A study of the spatial-temporal tradeoff in *k-t* BLAST reconstruction

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BACKGROUND *k-t* BLAST is a recently developed method[1] that exploits spatial-temporal correlations in dynamic imaging to accelerate acquisition. The acceleration is achieved through optimized packing of signals[2-4] in *x-f* space (reciprocal of *k-t* space) and by resolving any remaining aliasing in *x-f* space using prior knowledge acquired in a fast training acquisition. Applying this method to time-resolved gated cardiac imaging, scan-time reduction can be achieved without sacrificing spatial resolution in two ways : A) using *k-t* BLAST to achieve all of the acceleration or B) reducing the number of cardiac phases and using a lower acceleration factor for *k-t* BLAST. For example, a 5x scan-time reduction can be achieved with a 5x acceleration in approach A or a 2x acceleration with 2.5x fewer cardiac phases in approach B. In this work, we compare the two approaches using simulation and *in vivo* data. We compared with 2x acceleration because it was shown previously that if the acceleration was achieved solely by optimized packing in *x-f* space, 2x acceleration represented a practical limit for typical cardiac images[4].

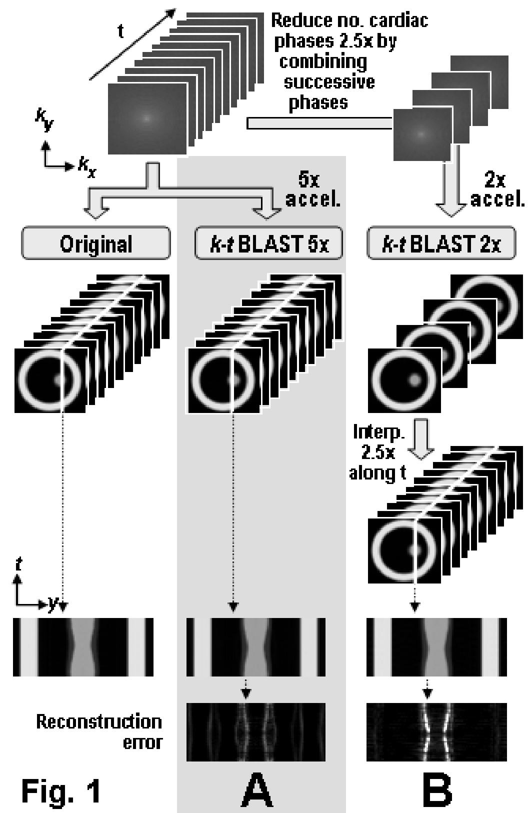

Fig. 1

MATERIALS AND METHODS The two approaches (A: 5-fold acceleration, B: 2-fold acceleration with 2.5 fewer cardiac phases) were evaluated using simulation and *in vivo* data. For simulation, a computer model was used, mimicking an idealized motion scenario with a contracting sphere inside a stationary cylinder. The wall of the sphere (i.e. the ventricular wall) was kept at constant volume during contraction. For the *in vivo* data, a set of fully sampled 2D images was acquired in a breath hold. Both the simulation and *in vivo* data contained 40 cardiac phases, and were decimated and reconstructed as illustrated in Fig. 1. Ten percent of the central phase encoding lines were used as training data for *k-t* BLAST reconstruction. In both approaches, optimized *k-t* sampling patterns were used for the respective acceleration factor. In approach B, the number of cardiac phases was reduced 2.5x by combining adjacent cardiac phases. Afterwards, the reconstructed images were sinc-interpolated back to the original number of cardiac phases.

For comparison, the difference between the original and the reconstructed images (i.e. the reconstruction error) was plotted as a function of phase-encoded position *y* and cardiac phase *t* for representative frequency-encoded position(s) *x* passing through the heart. Relative root-mean-square (RMS) reconstruction error was calculated at each cardiac phase as the RMS difference between the original and reconstructed images normalized by the RMS intensity of the original.

RESULTS The lower part of Fig. 1 illustrates the reconstruction error for one representative frequency-encoded position *x* in the simulated dataset. The 5x accelerated images (A) showed less artifact error than the 2x accelerated images with fewer cardiac phases (B). Mean / maximum relative RMS error were 0.8% / 0.9% for approach A and 1.6% and 2.5% for approaches A and B, respectively. Similar plots of reconstruction error for the *in vivo* data are shown in the Fig. 2 for two representative frequency-encoded positions *x*. Mean (and maximum) relative RMS error was 17.9% (22.5%) and 21.9% (29.7%) for approaches A and B, respectively. Note that approach A led to reduced artifacts, especially in regions with rapid changes (such as the aorta), which were problematic to reconstruct faithfully when fewer cardiac phases were acquired (B).

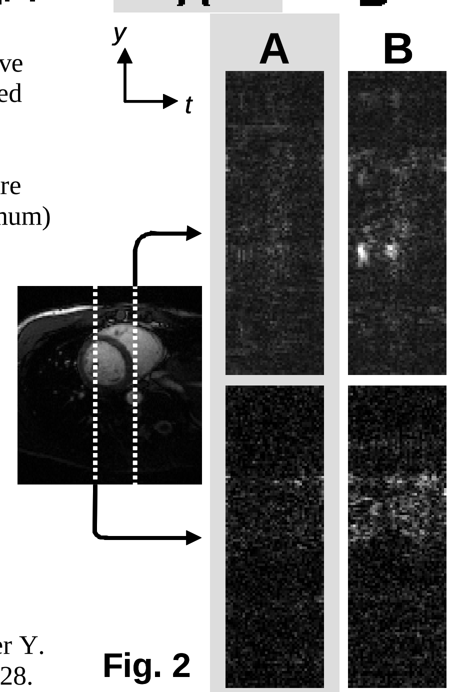

Fig. 2

DISCUSSION The use of higher acceleration offers the opportunity to trade off sampling in the spatial and temporal domains in a much more flexible manner. The implication of this flexibility was examined by comparing two approaches for achieving a net 5x scan-time reduction in gated cardiac imaging. The results showed that achieving 5x acceleration directly with *k-t* BLAST (A) caused less degradation of image quality compared to using a lower acceleration factor with fewer cardiac phases (B). In the present case, the overall image quality benefited from trading off some spatial sampling for some additional temporal sampling. This trade-off was made possible by the higher acceleration factor afforded by the *k-t* BLAST approach.

REFERENCES 1. Tsao J et al., Magn Res Med 2003; 50: 1031-1042. 2. Willis NP, Bresler Y. IEEE Trans Imag Proc 1995; 4: 642-666. 3. Madore B. Magn Reson Med 1999; 42(5): 813-28. 4. Tsao J. Magn Reson Med 2002; 47: 202-207.