Fully automated quantification of LV regional wall motion from echocardiograms to detect myocardial infarction

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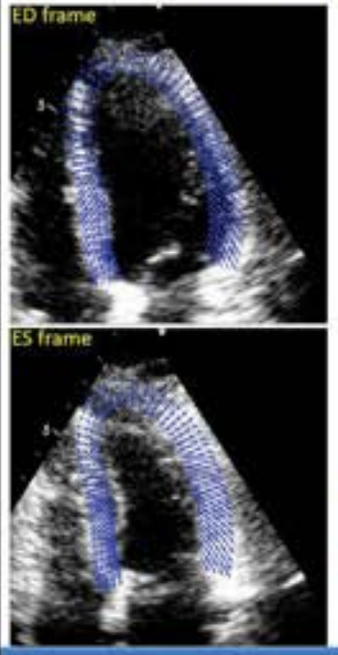
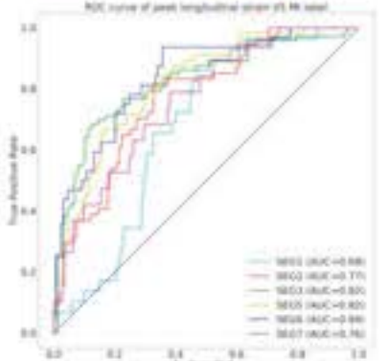
Introduction

- Myocardial wall motion analysis from echocardiography allows precise assessment of cardiac function.
- Current strain analysis software packages require manual endocardial delineation and contour adjustment based on tracking results, causing significant variability.
- We present a fully automated pipeline for tracking left ventricular (LV) wall motion to quantify global and regional longitudinal strain from 2D echocardiograms.

Methods and Results

DATASET: The pipeline was validated on the HMC-QU myocardial infarction (MI) dataset which consists of a single cardiac cycle from the A4C view from 93 MI patients and 68 non-MI subjects. The LV wall was divided into 7 segments, MI or non-MI was labeled in each segment except SEG4.





▲ *Fig.2: ROC curves of peak longitudinal strain in different wall segments.*

◀ *Fig.1 Example of displacement field corresponding to: contraction motion from end-diastolic (ED) to end-systolic (ES) at frame ED and relaxation motion from ES to ED at frame ES.*

METHODS: The proposed pipeline includes the following steps: (1) delineate the endocardial border with our deep learning-based automated contouring method; (2) track the wall motion with bidirectional spline-based elastic image registration, with LV contour to regularise the tracking; (3) update the myocardial points based on the displacement field (Fig.1); (4) compute regional strain.

Fig.3: Box plots of peak longitudinal strains in MI vs non-MI segments. A Wilcoxon signed-rank test was used to determine significance.

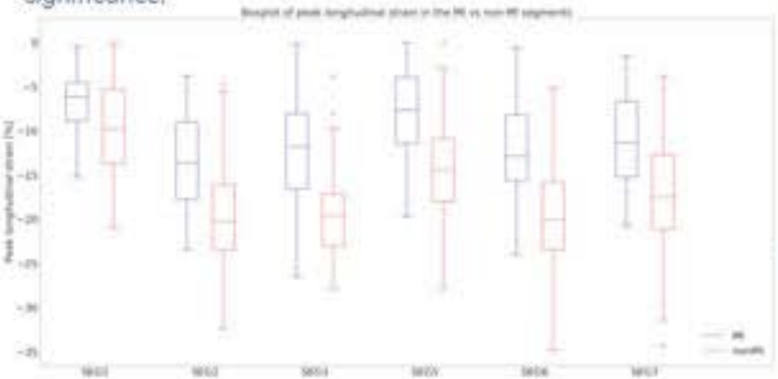
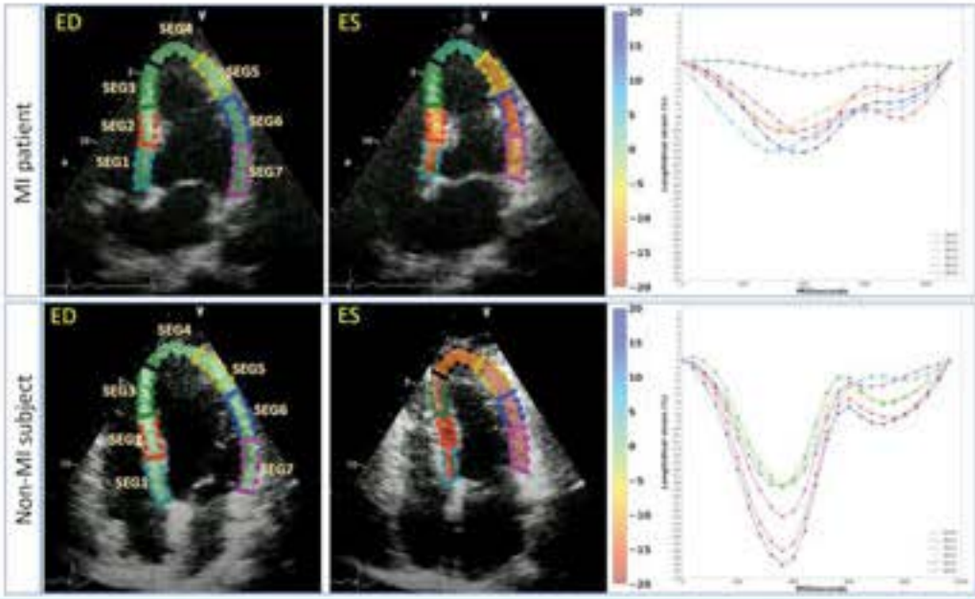


Fig.4: ▶ *Example of tracking myocardial points, strain heatmaps for both ED and ES frames, and strain curve across a cardiac cycle estimated in a non-MI subject and an ischemic patient whose SEG3 was labelled as scarred region.*

RESULTS: Fig.2 shows ROC curves of peak longitudinal strain for detecting MI, with the best performance in the mid-anterolateral segment (AUC 0.84). Fig.3 shows that peak longitudinal strain computed from our pipeline was statistically significantly more positive in segments with MI scarring. Fig.4 shows an example of strain time-curve estimated from an ischemic patient and a non-MI subject.



Conclusions

A fully automated pipeline was developed for calculating segmental strain across a cardiac cycle to identify infarcted segments without any observer variability. Clinical application of this method has the potential to identify and monitor regional myocardial function and benefit patient management.

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