RSNA/QIBA Ultrasound Shear Wave Speed Biomarker Committee

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ORGANIZATION & QIBA PROFILE

1. The Ultrasound Shear Wave Speed Biomarker Committee

A. Has served for 6 years, now under the Ultrasound Coordinating Committees (CC) (Cochairs T.J. Hall and B. Garra)

B. The SWS Biomarker committee is cochaired by B. Garra, T.J. Hall, and A. Milkowski

C. Task Force Groups (TFGs) include:
System Dependencies and Phantoms
(Co-chairs M. Palmeri, K.A. Wear)

Clinical and Applications (Co-chairs A. Samir and D.O. Cosgrove)
Profile writing (B. Garra and M. Dhyani)

2. Profile Development

The second draft of the profile, aimed at assessment of liver fibrosis has been circulated amongst the committee members. Post receipt of the feedback and consolidation – the profile will be released for public comment.

Key provisions of the profile include:
- Several open issues
- Closed issues – after consensus amongst committee members.
- Vendor specific information that has been provided by all vendors and is specific to performing SWS measurements on their individual systems.
- Clinical Context and Claims

3. Conformance procedure studies will be performed in the coming year.

4. Groundwork projects Include:

US SWS Technical Projects

Quantitative Imaging Biomarkers Alliance

RSNA

US SWS TECHNICAL PROJECTS

ULTRASOUND VS. MAGNETIC RESONANCE ELASTOGRAPHY (MRE) STUDY

Objective

In viscoelastic media, shear wave speed (SWS) depends on shear wave frequency. MRE uses a relatively low frequency (60 Hz) while Ultrasound uses higher frequency shear waves. The goal of this project was to assess the dependence of SWS on frequency in order to establish the relationship between MRE and Ultrasound measurements of SWS

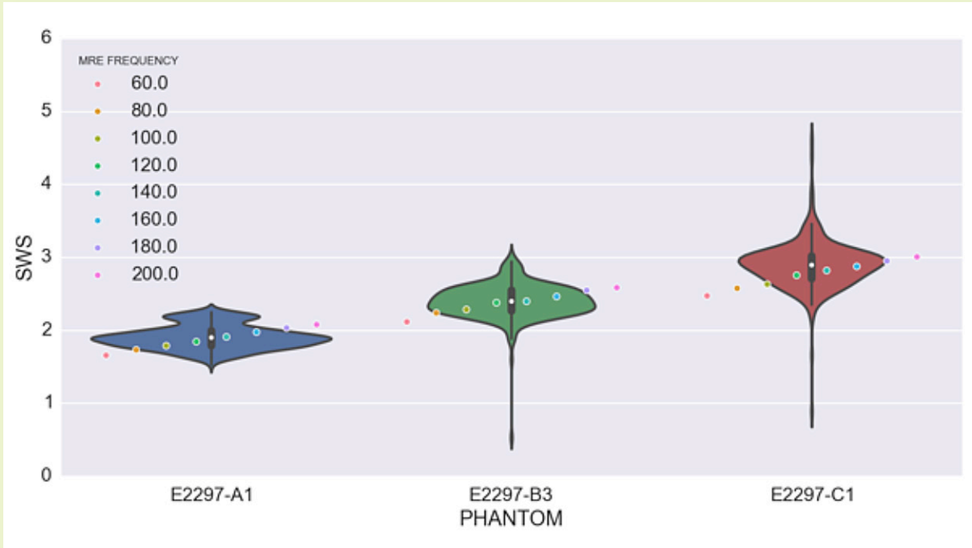
Methods

- CIRS, Inc. (Norfolk, VA) fabricated 3 phantoms (E2297-A1, -B3, -C1) using a proprietary oil-water emulsion infused in a Zerdine® hydrogel.
- MRE SWS was measured at the Mayo Clinic with a GE MRE System at 8 different shear wave frequencies: 60, 80, 100, … 200 Hz.
- Ultrasound SWS was measured at academic, clinical, government and vendor sites using different systems with curvilinear arrays.

Vendor System Model	Number of Sites
General Electric (phantom mode) LOGIQ E9	3
Philips EPIQ	3
Philips iU22	2
Samsung Medison RS80A	3
Siemens S2000	1
Siemens S3000	3
SuperSonic Imagine Aixplorer	5
Toshiba Aplio 500	3
Zonare ZS3	1

Results

The violin plots (blue, green, and red) show the distributions of 24 Ultrasound SWS measurements for each of the 3 phantoms with the 9 Ultrasound Systems. The multi-color dots show the MRE SWS measurements at 8 different shear wave frequencies.



