Cardiovascular Magnetic Resonance Radial and Circumferential Strain: comparison between SSFP feature tracking, MRI tagging, and speckle tracking Echocardiography

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Target audience: This data has relevance to clinicians and researchers performing myocardial strain imaging by echocardiography or MRI techniques to quantitate myocardial deformation.

Purposes: Myocardial deformation imaging with strain imaging using speckle tracking Echocardiography (STE) now has been applied for routine clinical practice for follow up and monitor myocardial deformation. CMR strain using grid tagging (eg SPAMM or CSPAMM) can be applied for clinical deformation imaging but is limited by tag fading and time consuming, technically complicated analytic requirements. Consequently, CMR tagged is not widely used for clinical deformation imaging. Recently, feature tracking on standard steady state free precession imaging (SSFP–FT) has been developed for the assessment myocardial deformation. The purpose of this study was to compare circumferential and radial strain by feature tracking on SSFP cine CMR images as compared to SPAMM tagging technique and speckle tracking echocardiography.

Methods: 15 healthy volunteers (46 ±10 years, 7 male) underwent speckle-tracking echocardiography (STE) and comprehensive CMR protocol on a Siemens Aera 1.5T system; SSFP imaging for LV function and LVmass, myocardial tagging using SPAMM. Radial and circumferential strain (%) was performed and reported in AHA-16 segment model. SSFP–FT strain maps were performed using Circle Cvi42 Tissue Tracking prototype software (version 4.1.5 WIP) on standard LV short axis SSFP cine images at end-systole and end-diastole using the same, standard epicardial and endocardial contours as drawn for diastolic and systolic volume analysis –figure 1. Tagging SPAMM analysis was performed on identical location of LV slices using harmonic phase imaging (HARP). SSFP–FT, SPAMM, and STE agreement were calculated using Spearman rank correlation and Bland Altman-analysis (SPSS, V.20).

Result: Global peak systolic radial strain of SSFP–FT, SPAMM, and STE was 22±8%, 16±5% and 17±6, respectively. Global peak circumferential strain of SSFP–FT, SPAMM and STE was -16±3%, -16±5% and -17±2%, respectively. SSFP–FT circumferential analysis showed a good correlation with SPAMM HARP analysis ($r=0.91$, $p<0.01$) and STE ($r=0.83$, $p<0.01$). Female volunteers had a higher circumferential strain and lower radial strain compared to male volunteers ($p<0.05$), in concordance with previous publication 1. Analysis time was <1 minute in addition to standard LV contours which were performed for LVEF analysis, which is substantially shorter than analysis times published for SPAMM processing (~10 minutes per dataset). The complexity of post-processing was low. Inter-observer agreement was not measured in this feasibility study.

Discussion and Conclusion: CMR SSFP–FT measurements of radial and circumferential global strain show favorable agreement with tagged SPAMM and STE techniques in health volunteers. SSFP–FT is a feasible technique for quantification of circumferential and radial strain without having to acquire additional images for tagging, thereby reducing overall scan time. Post-processing time was rapid. Further studies are needed in pathologies with abnormal strain, and for agreement with other vendors' feature tracking algorithms.

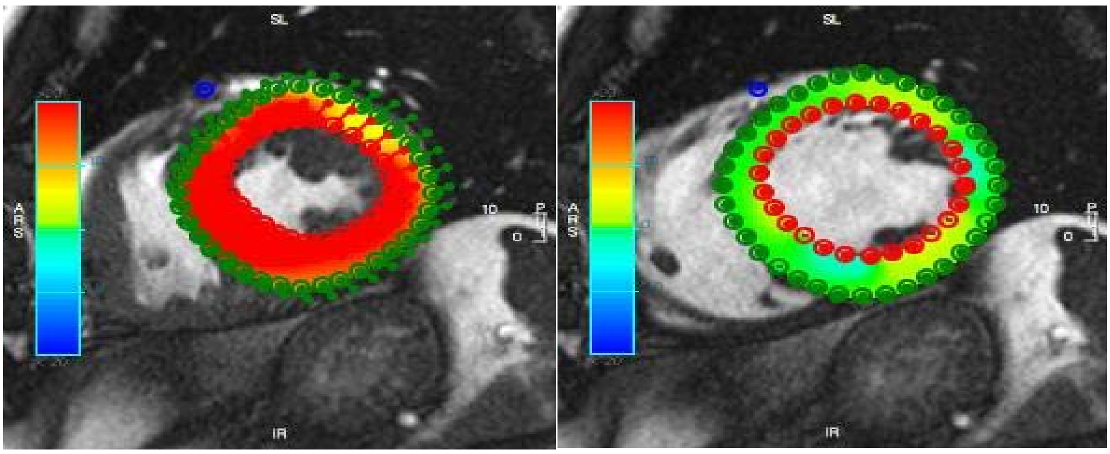

Figure 1: LV short axis image at end-systole (left) and end-diastole (right) with Tissue Tracking overlays (Circle Cvi42 Tissue Tracking prototype software, V.4.1.5 WIP).

Reference:

Sun JP, Lee AP, Wu C, et al. Quantification of left ventricular regional myocardial function using two-dimensional speckle tracking echocardiography in healthy volunteers--a multi-center study. Int J Cardiol. 2013. 167(2): 495-501.