Validation of Electromechanical Wave Imaging in canine left ventricles against electrography

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Background, Motivation and Objective:
Electromechanical Wave Imaging (EWI) is a technique that can image the transient deformation in the myocardium resulting from electrical activation. This technique can be used as a surrogate for the measurement of the electrical activation of the heart. EWI has been shown capable of detecting and characterizing ventricular pacing, left bundle branch block (LBBB) and atrial flutter. A previous study has shown good agreement between electromechanical and electrical activation in a canine. However, this technique has not been fully validated *in vivo*. The objective of this study is to investigate the relationship between electromechanical and electrical activation.

Statement of Contribution/Methods:
In this study, six canines were investigated. The canines were anesthetized and their chest was opened by lateral thoracotomy. A 64-electrode basket catheter was inserted through the apex of the left ventricle. Two external electrodes were sutured onto the epicardial surface of the left ventricle in the anterior and lateral regions. A suture was attached to one spline of the basket catheter as a landmark to determine the location of the splines. Ultrasound channel data were acquired at 2000 Hz using a 2.5 MHz center frequency operated by a Verasonics system. Four different apical views were acquired: the standard 4-, 2- and 3-chamber views as well as the 3.5-chamber view which is located between the 4- and the 2-chamber views. Axial motion was estimated using normalized 1-D cross-correlation with a window length of 6.2 mm and 90 % overlap. Axial strain was computed from axial displacement using a least-squares estimator with a kernel of 5 mm. Channel data, ECG and endocardial potential were acquired synchronously during sinus rhythm, pacing from the sutured electrodes or pacing from one electrode of the basket catheter. Electromechanical activation timing at a given location was defined as the first zero-crossing of the EWI strain curve after the onset of the Q-wave and electrical activation timing was defined as the time of maximum amplitude of the depolarization wave.

Results/Discussion:
A linear regression was performed between electromechanical and electrical activation timings and the mean correlation coefficient (R) and intercept (i) were computed across all six animals. The mean correlation coefficient and intercept for sinus rhythm were $R = 0.56$ and $i = 41$ ms respectively, for pacing from the sutured electrodes we obtained $R = 0.74$ and $i = 33$ ms and for pacing from one electrode of the basket we obtained $R = 0.62$ and $i = 35$ ms. The suboptimal alignment between the basket splines and the image planes due to lack of simultaneous CT imaging may have impacted the correlation.
Despite these shortcomings, the relatively good correlation between EWI and electrography further support our initial findings that EWI-based electromechanical activation is linearly related to electrography-based electrical activation.