Statistical Shape and Motion Model for Myocardial Deformation from Tagged MRI

Thalia Eleni Seale*, Vicente Grau, Abhirup Banerjee
Institute of Biomedical Engineering, Department of Engineering Science, University of Oxford, Oxford, United Kingdom

Introduction: Abnormal myocardial function is associated with adverse cardiovascular outcomes, including myocardial infarction (MI), but clinical strain measures often reduce complex regional dynamics to a limited set of metrics. Tagged MRI encodes a spatial reference pattern within the myocardium, enabling direct tracking of tissue deformation and myocardial modelling.

Aims: To develop a data-driven framework for characterising regional myocardial dynamics from tagged MRI, capturing subtle and heterogeneous deformation patterns associated with cardiac pathology.

Methods: We constructed point clouds capturing myocardial deformation over a full cardiac cycle using dense optical flow from tagged MRI. A principal component analysis (PCA)-based statistical shape and motion model (SSMM) was then fitted on the point clouds to capture geometric and temporal variation.

Results: The model was evaluated on 759 UK Biobank subjects. SSMM-derived features achieved an area under the receiver operating characteristic curve (AUC) of 0.706 for incident MI and 0.766 for prevalent MI. Latent space analysis (Fig. 1) shows that these features characterise myocardial deformation patterns not observable with conventional cine imaging and are significantly associated with MI.

Conclusion: Modelling dense spatiotemporal myocardial deformation provides information beyond conventional metrics, enabling interpretable phenotyping and capturing clinically relevant variation associated with MI.

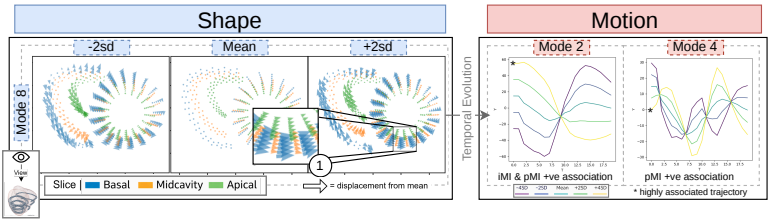

Figure 1. Latent space traversal of the SSMM visualising variation in myocardial deformation across the cardiac cycle. Shape modes reflect deformation of the myocardium; motion modes capture temporal variation in these patterns.