Parameters affecting the accuracy of pulse wave velocity estimates: A comprehensive comparison between different imaging methods.

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Background, Motivation and Objective

Tracking the displacement of an arterial wall can be used to estimate the pulse wave velocity (PWV). Several scan sequences have been tested, all with pros and cons related to the tradeoff between image quality, spatial resolution, and frame rate (FR). Therefore, a comprehensive comparison between different scan methods is needed to identify the best sequence for accurate PWV estimation with the highest spatial resolution.

Statement of Contribution/Methods

In the present study, we contrasted three families of scan formats: one beam line-by-line (LL), dual transmit beams LL, and plane waves (PW). For LL format, we explored several levels of parallel receive beamforming. For PW format, we compounded with 5-angles and 15-angles. Phase-sensitive speckle tracking helped estimate wall displacement at each position along the vessel, and time shift between wall displacements. Different sequences were compared using both synthetic and experimental data. Synthetic B-mode images were produced with Field II. Figure 1(a) shows the B-mode image and displacement model (PWV = 5 m/s) for the simulation. A PVA vessel phantom was fabricated using established methods. Data on pulsatile wave propagation in the phantom were acquired using different scan formats programmed on a Verasonics Vantage system (e.g., Figure 1(c)).

Results/Discussion

PWV estimated along the vessel (i.e., time delay between displacements along a vessel wall segment) is presented in Figure 1(b) for synthetic data. For LL beamforming, parallel receive beams can increase FR but produce artifacts at distances where receive beams overlap. For PW beamforming, errors are more significant for increased angular compounding where time and space dimensions are mixed. Clearly, error increases with finer spatial resolution for both beamforming approaches. Figure 1(d) displays preliminary phantom data for both methods. Experimental results will be used to define the best scan sequence optimizing the tradeoff between spatial resolution and artifact level in PWV estimation.

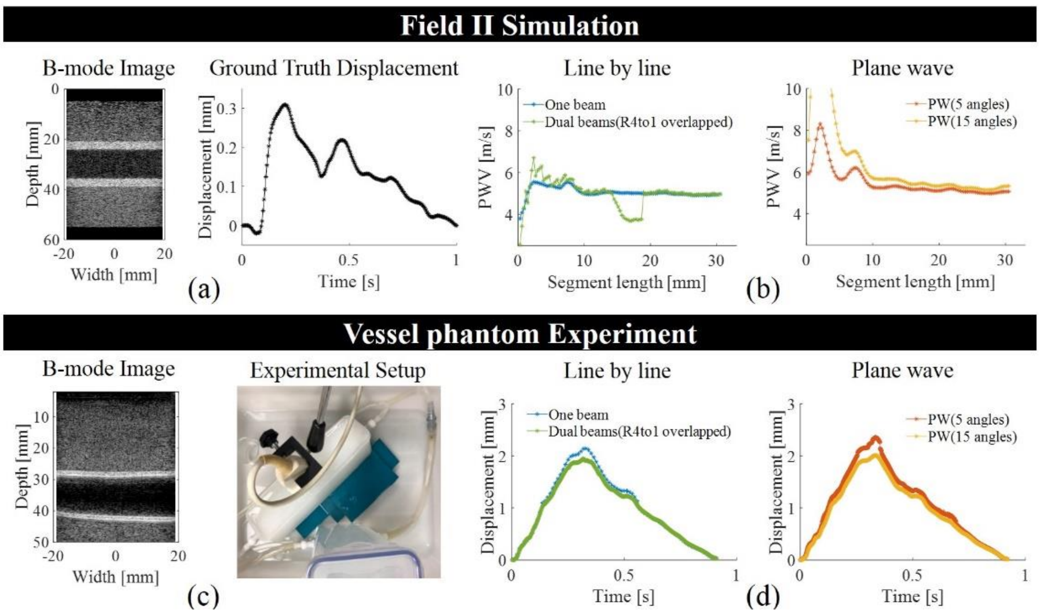

Figure1. (a) Simulated vessel and displacement waveform; (b) Estimated PWV as a function of segment length with simulated data ; (c) Experimental setup and typical B-scan image of phantom; (d) measured displacement waveforms comparing different scan formats.