Myocardial Tagging in the Polar Coordinate System; Initial Clinical Results

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Introduction: Cartesian grid tagging is frequently used for quantitative myocardial strain analysis, and the visual deformation of the grid can give clinical insight into regional contractility[1]. However, parallel straight lines are not ideal for representing curved displacements and on short axis images the resulting distortion rather than displacement of the lines make it difficult to visually isolate the radial and circumferential components of displacement and strain. This study evaluates the potential of a polar coordinate tagging system[2] for visualization and quantification of radial and circumferential myocardial displacement.

Methods: 28 subjects (10 healthy volunteers, 10 patients with congenital heart disease (CHD) and 8 with cardiomyopathy (CM)) underwent cardiac SSFP cine and myocardial tagging in the mid-ventricular short axis plane with grid tags (line separation 5-7 mm), circular tags (line separation 4-5 mm) and radial tags (11 lines per semi-circle; 18 degree separation) patterns. Visual assessment of radial and circumferential displacement was performed by two observers for each of the six mid short axis segments. Scores were assigned for: overall tag quality (4 point scale), strain (5 point scale; normal +2, hypokinesia 1, akinesia 0, mild dyskinesia -1, severe dyskinesia -2), confidence in the findings (3 point scale) and ease of interpretation (4 point scale). Quantitative analysis of circumferential and radial strains was performed using a semi-automated tool previously described[3]

Results: Healthy volunteers (see Figure 1) had the highest scores for tag quality, strain, confidence and ease of interpretation, followed by CHD and CM patients. Tag quality and confidence in strain assessment was not scored significantly differently among the three tag groups. However, polar tagging was easier to interpret (average 3.6) than grid tagging (average 2.9). Quantitative strain results in the polar tagging sequences showed diminished radial strain rate (1.19±0.26 sec^{-1}) among patients with CM (see Figure 2) when compared to volunteers (1.64±0.61 sec^{-1}).

Conclusions: Polar tagging has advantages for the visual and quantitative assessment of myocardial strain. Compared to conventional grid tagging, radial and circular tags are easier to interpret when looking specifically at radial and circumferential displacement. Overall tag quality, strain, confidence in assessment and ease of interpretation of the image were highest in healthy volunteers, second highest CHD patients and lowest in CM patients.

Figure 1: Images from a healthy volunteer. (A) SSFP Cine image in the mid ventricular slice (B) Cartesian grid tagging pattern (C) Radial tagging pattern (D) Circular tagging pattern.

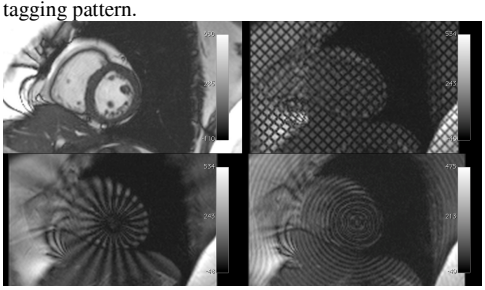
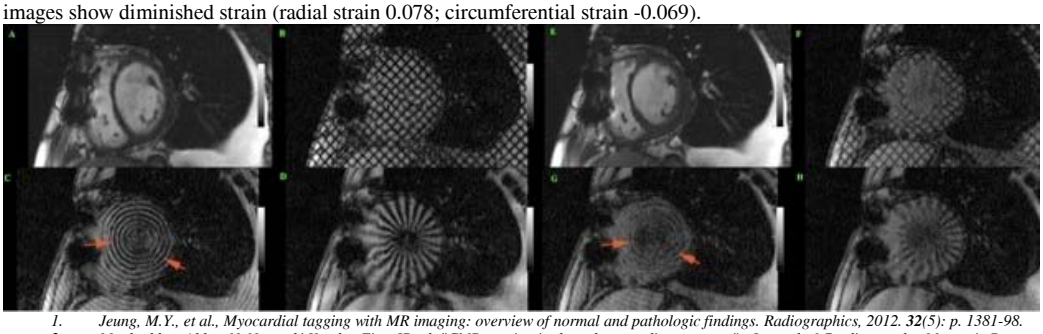


Figure 2: 53 year old CM patient with infarction affecting the septum and global ejection fraction 20%. Diastolic (left group of four) and systolic (right group of four) images show diminished strain (radial strain 0.078; circumferential strain -0.069).



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