Detection of Myocardial Wall Motion Abnormalities Using Real-Time TSENSE

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Introduction:

Real-time cine imaging offers a number of important advantages over segmented, breath-hold acquisition techniques. Overall scan time is significantly shorter, breath-holding is not required, and the technique is insensitive to arrhythmia. However, real-time imaging sacrifices spatial and temporal resolution compared to a segmented, breath-hold scan. Previous studies have shown that global cardiac function parameters (EF, SV, mass, etc.) can be accurately determined by real-time imaging methods (1, 2). However, detection and grading of regional wall motion abnormalities may be more sensitive to decreased spatial and temporal resolution. Accurate assessment of regional myocardial wall motion is critical in the evaluation of cardiac patients. We hypothesize that the recently developed TSENSE parallel imaging technique (3), combined with SSFP, provides sufficient spatial and temporal resolution and image quality for accurate evaluation of myocardial wall motion without breath-hold or cardiac synchronization.

Materials and Methods:

Pulse sequences: Breath-hold cine imaging was performed with a segmented SSFP sequence accelerated x2 using GRAPPA (4), and real-time imaging with single-shot SSFP accelerated x3 using TSENSE. Segmented acquisitions used retrospective ECG gating and breath-holding; real-time imaging was done without cardiac synchronization or breath-holding. Each real-time slice was scanned for approximately 3 seconds. A summary of relevant parameters for both the real-time TSENSE and segmented retrospectively-gated sequences is provided in Table 1.

Table 1 – Real-time and breath-hold cine MR imaging parameters

	Breath-hold Cine	Real-time TSENSE
TR	2.7	2.4
TE	1.2	1.0
Flip Angle	80º	70º
Slice Thickness	8mm	8mm
Field of View (typical)	290mm x 360mm	270mm x 360mm
Matrix (typical)	156 x 192	80 x 192
Pixel Dimensions (typical)	1.9mm x 1.9mm	3.4mm x 1.9mm
Lines per segment	14	-
Temporal Resolution	38 msec	65 msec
Cardiac Synchronization	Yes, retrospective gating	No
iPAT Acceleration	GRAPPA x 2	TSENSE x 3

Data Acquisition: 27 patients (17 male, age 54±19 yrs.) with varying cardiac diseases (LVEF = 39±20, HR = 75±16) underwent assessment of left ventricular function on a 1.5T, 32-channel, whole body MRI system (MAGNETOM Avanto; Siemens Medical Solutions). Twelve elements of the body matrix coil were used. Real-time and breath-hold images were obtained in short-axis views at 10 mm intervals, as well as vertical and horizontal long-axis, and three-chamber orientations.

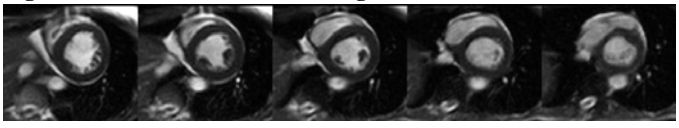
Data Analysis: Breath-hold and real-time images were analyzed by two observers unaware of patient identities. All breath-hold images were first scored, and then several days later all real-time images were scored to avoid any recollection of previous scores. Segmental wall motion was scored using the 17-segment LV model. Degree of segmental wall motion was agreed on by the two observers and graded on a five-point scale in which a score of 0=normal, 1=moderate hypokinesia, 2= severe hypokinesia, 3=akinesia, and 4=dyskinesia. A weighted kappa analysis was performed on each myocardial segment to determine the agreement between the two techniques.

Results: Imaging was successfully completed and good image quality (Figure 1) was obtained using the real-time TSENSE sequence in all patients. The median κ value for all 17 segments was 0.75, indicating very good agreement between the two methods. Quartile ranges and breakdown by base, mid, and apical sectors are provided in Table 2.

Table 2 – κ statistics for comparison of TSENSE and BH cine

	Base	Mid	Apex	Overall
Median κ	0.69	0.73	0.77	0.75
Quartile range	.58 - .76	.69 - .83	.73 - .81	.64 - .80

Figure 1 – Real-time TSENSE images at five short-axis levels.



Discussion: Breath-hold segmented imaging provides substantially higher spatial and temporal resolution than real-time imaging. However, the results of this study indicate that real-time TSENSE has sufficient resolution and image quality, to permit accurate visual assessment of segmental wall motion. Currently, real-time cine is primarily applied only in situations in which conventional breath-hold imaging is not feasible. Patients unable to cooperatively breath-hold, or with severe arrhythmia, may only be successfully imaged by single-shot and real-time techniques. These techniques continue to improve through novel acceleration methods like TSENSE, and the design of coils optimized for parallel acquisition. The data presented here, together with earlier work showing the accuracy of global cardiac function parameters, indicate that real-time imaging may be ready to assume a primary role in the assessment of regional and global cardiac function.

References:

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