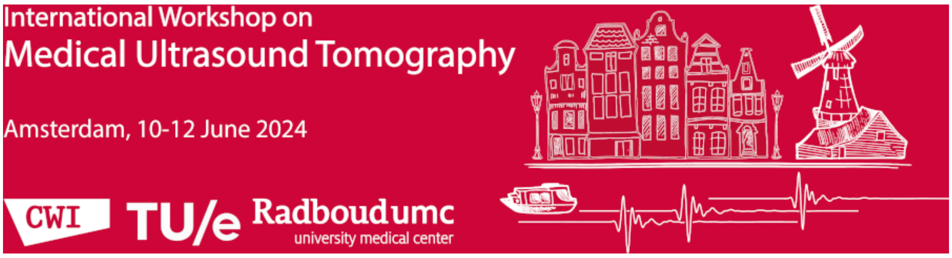

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In Vivo Bistatic Multi-Aperture Ultrasound Imaging and Elastography of the Abdominal Aorta

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Abdominal aortic aneurysms (AAA) are large dilatations of the abdominal aorta, that are typically asymptomatic until a life-threatening rupture occurs. Knowledge of AAA geometry and local mechanical wall parameters using ultrasound is paramount for risk stratification and intervention planning. However, such an assessment is limited by the lateral lumen-wall contrast and resolution of conventional ultrasound. Fundamentally, a semi-tomographic set-up using multiple apertures would produce images with improved angular coverage of the vessel wall. In this study, this concept is assessed by introducing dual-aperture bistatic imaging, in which two curved array transducers alternately transmit and both probes receive simultaneously on each transmit event, which allows for the reconstruction of four ultrasound signals.

The performance of dual-aperture bistatic ultrasound imaging and elastography was assessed in vivo in 20 healthy volunteers and 40 patients with an AAA. Automatic probe localization was achieved by optimizing the coherence of the trans-probe data, using a gradient descent algorithm. To measure deformation and strain inside the aortic wall, motion tracking was performed on the four individual ultrasound signals, after which the respective axial displacements were compounded. To mitigate the impact of aberrations, an Eikonal-based beamforming method was tested in vivo.

The automatic probe localization approach improved the lumen-wall contrast of the trans-probe data by 3.7 dB, compared to manual registration. The results in healthy volunteers and AAA patients show both the feasibility and promise of multi-aperture ultrasound 1. The lumen-wall generalized contrast-to-noise ratio (gCNR) is increased by 40% on average, yielding more homogeneous and more accurate strain estimates (+12dB), compared to conventional ultrasound. Eikonal-based beamforming improved the alignment of image features in coherent dual-aperture image fusion, and increased lumen-wall contrast by 1.5 dB. Our future vision is the use of this concept while imaging the abdomen with a large, flexible transducer and using 3-D ultrasound

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