METHODS

Quantitative Parameter Mapping

The effectiveness of the proposed method for accelerated T1 mapping was evaluated by retrospectively undersampling T1-weighted image acquisitions in the brain [32]. Imaging data for T1 mapping was acquired using an inversion-recovery, turbo spin echo sequence with turbo factor 8, in-plane resolution of 2×2 mm^2, matrix size 192×144, slice thickness of 3 mm, and inversion times of 150, 300, 600, 1000, 1500, and 2000 ms, with TR = 10000 ms. One slice of this data set was retrospectively undersampled at reduction factors of 2, 3 and 4, and was reconstructed using PS = 6, 8, 10, and 12. A fully-sampled, circular region with a 6-pixel diameter was retained in each 2D undersampling mask, while a set of 12 fully sampled central phase-encoding lines were retained in the 1D undersampling mask. The results from both CLEAR and LLR-IRPA were compared against the T1 maps computed from fully sampled data. For assessing mapping accuracy, nRMSE values and quantitative mapping quality were compared against those of the T1 map computed from the fully-sampled data.

To perform both CLEAR and LLR-IRPA reconstructions, multi-coil image data taken from multiple inversion times (TI) was reconstructed jointly, in which the four-dimensional image was unfolded along the coil dimension, i.e., local image features from different contrasts are assumed to be highly correlated along the coil dimension. This approach exploits the fact that images from different TI's and coil elements are correlated structurally, in addition to the correlation along the coil dimension.

RESULTS

Quantitative Parameter Mapping

T1 mapping results using 1D and 2D undersampling show similar results from both CLEAR and LLR-IRPA reconstructions. At a reduction factor of 2 (a relatively high reduction factor for 1D undersampling), one can observe that the T1 maps obtained from LLR-IRPA reconstruction remain close to the true map, which is a considerable result since block artifacts tend to be more pronounced in the multi-contrast formulation of the LLR problem (Fig. S5). As shown in Table SI, nRMSE values of T1 maps reconstructed with LLR-IRPA are consistently comparable to those reconstructed with CLEAR. In all cases, however, LLR-IRPA outperforms CLEAR in terms of total reconstruction time by a factor of approximately 3.

The block artifacts evident in the T1 map reconstructed with non-overlapping patches and the corresponding difference image are corrected to the same degree with both CLEAR and LLR-IRPA. In Fig. S4, the T1 map reconstructed with CLEAR displays the same minimal level of block artifacts as LLR-IRPA in the reconstruction, yet the block artifacts are less evident in the T1 maps reconstructed with non-overlapping patches due to the Poisson-disk undersampling pattern that encourages more incoherent aliasing artifacts, in contrast to the 1D undersampling case (Fig. S5). In both undersampling scenarios, the nRMSE values show that LLR-IRPA performs comparably and in some instances better than CLEAR, though the imaging results are similar.

TABLE SI: nRMSE results from T1 mapping using retrospective 1D and 2D undersampling, for various reduction factors (RF) and patch sizes (PS).

		RF=2		RF=3		RF=4	
	PS	CLEAR	LLR-IRPA	CLEAR	LLR-IRPA	CLEAR	LLR-IRPA
1D	6	4.19E-2	4.19E-2	6.10E-2	6.19E-2	6.75E-2	7.04E-2
	8	4.21E-2	4.12E-2	6.00E-2	5.94E-2	6.92E-2	6.83E-2
	10	4.26E-2	4.10E-2	5.95E-2	6.07E-2	6.83E-2	6.89E-2
	12	4.23E-2	4.49E-2	6.06E-2	5.97E-2	6.74E-2	6.84E-2
2D	6	2.51E-2	2.50E-2	3.34E-2	3.16E-2	4.20E-2	4.38E-2
	8	2.41E-2	2.62E-2	3.51E-2	3.34E-2	4.22E-2	4.02E-2
	10	2.47E-2	2.64E-2	3.44E-2	3.25E-2	4.18E-2	4.09E-2
	12	2.54E-2	2.40E-2	3.38E-2	3.21E-2	4.00E-2	4.10E-2