

# Three-segment Center Point Trajectory Model for Segmental Motion Tracking of Myocardial Infarction

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## Introduction

In ischemic heart disease, the number and extent of at risk vascular territories are commonly used to characterize the severity of disease determine prognosis, and plan the most appropriate therapeutic intervention [1]. We describe an automated and quantitative approach for the evaluation of discrete myocardial wall motion in terms of vascular territory (i.e. LAD, RCA, and LCX), using a novel wall motion characterization method called regional center point trajectory algorithm. The three-segment center point model enables separate analysis and quantification of coronary artery disease by their respective vascular territories, thereby allowing segmental tracking and quantification of wall motion.

## Methods

Cardiac MRI was performed on a total of 11 subjects were in a retrospective study protocol and consisted of 6 patients (average age: 64±11 years, 6 males; EF: average = 40% ± 12%) with ischemic heart diseases; and 5 healthy volunteers (average age: 52±10 years, 3 males; EF: >55%). Using standard short axis cine SSFP images, the proposed center curve model is composed of the following steps: segment endocardium; divide left ventricle (LV) into LAD, RCA and LCX regions; within each region, a center point trajectory is calculated based on centroid movement in the corresponding binary mass; calculate the maximum radial motion (Fig.1).

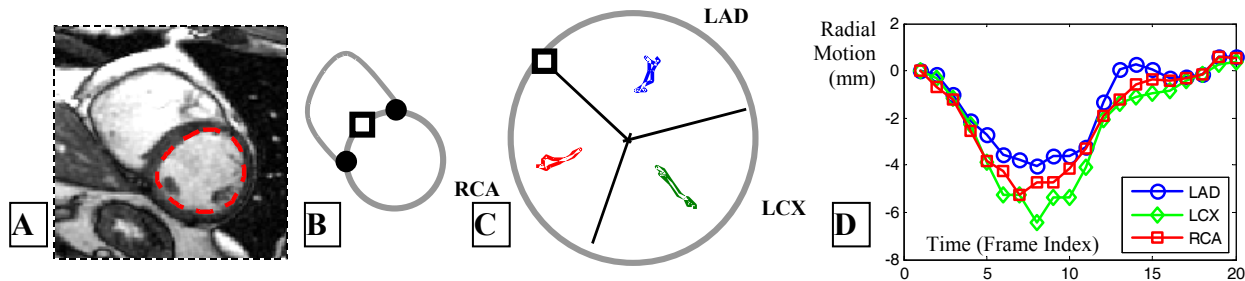


Figure 1. Diagram of three-segment center point trajectory approach. A, endocardium segmentation; B, rectangular shape indicates user chosen middle point between two hinged points of LV and RV; C, connect center of the chamber and the rectangular shape point to divide LAD and RCA; rotate the division 120 degree clockwise to define LAD, and rotate the previous division 120 degree counterclockwise to determine RCA; the remaining area is LCX; center point trajectory are calculated in each segment; D, after decomposing the motion in the radial direction, magnitude over time curves are shown in a normal volunteer.

## Results

Fig. 2. Three-segment center point trajectory radial motion time course of three patients (Fig. 2A, 2C, and 2E) showed consistent findings with delayed enhancement imaging about myocardial infarction at LAD (Fig. 2B), RCA (Fig. 2D), and global (Fig. 2F). In Fig 2A, it shows a 63-year-old male patient (ejection fraction: EF of 39%) with known chronic myocardial infarction in the left anterior descending artery (LAD) distribution with residual left ventricular dilation (68 mm). Note that this is associated with dyskinesia of the infarct regions with resultant reduction in resting left ventricular function. The magnitude of the maximum radial motion in LAD is 1.21mm versus 4.83 and 4.28mm in LCX and RCA. In Fig 2C, it shows a 78-year-old male patient with dilated left ventricular cardiomyopathy and marked reduction of function (EF 30%). The maximum radial motion in RCA is 1.15mm versus 3.11 and 3.75mm in LAD and LCX, respectively. Fig 2E shows the same 56-year-old male patient (EF 26%) with apical aneurysm of the left ventricle with hyper enhancement pattern on myocardial delayed enhancement imaging which is consistent with chronic myocardial infarction and diffuse multi-vessel coronary artery disease, which demonstrates reduced motion in all multiple segments. The magnitude of the maximum radial motions is 0.80, 0.91, and 0.19 mm in LAD, LCS and RCA regions. In a two-sample t-test performed between known diseased segments from patients and normal segments from healthy volunteers, the radial motion values of the patients were found to be significantly different ( $p=0.0009$ ) from that of the healthy volunteers. The 5 healthy volunteers had a measured radial wall motion of  $4.71\pm 1.27$  mm. All 6 patients had limited radial wall motion segment in the three-segment center point trajectory analysis ( $1.33\pm 0.79$  mm).

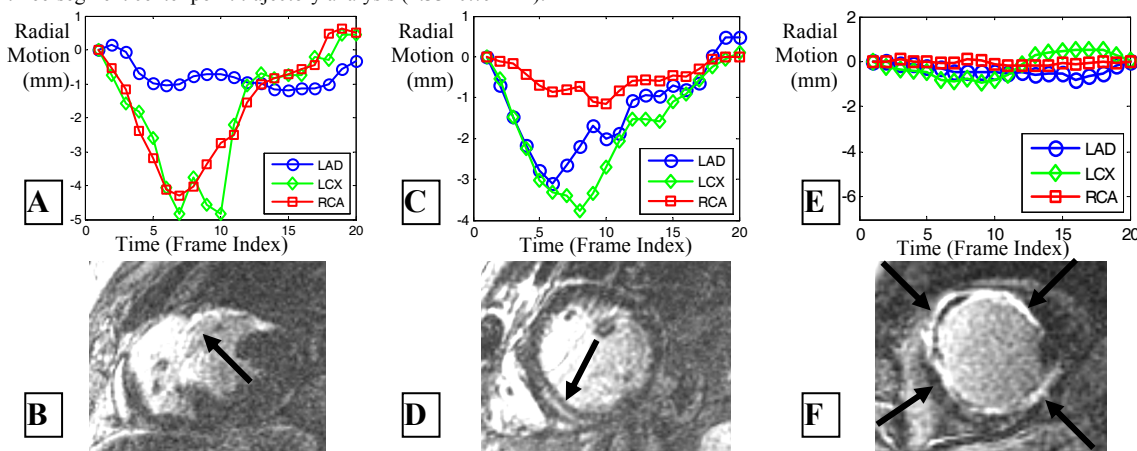


Figure 2. Three-segment center point trajectory radial motion time course of three patients (A, C, and E) showed consistent findings with delayed enhancement imaging about myocardial infarction at LAD (B), RCA (D), and global (F).

## Conclusions

A novel three-segment center point trajectory method for measurement of LAD, RCA, and LCX regional wall motion that uses standard cine MRI is presented. This automated post-processing method does not require any specialized image acquisition scheme or any specific operator-defined interaction. This method provides a simplified method to quantify regional wall motion in patients with suspected or known ischemic coronary artery disease.

**References** [1] Shihua Zhao, et al, Magnetic Resonance Imaging, Vol15, 8: 891-898, 1997