High frame rate synthetic aperture vector flow imaging for transthoracic echocardiography.

This work presents the first in vivo results of 2-D high frame rate vector velocity imaging for transthoracic cardiac imaging. Measurements are made on a healthy volunteer using the SARUS experimental ultrasound scanner connected to an intercostal phased-array probe. Two parasternal long-axis view (PLAX) are obtained, one centred at the aortic valve and another centred at the left ventricle. The acquisition sequence was composed of 3 diverging waves for high frame rate synthetic aperture flow imaging. For verification a phantom measurement is performed on a transverse straight 5 mm diameter vessel at a depth of 100 mm in a tissue-mimicking phantom. A flow pump produced a 2 ml/s constant flow with a peak velocity of 0.2 m/s. The average estimated flow angle in the ROI was 86.22° ± 6.66° with a true flow angle of 90°. A relative velocity bias of −39% with a standard deviation of 13% was found. In-vivo acquisitions show complex flow patterns in the heart. In the aortic valve view, blood is seen exiting the left ventricle cavity through the aortic valve into the aorta during the systolic phase of the cardiac cycle. In the left ventricle view, blood flow is seen entering the left ventricle cavity through the mitral valve and splitting in two ways when approximating the left ventricle wall. The work presents 2-D velocity estimates on the heart from a non-invasive transthoracic scan. The ability of the method detecting flow regardless of the beam angle could potentially reveal a more complete view of the flow patterns presented on the heart.

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