UNFOLD-SENSE accelerated SSFP cine cardiac imaging: correlation of LV volumetric measurements with conventional SSFP cine

T. N. Sheth[1], B. Madore[2], R. Mulkern[2], M. Averbach[3], R. Kwong[3], F. Rybicki[1], E. K. Yucel[1]

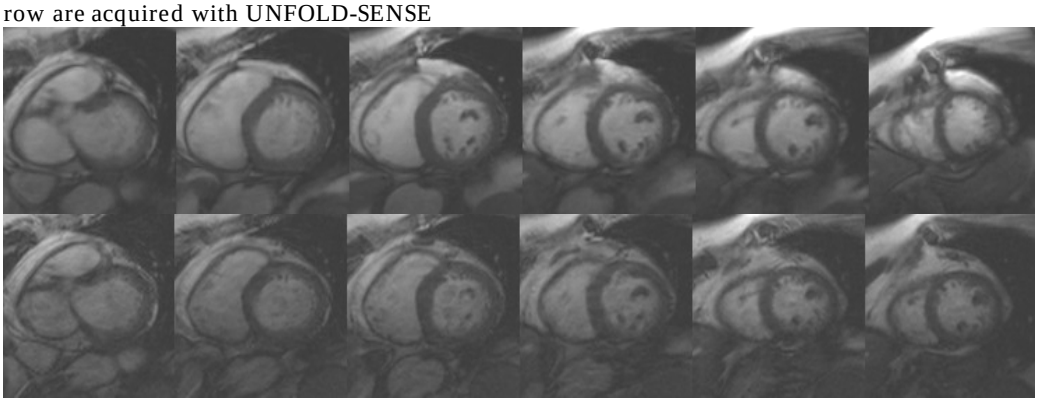
[1]Division of Cardiovascular Imaging, Department of Radiology, Brigham and Womens' Hospital, Boston, MA, United States, [2]Department of Radiology, Brigham and Womens' Hospital, Boston, MA, United States, [3]Cardiovascular Division, Department of Medicine, Brigham and Womens' Hospital, Boston, MA, United States

Purpose: In cardiac imaging, parallel techniques accelerate image acquisition. The greater speed can be used to achieve shorter scan times or to increase temporal resolution within the cardiac cycle. However, parallel imaging can cause an increase in artifact content. Most of these artifacts can be suppressed by UNFOLD (1). In addition, parallel imaging requires a separate calibration scan to determine the sensitivity profiles of the coil array. UNFOLD-SENSE is a parallel imaging method with artifact suppression and self-calibration (2) that may produce high-quality rapid clinical scanning. In this study, we used UNFOLD-SENSE to shorten breathhold duration. Our purpose was to verify that measurements of LV volumes and function are not adversely affected by the shorter technique.

Methods: Ten consecutive patients (3M, age range 30-86) referred for MR assessment (1.5T GE Medical Systems, Milwaukee, WI) of LV volumes and function underwent both conventional SSFP cine imaging (0.75 excitation, 0.75 rectangular field of view) and UNFOLD-SENSE SSFP cine (1 excitation, full field of view, acceleration factor 2.5) at the same imaging session. Because partial-Fourier imaging is not yet implemented in UNFOLD-SENSE but is used in conventional scans, the relative acceleration was reduced to 2.5x0.75x0.75=1.4. Both sequences used a gradient strength = 40mT/m and slew rate=150T/m/s with a 4 channel cardiac phased-array coil and were performed at the same short axis slice locations spanning the LV with matrix 192 x 160, FA 40, receive bandwidth 62.5 kHz, TR 3.4-3.7, TE 1.2-1.4, 32cm FOV, 8 mm slice thickness with no gap. Views per segment (VPS) was maintained at 16 but was reduced in the setting of elevated heart rates (>80 bpm). Images at each slice location were reconstructed for 30 phases/cardiac cycle. Approval was obtained from the hospital Institutional Review Board, and written informed consent was obtained from each patient. UNFOLD-SENSE uses on-line reconstruction on a 1.6 GHz PC with time roughly 3 times the scan duration (e.g. 30s reconstruction for a 10s breathhold acquisition). LV volumes and ejection fraction (EF) were calculated using manufacturer provided software (CINETOOL, GE Medical Systems, Milwaukee, WI). In endocardial border tracing, papillary muscles were included as part of the LV volume.

Results: There was no statistically significant difference in LV volumes or function between the two sequences. For conventional SSFP and UNFOLD-SENSE, the mean +/-SD for LV end-diastolic volume, LV end-systolic volume, and LVEF was 179cc+/-65cc, 88cc+/-54cc, 54%+/-14% and 171cc+/-60cc, 87cc+/-50cc, 53%+/-13%, respectively. Correlation coefficients were 0.98, 0.99, 0.99, respectively. As expected, qualitative evaluation showed the UNFOLD-SENSE images to be slightly more grainy.

Figure 1: Selected end-diastolic short axis images from a clinical case. Top row are images acquired with conventional SSFP, bottom row are acquired with UNFOLD-SENSE



Conclusion: Assessment of LV volumes and function obtained with conventional SSFP and UNFOLD-SENSE cine imaging are quantitatively equivalent. The artifact suppressed parallel imaging technique we employed may be of benefit in the clinical evaluation of patients when shorter and/or fewer breathholds are required. Alternatively, the method could be used to increase temporal resolution within the cardiac cycle.

1. Madore B. Using UNFOLD to remove artifacts in parallel imaging and in partial-Fourier imaging. Magn Reson Med. 2002 Sep;48(3):493-501.
2. Madore B. UNFOLD-SENSE: A self-calibrated parallel imaging method with artifact suppression. ISMRM 2002, p. 198.