Combining imaging, biomechanical modeling and data analysis for myocardial infarct localization and characterization

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Résumé

Accurate localization and characterization of anomalous regions is essential for a tailored treatment of patients with cardiac ischemia. Cardiac ultrasound or Magnetic Resonance Imaging produce useful anatomical and functional information to characterize myocardial tissues, with however some limits in spatial/temporal resolutions and image quality due to acquisition constraints. Associating imaging data to biophysical models and data analysis models will help to better understand the complex mechanisms in the course of the disease, better characterize the myocardial status, and better predict cardiac recovery after revascularization. To this aim, we developed an approach to personalize a Finite Element model of the healthy cardiac function to real MR imaging data, and we modified its local parameters to model various myocardial infarcts and therefore validate data analysis algorithms on large controlled populations. Two hundred synthetic pathological cases from 5 real healthy left ventricle geometries were generated with damaged myocardial regions of random location, shape and degree of severity. This population was used to evaluate the sensitivity of 9 myocardial strain parameters to reflect the location of the myocardial damage. We used a state-of-the-art machine learning algorithm to link deformation patterns and infarct location. Based on our evaluation, we are able derive a three-group classification of the strain-based parameters according to their performance in locating infarcts, and we show their coherence with physiological interpretations.

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Mots-Clés: inverse biomechanical modeling, cardiac remodeling, cardiac magnetic resonance imaging, myocardial strains, integrative data analysis