Center Point Trajectory Model for Cardiac Wall Motion Abnormality Assessment Compared with Echocardiography Strain

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Introduction

Proper identification and quantification of left ventricular wall motion is essential for clinical management of many patients with cardiac disease [1]. An efficient post-processing method that can be applied to currently acquired images would greatly benefit patient assessment without the added scanning time. We recently proposed a technique called center point trajectory (CPT) analysis to measure left ventricular wall motion [2]. In this work the feasibility and accuracy of this method is validated via echocardiography strain analysis and myocardial delayed enhancement images.

Methods

The method entails the tracking of the left ventricular center point of the left ventricle on 2D SSFP images over time. A polar coordinate map can then be derived based on the center point trajectory. The amplitude and angle parameters in the polar map provide a quantitative way to describe systolic (red) and diastolic (blue) wall motion. For validation purpose, transthoracic echocardiography were acquired with 2D strain maps derived from speckle tracking (GE healthcare, Waukesha, WI). Myocardial delayed enhancement images were also acquired as an alternative validation approach. Three patients with myocardial infarction (3 Male, 67±4 y/o, EF 54%±14%) and one healthy volunteer (1 Female, 51 y/o, EF 63%) were enrolled in this IRB approved study. On the echocardiography peak systolic strain map, the smaller the absolute value, the less the echocardiographic strain measurement, and the more abnormality in myocardial wall motion. Center point model mapping utilized standard short axis cine SSFP images (TR/TE 3.6/1.6ms; 224 x 224 matrix; 8 mm slice thickness; 1.25 x 1.25mm, 1 NEX; VPS 20; 20 phases).

Results

CPT analysis demonstrates significant movement of the center point in all 3 patients Figures 1-3 (a) compared with normal volunteer Figure 4 (a). The corresponding short axis T2 weighted or delayed enhancement positive images illustrating damaged myocardial tissue are illustrated in Figures 1-3 (b). The echocardiographic strain maps are shown in Figures 1-3 (c) and Figure 4 (c). Figures 1 and 2 are patients with myocardial infarction of the anteroseptal wall of the left ventricle. The CPT plot provides amplitude (5.5mm and 7.3mm) and angle of center point progression, which reflects the degree of abnormal wall motion during both systolic contraction, and diastolic filling of the left ventricle. In these two cases, the center point trajectory points toward the hypokinetic anteroseptal wall (arrow on the T2 weighted and myocardial delayed enhancement images (1b and 2b) and echocardiographic strain maps (1c and 2c)), which showed consistent findings from both modalities. Figure 3 shows a patient with myocardial infarction (CPT 7.2mm) of the anterior and anterior lateral wall (3b, arrow) with corresponding hypokinesis and an abnormal strain map clearly visualized on echocardiography. Figure 4 shows a normal volunteer without significant center point movement (2.7mm) on CPT and corresponding normal echocardiographic strain maps. Strain analysis from echocardiography showed consistent results and strong correlation with findings from the center point trajectory map.

Conclusions

The center point tracking method can provide a quantitative tool for wall motion assessment using conventional 2D cine MR images. CPT was able to distinguish areas of abnormal wall motion as well as correctly classifying normal wall motion. Moreover, CPT analysis provided quantitative measurement of wall motion that correlated well with 2D echocardiographic strain maps as the reference standard.

References [1] H Huang et al, Acad Radiol, 13:2006. [2] T Song et al, ISMRM 2009, pp 649

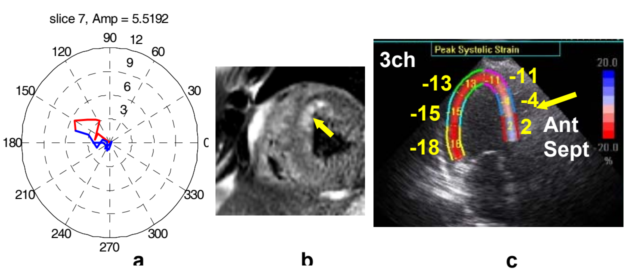

Figure 1. A patient with mid anteroseptal myocardial infarction. CPT map (5.5mm) (a) with corresponding T2 weighted image (b). CPT mapping demonstrates the same area (arrow) as indicated by increased signal consistent with edema on T2 weighted image; (c) Echocardiography strain map in 3-chamber view shows decreased strain in the same region (2 and 4 vs. 15 and18 in the inferolateral wall).

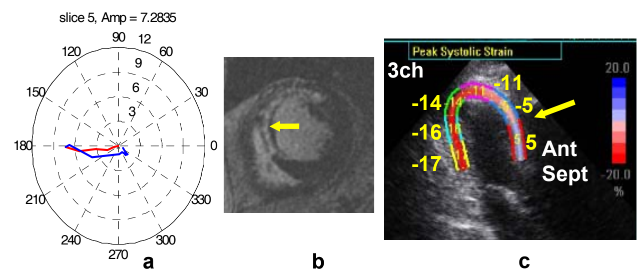

Figure 2. A patient with anteroseptal myocardial infarction CPT map (7.3mm) (a) with corresponding MDE image (b) anteroseptal hypokinesis with positive MI (arrow); (c) Echocardiography strain map in 3-chamber view shows decreased strain in the same region (5 vs. 16 and17 in the inferolateral wall).

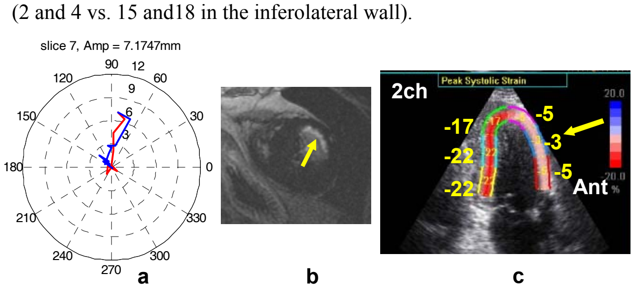

Figure 3. A patient with anterior and anterolateral myocardial infarction (arrow) CPT map (7.2mm) (a) with corresponding MDE image (b) showing anterior hypokinesis with positive MI. (c) Echocardiography strain map in 2-Chamber view shows decreased strain in the same region (3 and 5 vs. 22 in the inferior wall).

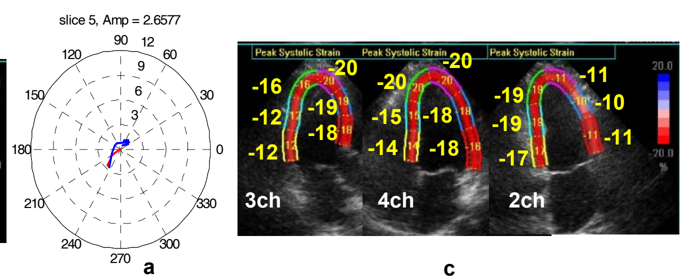

Figure 4. (a) A normal volunteer CPT map (2.7mm), (c) Echocardiography strain map in 3, 4, 2-chamber views.