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Intracardiac Myocardial Elastography at high temporal resolution in canines and humans in vivo

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Background, Motivation and Objective

Intracardiac echocardiography (ICE) is routinely used during radio-frequency (RF) ablation procedures for abnormality identification and procedural guidance. Combining ICE with an insight into the mechanical properties of the myocardium can provide additional information during the ablation procedure. ICE has been used in previous studies to estimate strain rates using tissue Doppler imaging (Wang, J Am Soc Echo. 2006). However, these studies could not achieve high temporal resolution in a large field of view to depict the mechanical function of a heart chamber within a single heartbeat. The objective of this study was to demonstrate initial feasibility of imaging myocardial strains in vivo within the same imaging plane as ICE at high temporal resolution.

Statement of Contribution/Methods

A normal canine and a human subject with atrial tachycardia were studied in vivo. The studies were approved by the Institutional Animal Care and Use Committee and an Institutional Review Board of Columbia University, respectively. A 5.8-MHz center frequency ICE probe inserted into the femoral vein was used to image the heart with an unfocused beam transmit method to achieve high frame rates (1200 frames per second) and the channel data were acquired on a clinical ultrasound system (Z.one ultra, Zonare, Mountain View, CA) during 620ms. The RF signals were reconstructed off-line on a 9cm depth and 90° field of view region with a delay-and-sum algorithm and axial cumulative displacement estimation was performed using 1-D cross-correlation using a window size of 2.6mm and 95% overlap. Axial cumulative strains were obtained from the axial displacements using a least-squares estimator with a kernel of 5.1 mm.

Results/Discussion

In the canine, the average cumulative axial displacement of the posterior-lateral wall of the left ventricle during systole was approximately 5mm and the cumulative strain was approximately 12% due to radial thickening. In the right ventricle, the average cumulative axial displacement of the lateral-apical wall during diastole was approximately 4mm and the cumulative strain was approximately -7% due to radial thinning. In the human subject, cumulative displacement of the lateral wall of the right atrium during systole was approximately 2mm and the cumulative strain was approximately -3% due to longitudinal shortening. The lower strain values may be attributable to the tachycardia.

Myocardial Elastography using ICE was shown feasible in vivo at high temporal resolution. This initial feasibility of may offer new prospects in RF ablation guidance when fully integrated with ICE.

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