Radial tagging for assessment of circumferential myocardial function

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INTRODUCTION: While cardiac tagging using spatial modulation of magnetization (SPAMM) for line and grid tagging of myocardium has been used in many clinical and translational research studies, it has not been adopted into routine clinical examination, in part due to complicated and often unreliable image processing. Myocardial tags applied in radial orientation using selective saturation bands may have distinct clinical advantages over SPAMM methods. The coordinate system of radial tags is well suited to the morphology of the left ventricle (LV) and may be preferred for circumferential assessment of myocardial function [1]. Early studies concluded that selective saturation and radial tagging were inefficient [2]. However, advances in system hardware may circumvent this shortcoming. In this study, we compared radial tagging to SPAMM grid tagging for efficiency and calculation of LV circumferential strain and rotation, and determined an optimal number of radial tag lines for efficiency and functional assessment.

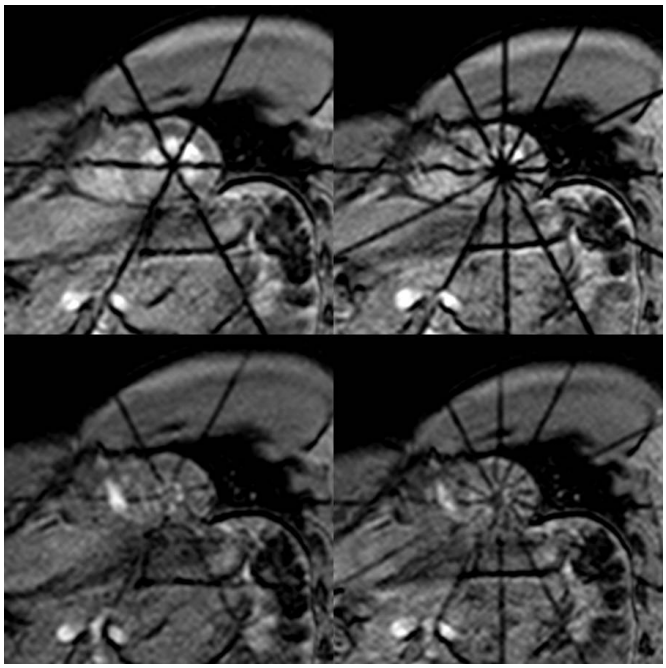

Figure 1. Images at end diastole (top row) and end systole (bottom row) with 6 and 12 radial tag lines.

METHODS: Five healthy volunteers (3 Male, age 30±3 years) were scanned under institutional review board consent on an Achieva 1.5T XR MR scanner using a 16-element phased array surface coil (Philips Healthcare, Best, Netherlands). Radial and grid tagging were performed using a cardiac triggered TFE sequence with TE/TR/α 1.8ms/4.2ms/15˚, slice thickness 8 mm, breath hold 15 sec, 2.0x2.0 mm resolution reconstructed to 1.25x1.25 mm and SENSE factor 1.4. Grid tags were applied with 7 mm spacing. Radial tags were 3 mm thick. The number of TFE shots was adjusted per subject to acquire 20 cardiac phases. For functional calculations, SPAMM grid tagged images were analyzed using HARP software (Diagnosoft, Maryland, USA) and radial tagged images were analyzed using custom MATLAB software. Statistical analysis (ANOVA with Tukey pairwise comparisons) was performed between all groups. Tagging efficiency was defined by the time of the earliest acquired cardiac phase and the tag persistence by observation.

RESULTS: Radial tags persisted longer than grid tags on average (557-597ms and 512ms, respectively). The average first acquired image frame ranged from 46-82ms for radial tags, with each additional tag line requiring 6ms, and 47ms for the grid tags. There was no significant difference in end systolic strain or rotation between radial tagged images (any number of lines) and grid tagged images. Figure 2 shows the mean difference in end systolic circumferential strain and rotation between the grid tags and each set of radial tags. The results calculated from 12 radial tags had the least variation in both measures compared to the SPAMM method.

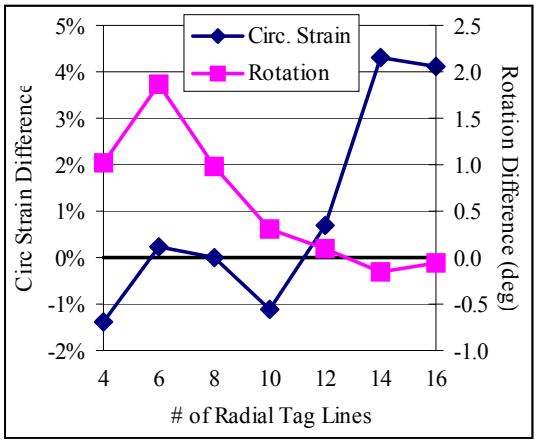

Figure 2. Difference in end systolic circumferential strain (blue) and rotation (pink) between grid and radial tagging.

CONCLUSION: For computing circumferential strain and rotation, radial tagging may be a fast and straightforward alternative to SPAMM tagging methods. Application of selectively saturated radial tags appears to be as efficient as SPAMM tagging, and has the potential for clinically reliable analysis. This method should be revisited as a clinically viable measure of circumferential myocardial function.

REFERENCES: 1) Bolster, et. al. Radiology (1990) 177:769-772.
2) Axel, et. al. Medical Image Analysis (2005) 9:376–393.