Ultrafast multiperspective ultrasound strain imaging of the abdominal aorta

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Background, Motivation and Objective

Abdominal aortic aneurysms (AAAs) are large dilatations that can result in a life-threatening hemorrhage. Ultrasound (US) imaging is used to monitor the diameter of the AAA wall. In recent years, geometry and strain assessment have been used to assess rupture risk. However, current techniques are limited by the low lateral resolution and poor contrast of US in lateral vessel wall segments, which cannot be tackled using beam steering due to the high imaging depth. To address these limitations, this study introduces an ultrafast multiperspective (MP) scanning mode, developed on a dual-transducer experimental US system. MP US acquisitions were used to assess geometry and perform strain imaging in a porcine aorta in an experimental set-up.

Statement of Contribution/Methods

A mock circulation set-up was used to perform inflation testing on an ex-vivo porcine aorta embedded in a phantom of the abdomen, including a spine and surrounding structures. US images were acquired with two curved arrays (C5-2v, Verasonics) using three acquisition schemes: MP ultrafast imaging, single perspective ultrafast imaging, and conventional focused scanning. MP images were compounded after registration. Moreover, MP motion and strain estimation were performed by compounding axial displacements, obtained using radiofrequency speckle tracking. The performance between the acquisition schemes was compared in terms of image quality, motion tracking precision, and strain estimation precision.

Results/Discussion

In single perspective US images, the contrast-to-noise ratio (CNR) between the aortic wall-lumen region was higher for line-by-line imaging than in ultrafast imaging. In MP US images, both lateral resolution and CNR increased after compounding envelope data (Fig. 1A-C). Using compounded displacements in motion tracking, cumulative errors decreased, in particular in the lateral wall segments. The mean error of MP motion estimates decreased with a factor of two compared to conventional scanning. For strain imaging, MP US did not outperform conventional scanning in two shadow regions caused by refractions. However, the elastographic signal-to-noise ratio (SNRe) increased in tenfold at the upper wall region and doubled at the lower wall region compared to single probe imaging.

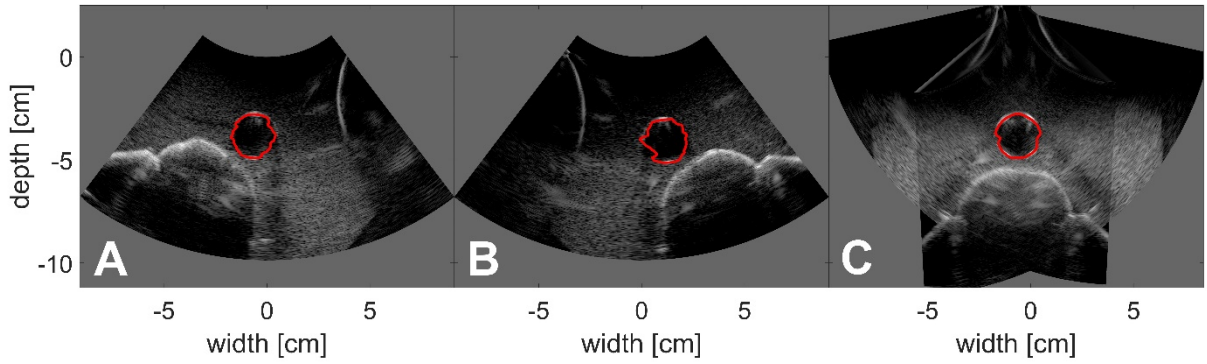

Fig 1. Brightness-mode (B-mode) ultrasound images of an inflated porcine aorta in an abdomen phantom acquired ultrafast from multiperspective angles. **A-B**. B-mode images and tracked wall positions of left-hand (**A**) and right-hand (**B**) transducer. **C**. Compound envelope image of A and B and tracked wall positions obtained after axial displacement compounding.