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Title

Validation of effect of different beamforming on backscatter coefficient analysis

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Background, Motivation and Objective

Backscatter coefficient (BSC) can characterize biological tissues as the quantitative parameter that does not depend on the clinicians and system settings. The stability of computed BSC on an ultrasound scanner need to be confirmed for the application of quantitative ultrasound (QUS) assessment by the BSC analysis. BSC analysis using ultrafast plane wave imaging (PWI) is also necessary to perform high-speed QUS. We aimed to overall explore the variation of the BSC in different scanners, transducers, and beamforming methods for QUS of biological tissues with fast motion, such as vessel wall and heart.

Statement of Contribution/Methods

Measurement objects were tissue mimicking phantoms (8 cm width × 2 cm length × 4 cm height) those included spherical shaped scatterers; Mean diameters of 20 and 30 μm; Concentrations of both diameters of scatterers at 0.5 (phantoms I and II) and 2.0 wt% (phantoms III and IV). Four ultrasound scanners I-IV with two single element transducers I-II and five linear probes of low (probes I, III, and V) or high frequencies (probes II and IV) were used to compare among the BSC in the different system. The beamforming method of each system was line-by-line formation using focused imaging (FI) except for scanner IV with probe V using PWI. The BSC was calculated using the reference phantom method. The RF data of phantoms I and II were used as the reference for the analysis data of phantoms III and IV, respectively. Specific analysis parameters such as the analysis window size to calculate BSC was optimized for each system. The bias error in relation to theoretical BSC computed from the Faran model was calculated as the benchmark to indicate the variation of analyzed BSC.

Results/Discussion

Figure 1 shows the analyzed and theoretical BSCs of phantoms III and IV in each system. The feature of theoretical BSC was comparable to that of each analyzed BSC independent of different system properties and imaging methods. The bias error was confirmed below ±2.8 dB on average, and also approximately within the SD (±2.2 dB at most) in all cases. These variations agree to the previous study by Nam et al. that indicates the largest error is about 3.5 dB among four different scanners with FI. In addition, the BSC in PWI is equivalent to that in the other methods, which indicates the possibility of high-speed QUS using PWI.

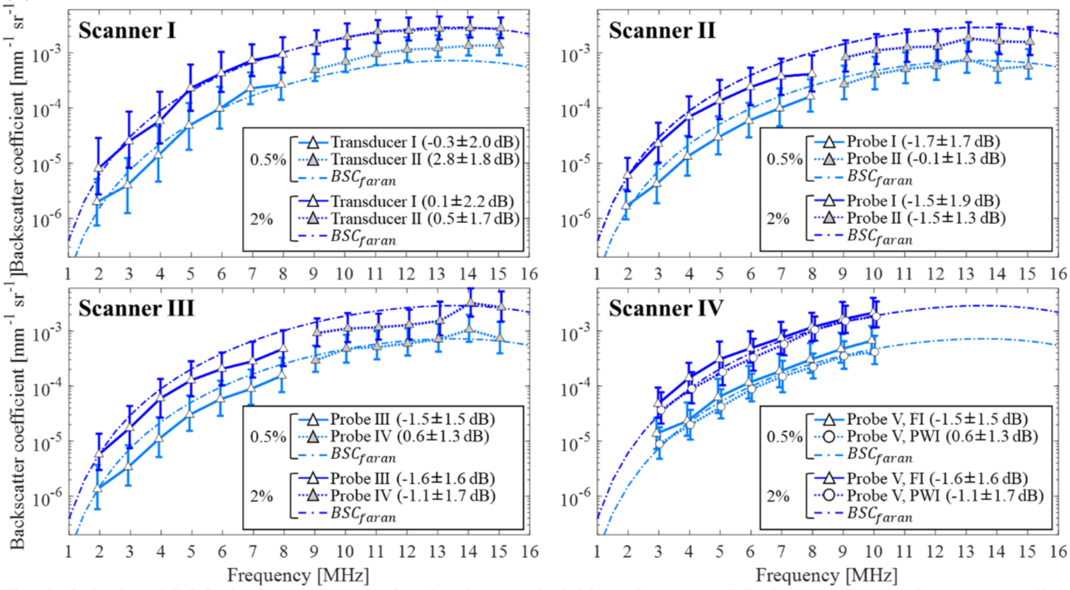

Fig. 1. Calculated BSCs in four scanners for the tissue-mimicking phantoms. Markers and error bars are median and interquartile range of the BSC at each frequency. The BSC of Faran model is also plotted with dot-and-dash line. The mean ± standard deviation of bias error [dB] between calculated and Faran BSCs are in parentheses.