stiffness on average.

Discussion and Conclusion:
This review of 1,377 clinical cases illustrates that hepatic MRE is a very robust imaging method for a broad spectrum of patients with a less than 5.6% technical failure rate, which can be decreased further with technical advances to reduce signal loss due to iron overload. The results also demonstrate that liver stiffness is correlated with many factors other than just fibrosis extent, including etiology, inflammation grade, mean blood pressure, hepatic metabolic function (AST, ALT and TB) and hepatic synthetic function (Alb). The use of MRE to assess changes in tissue mechanics associated with these factors could provide new insights into the pathophysiology of hepatic diseases and could have novel applications that should be explored.

References: