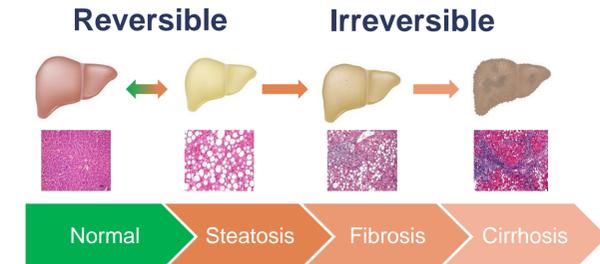


BACKGROUND



- Non-alcoholic fatty liver disease (NAFLD) affects 1 in 4 persons, globally. Steatosis is the first stage of NAFLD. This condition is reversible, but can progress into irreversible fibrosis and cirrhosis [1].
- Quantitative ultrasound (QUS) can potentially be an inexpensive and effective point-of-care steatosis screening tool.

OBJECTIVE

- We propose SWTV-QUS, a volumetric QUS parameter estimation method. We demonstrate the feasibility of the simultaneous *in-vivo* liver QUS mapping along with liver stiffness imaging using (S-WAVE, Sonic Incytes, Canada), a real-time elastography method [2].
- We demonstrate the efficacy of SWTV-QUS in steatosis detection by comparing its performance with MRI-PDFF, the current gold standard.
- We demonstrate that SWTV-QUS enables extending the fundamental trade-off between precision and resolution.

METHOD

- We apply a spatially adaptive regularization, where the regularization on backscatter term, β is modified by a weight matrix which is a descriptor of the tissue heterogeneity.

$$\hat{x} = \arg \min_x \{ \|y - Ax\|_2^2 + \lambda_1 TV(\alpha) + \lambda_2 SWTV(\beta) \},$$

where y is the measurement data, A is the system matrix, $x = [\alpha, \beta]$ is the QUS parameter, α is attenuation coefficient (ACE) and β is the backscatter coefficient (BSC).

Visual Comparison: Ultrasound QUS map can grade the severity of hepatic steatosis, with a performance comparable with MRI-PDFF, the current gold standard.

Correlation Analysis: The QUS parameters, ACE, IBC and ESD demonstrate a strong correlation with MRI-PDFF.

Improved Diagnosis: The SWTV-QUS improves the diagnosis of steatosis over the traditional reference phantom method by enabling clear separation between steatosis and non-steatosis samples.

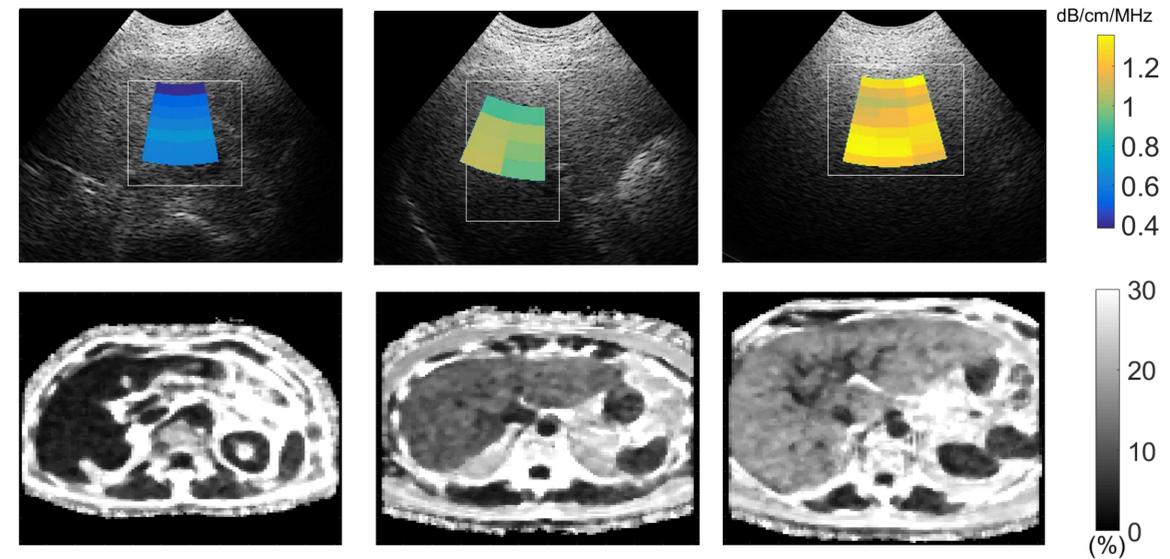


Figure 1: Three examples showing ACE map overlaid on the ultrasound B-mode image (top) and PDFF map (bottom) for a non-steatosis (left), mild steatosis (middle) and severe steatosis (right) case.

