

Left Ventricular Wall Motion Abnormalities: Using Center Point Trajectory (CPT) Mapping to Quantify Focal Lesions

T. Song¹, J. A. Stainsby², M. N. Hood³, and V. B. Ho⁴

¹Applied Science Laboratory, GE Healthcare, Bethesda, MD, United States, ²Applied Science Laboratory, GE Healthcare, Toronto, ON, Canada, ³Radiology, Uniformed Services University of the Health Sciences and National Naval Medical Center, Bethesda, MD, United States, ⁴Radiology, Uniformed Services University of the Health Sciences and National Naval Medical Center, Bethesda, MD

Introduction

Quantification and in some cases identification of focal left ventricular wall motion abnormalities remains problematic. Visual inspection of echocardiography or cardiac MR images remains the current clinical gold standard [1, 2]. We investigate the feasibility of using a novel image-processing algorithm called Center Point Trajectory (CPT) mapping for quantification of focal left ventricular wall motion abnormalities. CPT analysis yields amplitude and direction values to define focal wall motion abnormalities. The technique uses standard cine SSFP images and does not require specialized MR pulse sequences (e.g. DENSE or myocardial tagging).

Methods

The CPT mapping method tracks the center point of the left ventricular chamber over time. It entails inhomogeneity correction, ROI selection, binary image segmentation, convex hull detection, polar coordinate contour smoothing, centroid calculation, and map generation. A total of 11 subjects were enrolled in this IRB-approved protocol and included 4 patients (average age: 61±15 years; 4males) with focal wall motion abnormalities but normal ejection fractions (EF; average = 59%±4%) and 7 healthy volunteers (average age: 46±12 years; 5males) also with normal EF. All patients with focal wall motion abnormality also had abnormal signal on T2 weighted imaging and/or myocardial delayed enhancement (MDE) imaging in the same region. Two-sample t-test was performed for both groups.

Results

CPT mapping was successfully performed in all subjects. Using short-axis 2D cine SSFP images, center point trajectory analysis demonstrated significant movement of the center point during systole in all 4 patients (CPT amplitude 6.72 ± 1.97 mm) versus the 7 healthy volunteers (CPT amplitude 2.74 ± 0.59 mm). The CPT amplitude values of the patients were found to be significantly different ($p=0.01$) from that of the healthy volunteers (Figure 1). The CPT maps in two patients with myocardial infarction of the anteroseptal wall of the left ventricle (Figures 2 and 3) provides an amplitude and angle of center point progression, which reflects the degree of focal abnormal wall motion during both systolic contraction (red), and diastolic filling (blue) of the left ventricle. In this case, the center point moves toward the hypokinetic anteroseptal wall. The CPT maps in the two other patients with myocardial infarction (Figures 4 and 5) reveal focal wall motion abnormalities of the hypokinetic basal inferoseptal wall (Figure 4) and hypokinetic anterior wall (Figure 5). CPT map shows consistent results with T2 weighted and MDE images.

Conclusions

A center point tracking method can provide a quantitative tool for characterization of focal wall motion abnormalities of the left ventricle. This novel method can potentially be used not only for the longitudinal detection of left ventricular wall remodeling but also quantification of systolic and diastolic wall motion changes. CPT can also be potentially used for detection and quantification of left ventricular wall motion during pharmacologic testing.

References [1] S. Chalil, et al, JACC 50(3): 243-52 2007. [2] J. Abraham, et al, Circ Cardiovasc Imaging 1:79-84 2007.

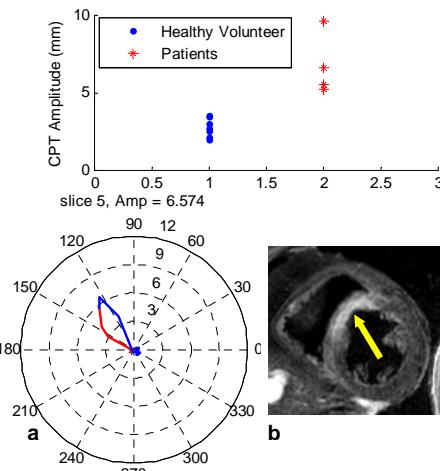


Figure 2. A patient with acute anteroseptal myocardial infarction CPT map (a) with corresponding T2 weighted image (b). CPT mapping demonstrates hypokinesis of the anteroseptal wall of the left ventricle as systolic movement of the center point towards the affected region.

Figure 1. Two-sample t-test evaluated CPT amplitudes on two groups revealed a significant difference between patients and healthy volunteers (p -value = 0.01). Column one is healthy volunteer's result; and column two is patient's result.

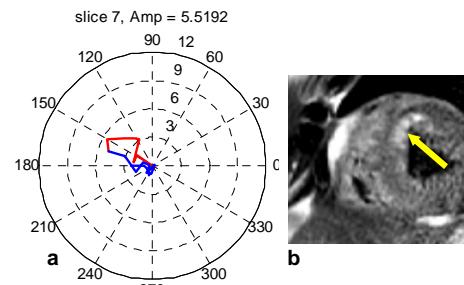


Figure 3. A patient with anteroseptal myocardial infarction CPT map (a) with corresponding T2 weighted image (b). CPT mapping demonstrates the same area as indicated by increased signal consistent with edema on T2 weighted image.

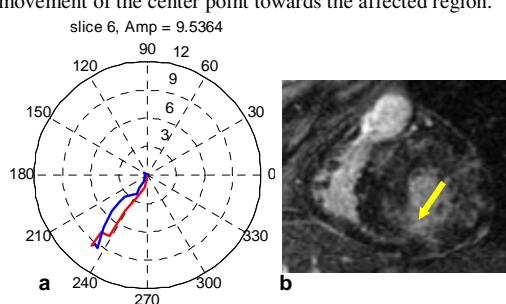


Figure 4. A patient with myocardial infarction CPT map (a) with corresponding MDE image (b) showing basal inferoseptal hypokinesis with positive MI.

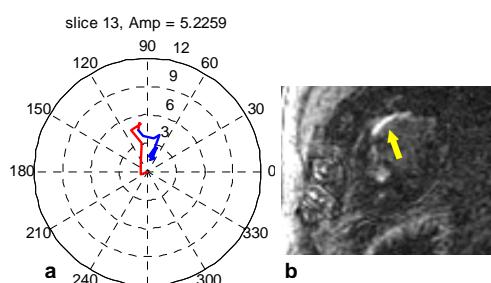


Figure 5. A patient with myocardial infarction CPT map (a) with corresponding MDE image (b) apical anterior hypokinesis with positive MI.