

Model-based and Unsupervised Machine-learning Approaches for the Characterization of Responder Profiles for Cardiac Resynchronization Therapy

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Context: Cardiac resynchronization therapy (CRT) has emerged as a recognized treatment option in patients suffering from systolic heart failure with reduced ejection fraction and a bundle branch block. Unfortunately, around 30% of patients receiving CRT do not respond to this therapy.

Imaging techniques such as echocardiography have established relations between CRT response and cardiac mechanical dyssynchronies, but the interpretation remains difficult due to the great heterogeneity in dyssynchronization patterns.

Methods: In this paper, we aim at proposing a patient-specific model-based approach of a cardiovascular system in order to improve the interpretability of a previous clustering analysis based on strain features and clinical data of 250 CRT candidates. Model parameters identifications were performed for patients associated of each cluster barycenter and parameters reflecting physiological mechanisms were analyzed.

Results: Five clusters were identified from clinical, original and classical echocardiographic features with response rates ranging from 50% to 92.7%. A match was observed between experimental and simulated myocardial strain curves of a representative patient of each cluster with a mean RMSE of 3.97% (± 1.74). Moreover, the identified model parameters provide us information about the mecano-electrical coupling and tissue properties.

Conclusions: The patient-specific identified parameters added to the strain features and classical clinical data could be a promising tool to improve understanding of LV mechanics and patient characterization and selection for CRT.

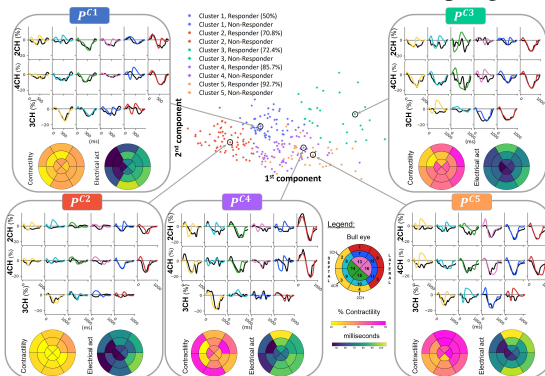


Figure 1: Experimental (black) and simulated strain curves (colored) with the bull eyes of identified parameters: contractility and electrical activation delay