I. INTRODUCTION

It is established that the mechanical activity of the myocardium is regulated by the complex interplay among the ionic currents across the cellular membrane system i.e., electrical activity. It is also known that the electrical activity is influenced by the mechanical status of the myocardium, often called as mechano-electrical feedback (MEF). MEF is believed to play a significant role in arrhythmogenesis mediated by the action of stretch activated channel. However, it is not fully understood how such microscopic activities lead to the changes in cellular or organ level phenomena. To clarify such complex interactions over the scale, we have attempted experimental studies at the multi-levels of biological system and integrated the results in a multi-scale numerical model.

II. METHODS

A. Stretching myocytes

To examine the membrane potential response of single cardiomyocytes to axial stretch, we coupled the carbon fiber technique for stretch with wide range of amplitude and speed with the ratio metric measurement of a fluorescent indicator of membrane potential.

B. Stretching the ventricle

We recorded both the membrane potential (optical mapping) and the local strain (marker tracking) while applying global stretch of varying amplitude to the arterially perfused rabbit right ventricular tissue. The 3D structure of the preparations was also evaluated with a laser displacement sensor. Similar measurements were performed in whole heart preparations while applying volume changes to the balloon inside the ventricle.

C. Multi-scale, multi-physics simulation

To gain insights into the mechanisms of mechanically induced arrhythmia, we performed the multi-scale, multi-physics simulations at the tissue and ventricular levels by incorporating the experimental results.

REFERENCES


