3D ACE: Attenuation Coefficient Estimation in 3D for the Detection of Hepatic Steatosis

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BACKGROUND

- Liver steatosis assessment through measurement of tissue attenuation via Controlled Attenuation Parameter (CAP, FibroScan®, Echosens, France) is currently used as a point of care tool in the assessment of individuals with non-alcoholic fatty liver disease. However, there remains an unmet medical need for a diagnostically accurate tool with visual guidance for the non-invasive assessment of hepatic steatosis.
- *Attenuation Coefficient Estimate* (ACE) is a quantitative measure of ultrasound attenuation [1,2]. ACE could be a potential clinical tool for the ultrasound guided non-invasive detection of diffuse liver disease, such as hepatic steatosis.
- Shear-Wave Absolute Vibro-Elastography (S-WAVE, Sonic Incytes, Canada) is a real-time elastography method for measuring liver stiffness [3, 4]. The raw ultrasound data acquired during the S-WAVE scan can be processed for ACE computation.

OBJECTIVE

- The first objective of the current study is to demonstrate the feasibility of simultaneous 3D ACE mapping with liver stiffness imaging during S-WAVE [3, 4].
- The second objective is to validate the efficacy of ACE to detect hepatic steatosis using Magnetic Resonance Imaging Proton Density Fat Fraction (MRI-PDFF) as a gold-standard [5].
- The third objective is to compare the performance of ACE with Controlled Attenuation parameter (CAP, FibroScan®, Echosens, France) [6].

MATERIAL & METHODS

- This cross-sectional study included 21 subjects including non-steatosis (N = 14) and steatosis (N = 7) cases. A subject with an MRI-PDFF value greater than 6% was considered to have steatosis. All the subjects underwent MRI, S-WAVE and Fibroscan® between May 2017 and May 2018.
- MRI was performed on a 3.0 T system (Philips Achieva, Philips Medical Systems) with a double-double-echo (DDE) sequence, consisting of two dual fast field echo sequences [7]. A three-point Dixon method was used to determine the MRI-PDFF. MRI PDFF was reported as the mean of PDFF from 15 regions-of-interest (ROIs) (5 ROI × 3 levels) with areas from 1.5 cm^2 to 2 cm^2.
- We computed ACE (dB/cm/MHz) using a reference phantom method from the 3D ultrasound radio-frequency data acquired for S-WAVE with an Ultrasonix SonixTouch machine (Analogic, Peabody, MA) and a 3D curved array transducer.
- The CAP values (dB/m) assessed at 3.5 MHz were acquired as part of the standard FibroScan® liver examination.