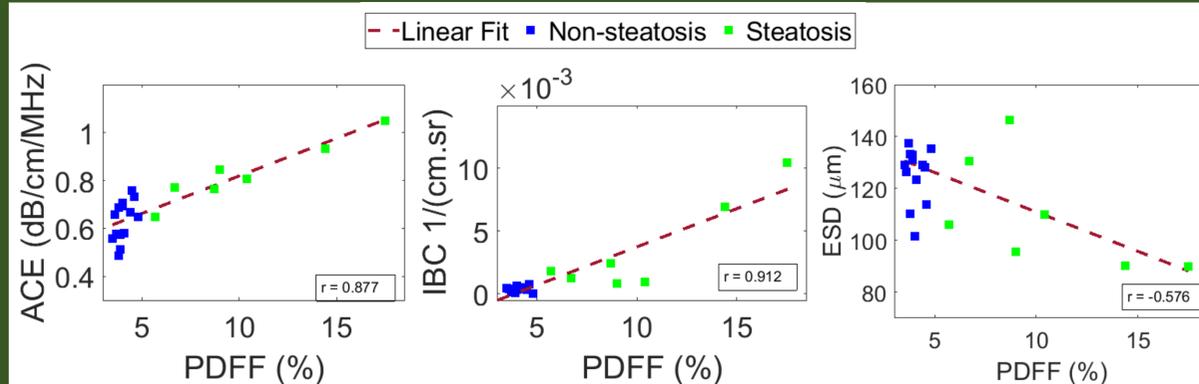


Figure 2. Relationship between ACE (left), IBC (middle), and ESD (right) with PDFF. The correlation coefficient (r) was calculated using Pearson's test.

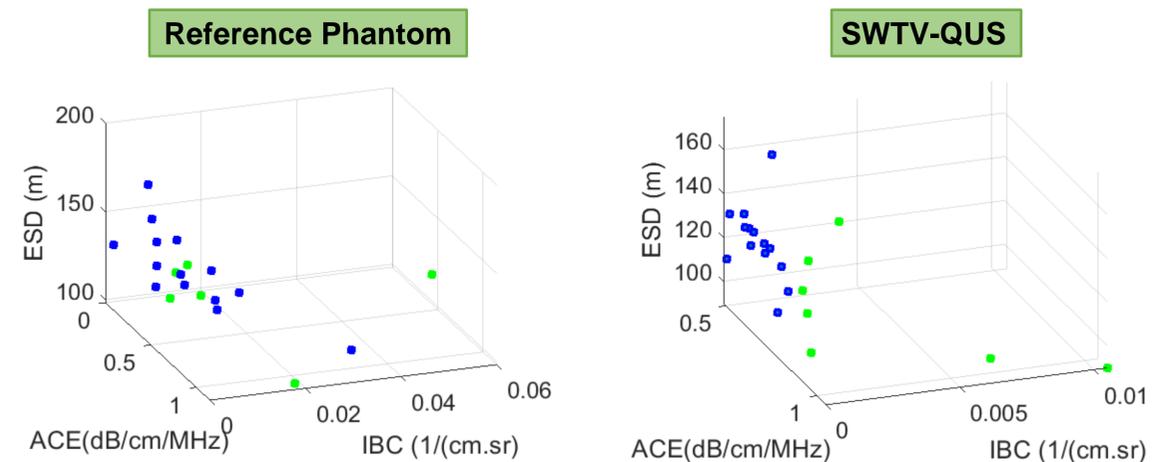


Figure 3. Feature analysis plot of ACE vs. IBC vs. ESD for the reference phantom method and the SWTV-QUS method.

IMPROVED TRADE-OFF

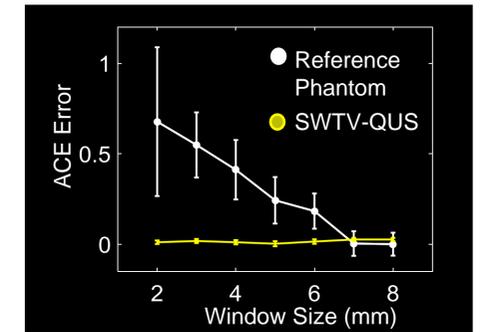


Figure 4: The ACE error and standard deviation vs window dimension. The SWTV-QUS improves the trade-off between estimation precision and resolution over the traditional reference phantom method.

CONCLUSION

- ACE map can be shown as an overlay on the ultrasound image, providing the spatial distribution of fat content, similar to MRI-PDFF.
- Improved resolution will provide local variation information within the liver. Improved precision would be required to qualify as a reliable diagnostic tool.
- The equivalence to MRI-PDFF shows that SWTV-ACE is a potential point-of-care tool for hepatic steatosis detection.

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