TGRAPPA Accelerated Free Breathing Real-Time Cine Cardiac Imaging with a 32-Channel Coil

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Introduction:

Cardiac cine imaging is generally performed using a segmented k-space b-SSFP sequence, which allow acquisition of 1-2 slices per breath hold. While k-space segmentation does shorten acquisition times, it uses data acquired during many heartbeats to create a single cine loop, which can result in blurring in the presence of small variations in heart rate or in the position of the heart. In addition, breath holding is required, which may not be possible or practical for some patients. Real time acquisition techniques avoid these difficulties, and allow accurate measurement of global ventricular function, but do not have sufficient temporal resolution for evaluation of wall motion abnormalities, which is generally considered to be 45 msec. Parallel imaging techniques can be used to accelerate real time imaging; time sensitive generalized auto-calibrating partially parallel acquisitions (TGRAPPA) derive coil reference data by using adjacent time frames of an interleaved k-space acquisition scheme, thereby reducing acquisition times. However, these techniques can suffer a loss of SNR with higher acceleration factors. Coils and MR systems with multiple receiver channels allow higher acceleration factors with fewer artifacts.

Purpose:

To determine if the use of TGRAPPA accelerated real time cine b-SSFP images obtained using a 32-channel coil allows acquisition of cine images with sufficient temporal resolution for wall motion analysis, and to compare the images obtained to TPAT accelerated segmented k-space cine b-SSFP images obtained using both 32-channel and 8 channel imaging parameters and coils.

Methods:

Cine imaging was performed on five volunteers using a 32-receiver channel 1.5 T system (Avanto, Siemens Medical Solutions). A TPAT factor 2 accelerated segmented k-space TrueFISP sequence with an average TR = 45 msec and TE = 1.9 msec was used. The number of segments of k-space acquired per heartbeat was adjusted to maintain a TR of approximately 45 msec for the particular subject's heart rate. Images obtained using a standard body matrix phased array coil with 4 independent channels placed anteriorly, and 4 channels from a spine array placed posteriorly were compared with those obtained using an experimental 32-channel phased array coil (In-Vivo Corp., Orlando, FL) with 16 anterior and 16 posterior elements. Subjects were also imaged with a real time, free breathing TGRAPPA accelerated TrueFISP sequence with an average TR = 47, TE = 1.1 using the 32-channel coil, and an acceleration factor of 4, with acquisition matrix 192*280. The average acquisition time per cine slice was assessed, as well as the reader's confidence in assessing wall motion.

Results:

Images obtained using the standard (Fig. 1a) and 32-channel (Fig. 1b) coils at TPAT factor 2 had excellent image quality, with higher SNR in the 32 channel vs. 8 channel images. The time of acquisition per cine slice group was 1.65 sec in the TGRAPPA accelerated real time images vs. 10.8 sec for the 32 channel images, and 8.68 sec for the 8 channel images. No segment of the wall motion was obscured by parallel image artifact/noise. The real time cine images (Fig. 1c), while demonstrating parallel imaging artifact, were still felt to be evaluable for regional wall motion.

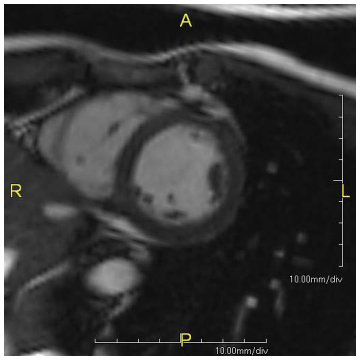

Fig. 1a

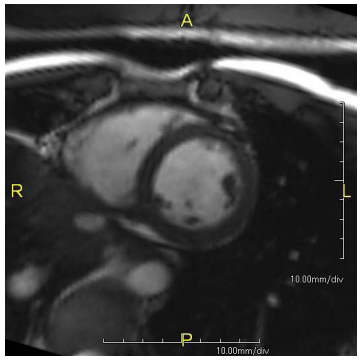

Fig. 1b

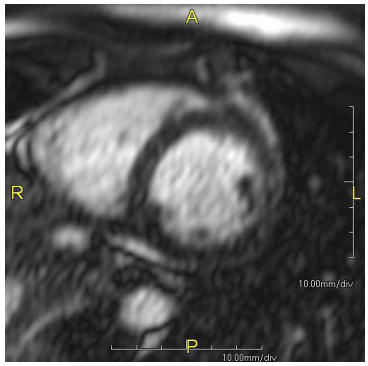

Fig. 1c

Conclusions:

Use of a 32-channel coil results in improved image SNR for the same segmented k-space cine sequence. Real time TGRAPPA 4 accelerated cine images, while suffering from diminished SNR as well as parallel imaging artifact, allow imaging with temporal resolution sufficient for wall motion analysis without k-space segmentation. These preliminary findings are encouraging, and further evaluation of this technology on patients with wall motion abnormalities will be undertaken.

Abstract Summary Statement: TGRAPPA accelerated real time free breathing cine imaging performed using a 32-channel coil allows satisfactory evaluation of wall motion in comparison to standard imaging techniques, with a TR approaching 45 ms. There is also improved signal in the 32-channel images.