RESULTS

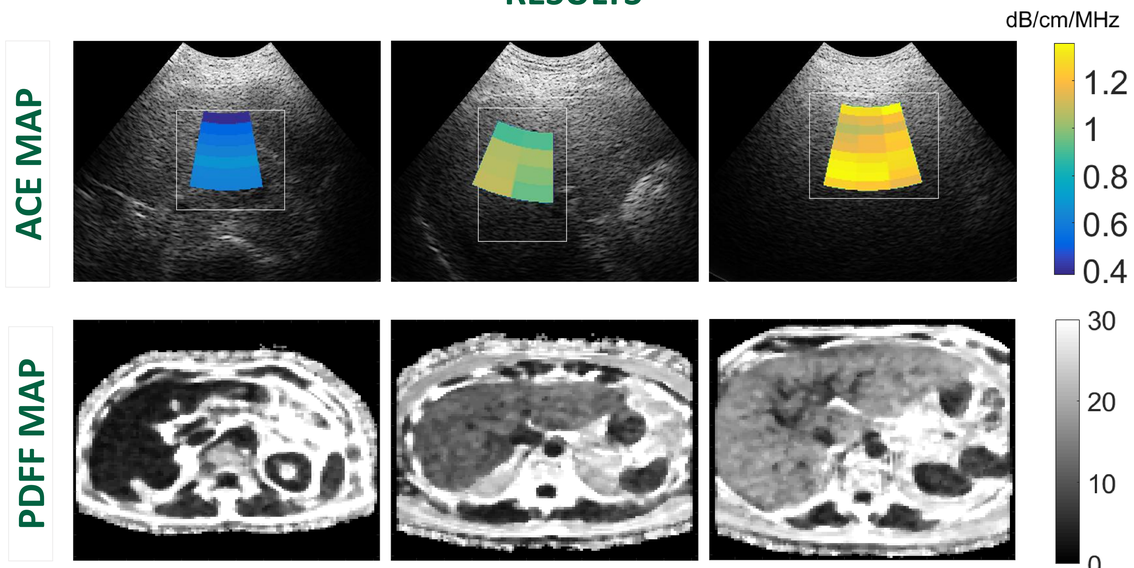

Figure 1:Three examples showing ACE map overlaid on the ultrasound B-mode image (top) and PDFF map (bottom) for a non-steatosis (left), a mild steatosis (middle) and a severe steatosis (right) case.

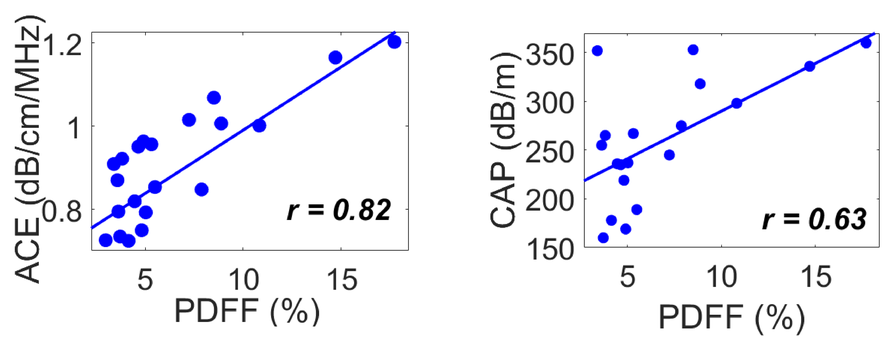

Figure 2: Relationship between ACE and PDFF (left) and CAP and PDFF (right). The correlation coefficient (r) was calculated using Pearson's test. ACE is strongly correlated with PDFF whereas CAP is found to be moderately correlated with PDFF.

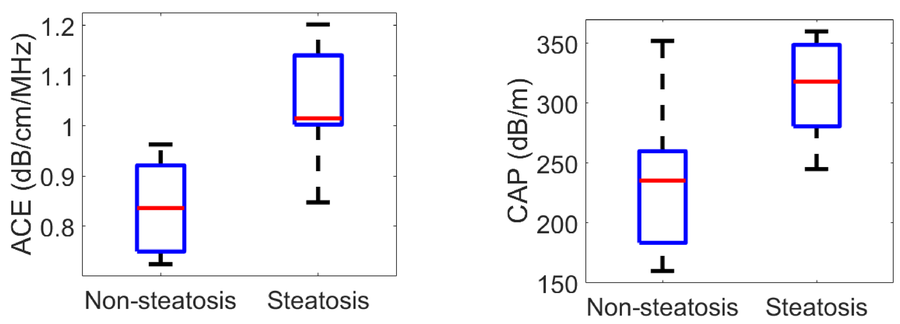

Figure 3: Distribution of ACE (left) and CAP values (right) for non-steatosis and steatosis patients (defined by MRI-PDFF>6%). Both ACE values (p = 0.0020) and CAP values (p = 0.0026) were significantly different for the two classes.

DISCUSSION

- This study presents a promising diagnostic tool, ACE for the quantification of steatosis.
- In this exploratory study, ACE outperforms the commercially available screening tool, CAP with respect to correlation to MRI-PDFF values.
- ACE map can be shown as an overlay on the ultrasound image, providing the spatial distribution of fat content, similar to MRI-PDFF.

CONCLUSION

This study indicates that ACE as described in [1] is strongly correlated with MRI proton density fat fraction. The correlation is significantly stronger than the correlation with FibroScan® CAP, and warrants further studies with a view of providing an accurate point-of-care assessment of liver steatosis.

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DISCLOSURES

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