High speed 3D CSPAMM

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Introduction

Tagging techniques have proven very valuable in extending the understanding of cardiac dynamics and have provided insights into alterations of cardiac motion associated with diseases (1). Recently a three-dimensional (3D) tagging technique for myocardial motion assessment was introduced to provide a true 3D description of cardiac tissue motion (2). Although this method has been shown feasible in volunteers, the large number of recurring breath-holds required for data collection has hampered the application in a larger study population. To accelerate the acquisition, the combination of 3D CSPAMM with k-t BLAST (3) acquisition has been suggested leading to a 2.5 fold scan-time reduction (4). In this work, we introduce a reduced sampling pattern which acquires only the eight signal peaks produced in k-space by 3D CSPAMM leading to a 9 fold acceleration of acquisition compared to the original acquisition scheme for 3D CSPAMM (2).

Methods

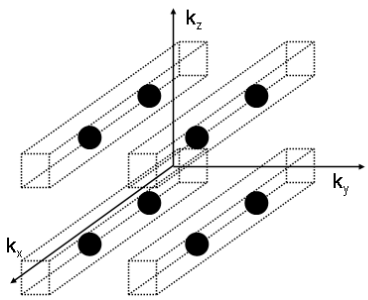

Figure1: *Reduced sampling pattern to acquire the signal peaks produced by 3D CSPAMM*

A 3D tagging pattern was generated using the 3D CSPAMM tagging technique as described elsewhere (2). After tagging preparation in three orthogonal directions with 8 mm grid-line separation, a 3D segmented EPI sequence was applied with FOV: 320x274x80 mm^3, matrix: 128x104x32, EPI factor: 11, T_R: 35 ms, T_E: 6.6 ms and 16 heart phases. This lead to the following positions in k-space for the eight signal peaks: *kx:* $\pm$ 20, *ky:* $\pm$ 20, *kz:* $\pm$ 5. The reduced sampling pattern included the acquisition of four times 33 ky-steps and 7 kz-steps around *ky*=$\pm$ 20, *kz*= $\pm$ 5 as shown in Figure 1. Four navigator controlled breath-holds of 21 RR-intervals duration each were performed to acquire the data. Reduced acquisition was implemented into the acquisition software of a Philips Gyroscan 1.5T system (Philips Medical Systems, Best, The Netherlands) and measurements were performed in a healthy volunteer. Data reconstruction was performed offline. Missing data were zero-filled and the data set was reconstructed to a matrix of 256x208x56.

Results

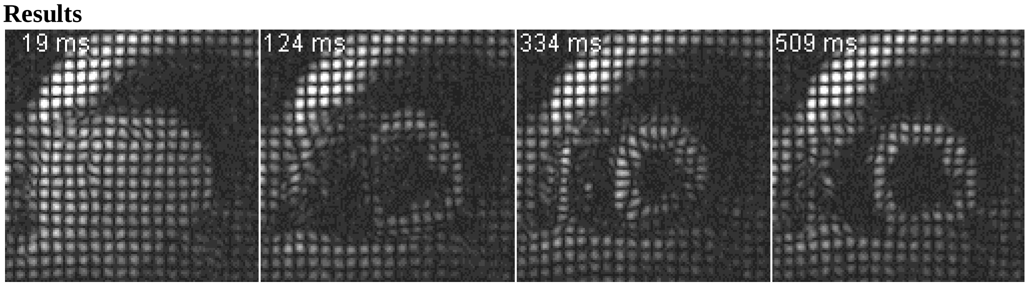

Figure 2: *Short axis cut through a 3D tagged myocardium. Four out of 16 heart phases are shown for the same spatial position (time after R-wave indicated). Due to the long-axis contraction, saturated material moves into the displayed plane at 124ms.*

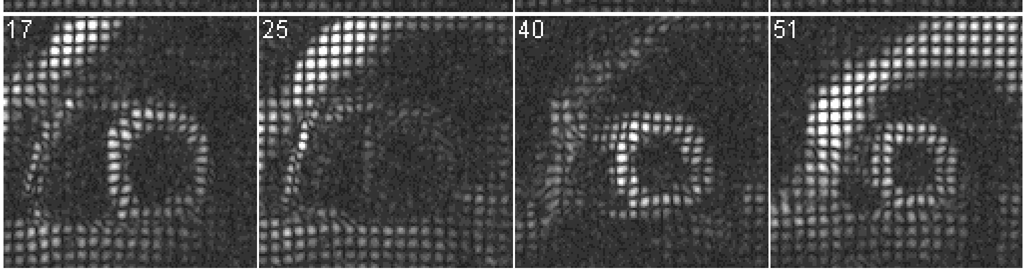

Figure 3: *Four out of 56 reconstructed slices at 474ms after R-wave. 17 is a basal slice, 51 a more apical slice. Some slices are saturated by the tagging pattern in the third dimension. Because of the long axis contraction the left ventricle is saturated whereas the chest-wall is visible in slice 25 and vice- versa in slice 40.*

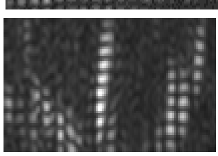

Figure 4: *Long axis cut through a 3D tagged myocardium 509ms after R-wave .Left ventricle at the right and right ventricle at the left side.*

Discussion

The acquisition of a 3D CSPAMM data set has been accomplished in only four breath holds using a reduced acquisition scheme. The acquired 3D tagging data have a good image quality allowing for the observation of short axis and long axis contraction. In combination with this reduced acquisition scheme 3D CSPAMM may become applicable in larger studies or in patients.

References

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2. Ryf S, et al., JMRI 2002; 16:320-325
3. Tsao J, et a., MRM 2001; 46:652-660
4. Ryf S, et al, Proc. ISMRM 2003