Conclusions

1. MRE SWS showed a linear dependence on shear wave frequency for all three phantoms.
2. Ultrasound SWS measurements corresponded most closely to MRE SWS measurements at 140 Hz.
3. While a linear extrapolation method appears valid for these viscoelastic phantoms, it may not apply to human SWS data if SWS dispersion is different in humans.

TEMPERATURE DEPENDENCE OF SWS STUDY

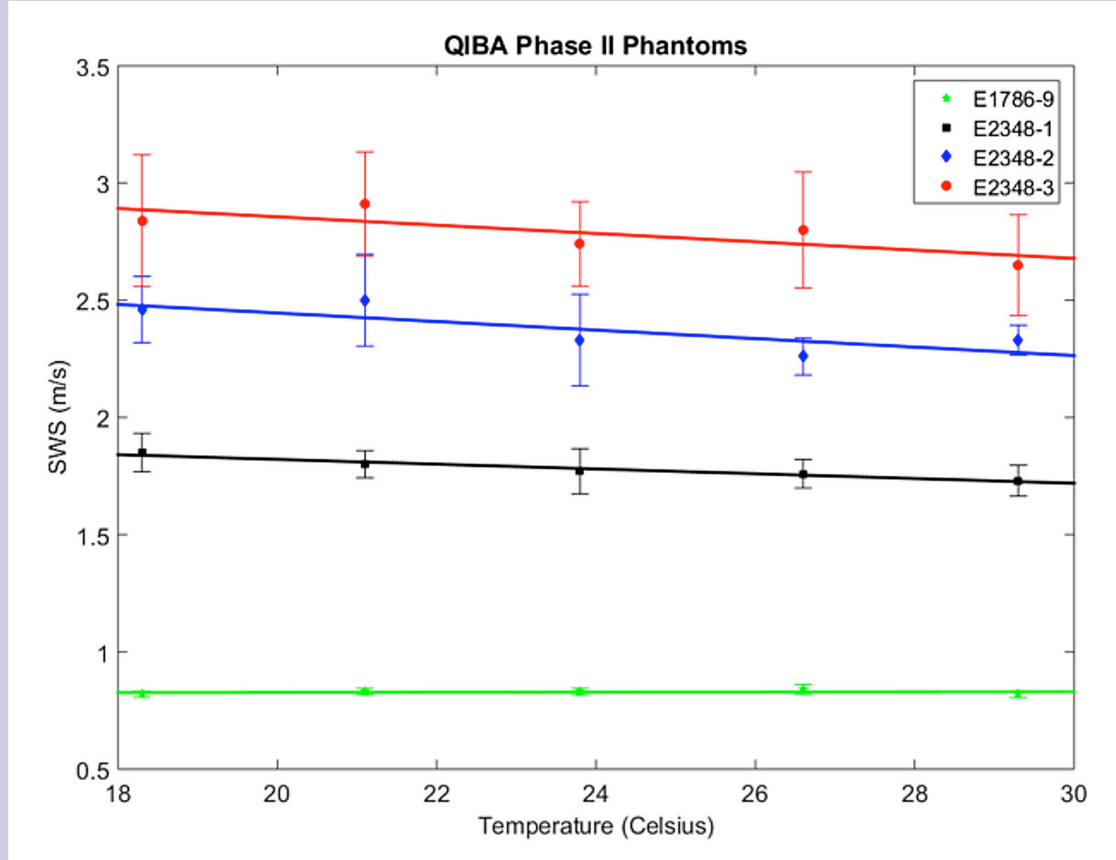
Objective

Temperature is a potential confounder in SWS measurements. The goal of this study was to measure the dependence of SWS on temperature in elastic and viscoelastic phantoms.

Methods

- CIRS, Inc. (Norfolk, VA) fabricated 1 elastic phantom (E1786-9) and 3 viscoelastic phantoms (E2348-1, -2, -3) using a proprietary oil-water emulsion infused in a Zerdine® hydrogel.
- Phantoms were placed in a temperature-controlled water bath.
- Ultrasound SWS was measured using a SuperSonic Aixplorer Ultrasound Imaging System.

Results



Conclusions

1. SWS showed no temperature dependence in the elastic phantom (green).
2. SWS showed small temperature dependence (on the order of -0.02 m/s per degree Celsius) in the viscoelastic phantoms (black, blue, red).
3. SWS is likely not a significant confounder in phantom experiments conducted near room temperature.

