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Low frequency acoustic response from biological tissues irradiated by a high frequency acoustic radiation pulse

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Background, Motivation and Objective. Quantitative characterization of the mechanical properties of biological tissue is important in the diagnostic of pathological processes. For example, breast tumors like Fibroadenoma and carcinoma are generally stiffer than surrounding healthy tissue. Recently elastographic techniques are being explored to evaluate stiffness of soft tissues. In this work, a new technique that uses acoustic radiation force has been developed as an alternative to evaluate slight differences in mechanical properties of biological tissues. This technique uses a single high-frequency pulse (MHz) to excite the medium. Non-linear interactions of this acoustic wave in the tissue produces a lower frequency signal (kHz) which is detected by a dedicated hydrophone. This signal carries information of mechanical and morphological properties of the studied region, therefore, it can be processed into images weighted in those characteristics.

Methods. In this study, we tested the use of this technique to characterize and to generate images of soft tissue. A short focused acoustic radiation pulse (f=3.1 MHz, t=15 μs) was used to mechanically excite the sample and the low frequency acoustic response was acquired by a dedicated hydrophone (ITC 6050) with acquisition band going from 1kHz to 70 kHz. A phantom made of paraffin-gel to mimic the soft tissue, containing three inclusions of the same based material with different stiffnesses and the same acoustic impedance was used to generate the acoustic images. A B-Mode image was generated to show that the inclusions had the same acoustic impedance as the base material, therefore they can't be seen in the B-Mode image.

Results. An Image using the method using acoustic radiation force were generated (Figure 1) and compared with the B-mode image (Figure 2).

Discussion and Conclusions Contrast have been seen for different stiffness in the phantom and the inclusions can't be seen in the B-mode image, that result shows that our method can generate images with contrast relative to mechanical characteristics of the tissue. This result shows the potential of the technique to evaluate mechanical properties of biological tissues and even quantitative information can be obtained depending on the processing method of the acquired signals.

Figures

Figure 1: Image of the phantom made using Acoustic Radiation Force

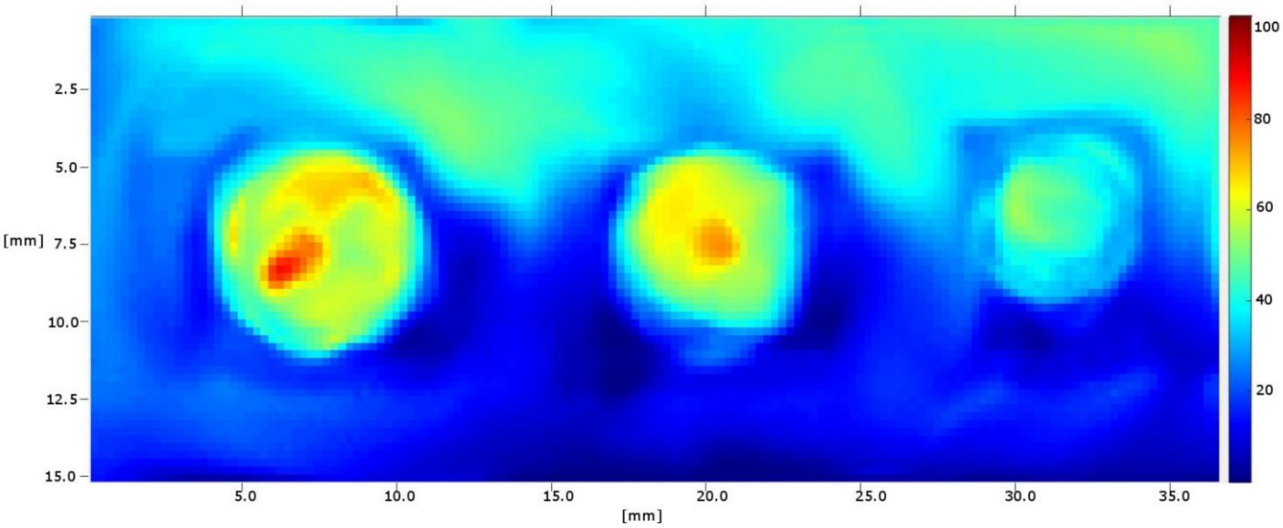
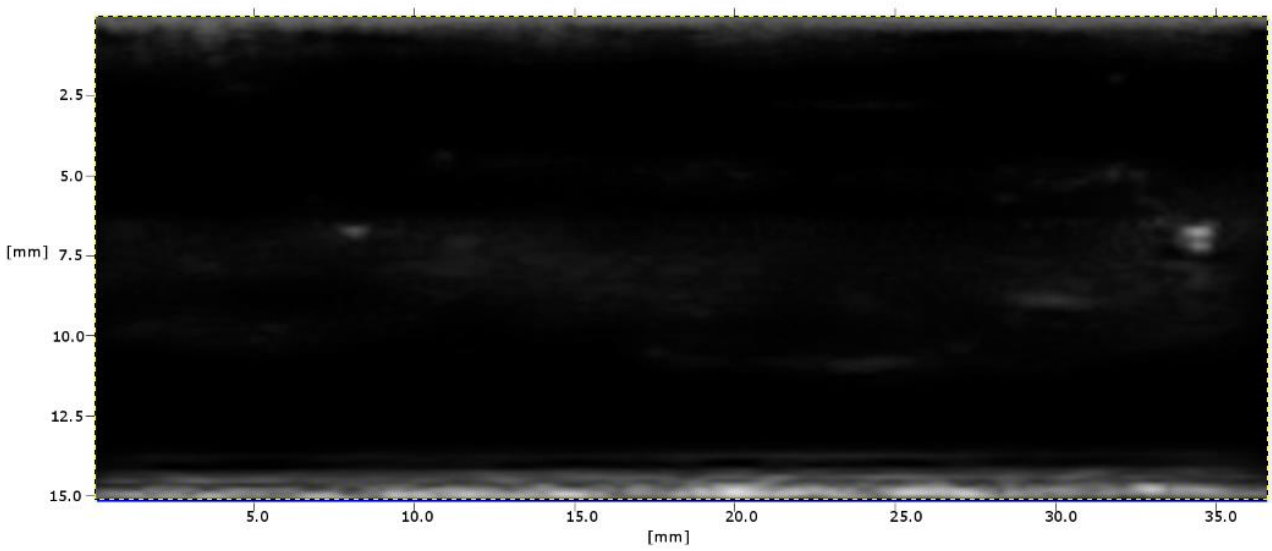


Figure 2: B-mode Image of the same phantom



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