Assessment of Seven Quantified Ultrasound Parameters for Detection and Staging of Nonalcoholic Fatty Liver Disease (NAFLD)

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Background, Motivation and Objective

Nonalcoholic fatty liver disease (NAFLD) is expected to be the dominant cause of end-stage liver complications in the U.S. by 2020. Preventative care requires accessible, bedside and inexpensive detection, characterization as well as monitoring of hepatic fat, fibrosis, and inflammation beyond current convention. Here, we assessed the diagnostic performance of seven quantified ultrasound parameters for detection and staging of hepatic steatosis in NAFLD patients.

Statement of Contribution/Methods

Twenty-four patients (sex: 12 men, 12 women; age: 53 ± 14.9; bmi: 30.2 ± 6.5) with or suspected of NAFLD were prospectively consented and recruited for our IRB-approved study. Patients had no history of chronic liver disease, and all had a proton density fat fraction (PDFF) measured by MRI, which served as a reference standard. A minimum of 10 ultrasound liver acquisitions were obtained for each patient. Each set of acquisitions included radio-frequency (RF) data and shear wave elastography measurements using consistent presets and were carried out with the Philips EPIQ 7 coupled to a C5-1 transducer. The following parameters were measured: the acoustic attenuation coefficient (AC), the hepatorenal index (HRI), the Nakagami parameter, the shear wave elasticity (SWE), and related shear wave viscosity (SWV) and shear wave dispersion (SWD) measures. Steatosis was categorized as S0, <5%; S1, 5-10%; S2, 10%-20% or S3 >20% based on the PDFF. The correlation of single or combined parameters to PDFF grading were assessed using the Spearman correlation coefficient (r). The diagnostic performance of the quantified parameters was evaluated with receiver operator curves (ROC).

Results/Discussion

Patient distribution was 25% S0, 13% S1, 29% S2 and 33% S3. Preliminary results indicated that the AC and HRI were the most significantly ($p < 0.0001$) correlated to the PDFF ($r = 0.84, 0.87$, respectively). The Nakagami parameter had a moderate ($p < 0.001$) correlation with PDFF ($r = 0.79$). The SWE, SWV and SWD parameters had poor correlations ($p > 0.01$) with PDFF ($r = 0.50, 0.57, 0.54$, respectively). The area under the ROC to correctly identify S3 steatosis was 0.87 for the HRI or the AC. Taken together, two of the seven parameters offer potential alternatives to PDFF for detecting and staging NAFLD.

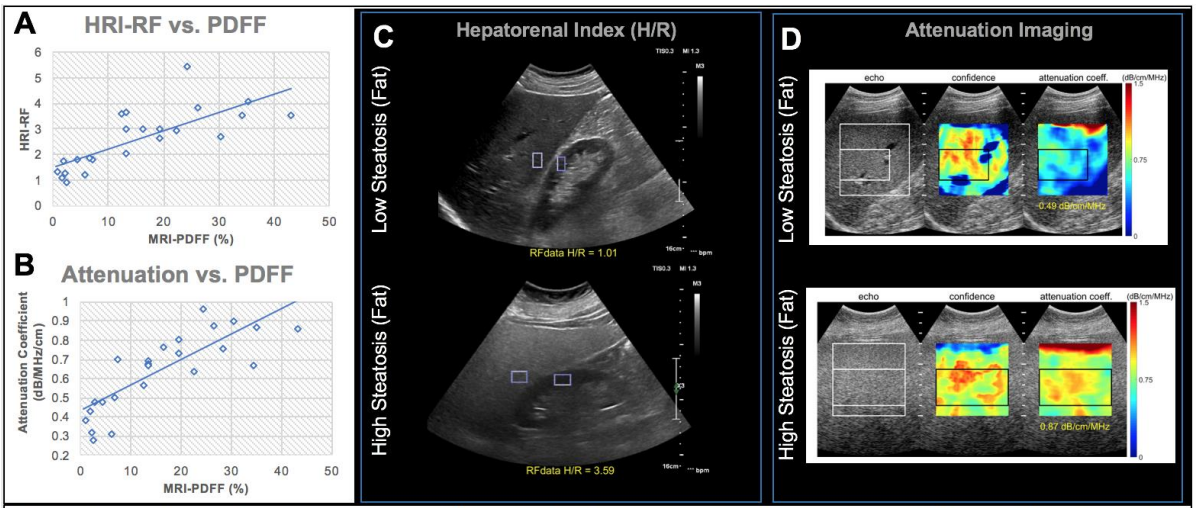

Figure: A) Scatter plot of hepatorenal index (HRI) against PDFF with a fitted line. B) Scatter plot of hepatorenal index (HRI) against PDFF with a fitted line. C) Top is Bmode image from 60 year old male (BMI 28.41) with normal/low PDFF (S0/1.4%), and bottom image is from a 55 year old female (BMI 43.56) with elevated PDFF (S3/43%). Images show how the ROIs for the HRI parameter were selected for these specific patients. D) Attenuation map images for the same two patients as C, showing (left to right) the Bmode image used, a confidence map for measurements, and the attenuation coefficient map.