EFFECTS OF PHASE ABERRATION AND ULTRASOUND ATTENUATION ON SWS MEASUREMENTS

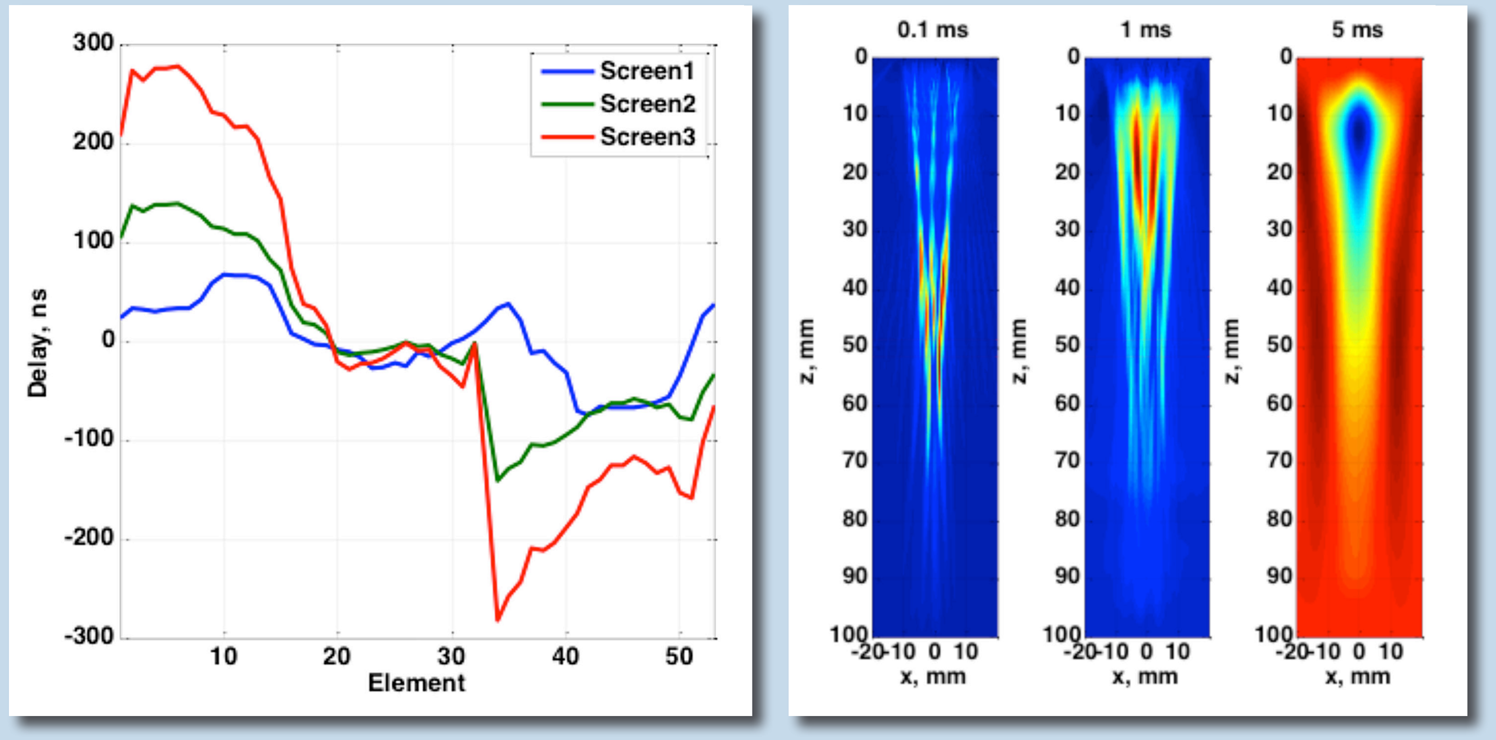
Objective

The discrepancy in sound speed between fat (~1450 m/s) and other soft tissues (~1540 m/s) causes phase aberration. Phase aberration can defocus the push beam and cause variation in the SWS measurements. The goal of this simulation study was to determine how the level of aberration relates to SWS bias.

Methods

- To explore how phase aberration affected SWS measurements, the acoustic intensity was simulated through phase screen aberrators with root-mean-square time delays of 0, 40.2, 83.2, and 166.9 ns.
- To investigate the effects of ultrasound attenuation we calculated the acoustic intensity in media with attenuations of 0.5, 0.7, and 1.0 dB/cm/MHz.
- Digital elastic and viscoelastic phantoms were used to take the acoustic intensity and apply it as an acoustic radiation force with a finite element modeling approach.
- Wave motion data was analyzed for group velocity in the time-domain, and phase velocity was analyzed in the frequency domain.

Results



Phase screens used for phase aberration tests and wave propagation from screen 3 (166.9 ns rms time delay). The phase screens were averages from measurements with a needle hydrophone using a porcine abdominal section.

Conclusions

1. Higher aberrator strengths yielded more variation and more bias in SWS measurements.
2. In viscoelastic media, the frequency-domain measurements of phase velocity were degraded in terms of the bandwidth covered.
3. Results with higher ultrasound attenuation did show some biased SWS values.

Acknowledgements & Disclaimers

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