Evaluation of High-Resolution 3D Myocardial MR Delayed Contrast Enhancement Acquired During Free Breathing Using Realtime Motion Correction

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Background

Myocardial MR delayed contrast enhancement (DE) permits the extent and stage of myocardial infarction to be accurately evaluated, and there have been a number of reports discussing its effectiveness in the diagnosis of myocardial viability. Both 2D and 3D DE images are acquired using the inversion recovery (IR) method. Recently, the 3D method, permitting all 3D images within a single breathhold time, has gained widespread acceptance. However, image matrix or slice thickness is reduced so that 3D acquisition can be employed within a breathhold. More often the study may fail when the patient is unable to hold his or her breath, and the in-plane resolution and slice-direction resolution are insufficient. In this study, we proposes a method that permits acquisition of high-resolution images during free breathing using real-time motion correction (RMC) to overcome these limitations and also discusses the clinical usefulness of this method.

Materials and Methods

A total of 62 patients with clinically suspected myocardial infarction underwent DE examinations. All MR images were obtained using an Excelart XGS 1.5-T scanner (Toshiba), equipped with a QD Torso SPEEDER coil (8 channels). The imaging parameters of IR-3D FFE were TR = 5 ms, TE = 2.2 ms, number of segments = 3, TI = 250-300 ms, parallel imaging (SPEEDER) reduction factor = 1.8, matrix = 170*256, FOV = 350(350 mm, slice thickness = 5-8 mm, resolution = 1.0*0.7*2.5 mm, and combining with RMC (threshold range = 5 mm). Short-axis images of the left ventricle were acquired with a slab thickness of 100 mm during free breathing.

Differences in the visualization in terms of clarity of the margins of the infarcted region depending on the slice thicknesses was examined, as well as differences in the area of the infarcted region. The acquisition range was limited to cover only the area of each infarcted region and the slice thickness was varied to 10.0 mm, 7.5 mm, and 5.0 mm, within a single breathhold time.

In addition, differences in signal-to-noise (SNR) and clarity of the infarcted region depending on the in-plane resolution were evaluated as well as differences in the area of the infarcted region. Similarly, the acquisition range was limited to cover only the area of each infarcted region, and the resolution was set to 1.4*1.4 mm, 1.4*0.7 mm, and 1.0*0.7 mm, within a single breathhold time.

Results

The DE images obtained from all patients were evaluated. Acceptable image quality of DE images was achieved even in patients who had difficulty holding their breath. The acquisition time was 1 to 4 minutes. The results for the evaluation of slice thicknesses shows that as the slice thickness is reduced, the infarcted area is depicted with greater clarity and the area of the infarcted region becomes smaller, indicating less tendency to overestimation. In addition, such differences are greater at the apex of the heart than at the base. The results for the evaluation of in-plane resolution show that as the resolution is increased, the images show significantly clear but lower SNR in normal myocardium. However, no marked differences are observed in the area of the infarcted region.

These findings suggest that in order to accurately evaluate the extent and stage of infarction, increasing the slice-direction resolution by reducing the slice thickness is more effective than increasing the in-plane resolution.

Conclusion

The method described here permits images to be acquired during free breathing and can be performed with a high success rate in patients who have difficulty holding their breath. For the accurate assessment of the extent and stage of infarction, improving the slice-direction resolution by reducing the slice thickness is more effective, but with conventional breath-hold scanning, the improvement in resolution that can be achieved is limited due to the restricted acquisition time. Our proposed method permits acquisition of high-resolution images during free breathing and is considered to be an effective method for accurately assessing the extent and stage of infarcted regions.