Pre- and postcontrast Three-dimensional Cardiac Cine MRI using SENSE and k-t BLAST

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INTRODUCTION

Cardiac MRI is useful for the assessment of both morphology and function of the heart. Two-dimensional (2D) cine cardiac MRI estimates the regional wall thickness and motion, volume of the left ventricular (LV) cavity, LV ejection fraction, and LV myocardial mass. One disadvantage associated with 2D cine MRI is a number of repeated breath-holds, which are required to cover the whole LV cavity in the short axis view. Three-dimensional (3D) cine MRI using rapid data acquisition methods can allow the whole LV coverage during a single breath-hold, but the correlation between 2D and 3D cine MRI on the quantitative data have been limited in the volunteers or small numbers of patients. The purpose of this study is to compare the data on some cardiac functions acquired using 3D cine MRI with sensitivity encoding (SENSE) or k-t broad-use linear acquisition speed-up technique (k-t BLAST) with those acquired using 2D cine MRI.

METHODS

Seventeen patients with acquired cardiac diseases were enrolled. MRI examinations were performed using a 1.5T unit with high performance gradient. A five-element phased-array coil and vector electrocardiography were used for signal reception and cardiac gating, respectively. Two-dimensional cine balanced turbo field-echo (TFE) imaging (TR, 2.8 ms; TE, 1.4 ms; FA, 60; slice thickness, 8 mm with 2 mm gap; 20 phases) was acquired in the short axis plane for the standardized evaluation of cardiac functions. Three-dimensional cine balanced TFE imaging (TR, 3 ms; TE, 1 ms; FA, 60; slice thickness, 10 mm with 5 mm interpolation; 16 phases) in the short axis plane was performed before and 5-10 minutes after gadolinium injection at the dose of 0.15 mmol/kg. For the 3D cine MRI, SENSE with a reduction factor of 3.24 (1.8 in y-direction x 1.8 in z-direction) was employed in 12 patients and k-t BLAST with a factor of 5-8 was employed in the five patients. The breath-holding time was 5-6 sec x 10-12 slices in 2D cine MRI, 24-28 sec for 3D cine MRI using SENSE, and 16-20 sec for 3D cine MRI using k-t BLAST.

The SNRs of myocardium and LV cavity and CNRs between the myocardium and LV cavity were estimated in 2D and pre- and postcontrast 3D cine MRI at end-diastole. The end-diastolic and end-systolic volumes (EDV and ESV) of the LV cavity, LV ejection fraction, and myocardial mass were also assessed in these cine MRI. The statistical differences and correlation on these quantitative data between 2D cine MRI and pre- or postcontrast 3D cine MRI were statistically assessed using paired t test and correlation analysis, respectively. A P-value < 0.05 was defined as significant.

RESULTS

The SNR of LV cavity was significantly higher than that of LV myocardium in all 2D and 3D cine MRI, which provided the good contrast between the myocardium and cavity. The use of gadolinium injection in the 3D cine MRI significantly increased the SNRs of LV myocardium and cavity ($P < 0.01$) and the CNR ($P < 0.05$), although the CNR of the postcontrast 3D cine MRI between the LV myocardium and cavity was lower than that of the 2D cine MRI ($P < 0.05$). There were significant correlations between 2D cine MRI and pre- or postcontrast 3D cine MRI for the EDV and ESV of the LV cavity, LV ejection fraction, and LV myocardial mass ($r > 0.90$).

DISCUSSION

Three-dimensional cine MRI combined with SENSE and k-t BLAST allowed the coverage of the whole heart and provided the 16-phase cine images for each slice within a single breath-hold. In particular, k-t BLAST shortened the breath-holding time to be 16 sec. Although precontrast 3D cine MRI showed acceptable contrast between LV myocardium and cavity and gave the functional data of the heart comparable to 2D cine MRI, the gadolinium injection improved the contrast in the 3D cine MRI. Therefore, the use of gadolinium may be recommended to compensate for the deterioration of imaging quality associated with the rapid MRI data acquisition techniques.

In conclusion, 3D cine balanced TFE MRI using SENSE and k-t BLAST provided cine cardiac images with the need of a single breath-hold, good contrast, and functional data of the heart comparable to 2D cine MRI.

REFERENCES 1. Jung BA, et al. MRM 48, 921-925, 2002, 2. Kozerke S, et al. MRM 52: 19-26, 2004