Kt-accelerated velocity-encoded black-blood MRI for quantification of myocardial motion at 3.0T

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Introduction

The analysis of myocardial contraction and relaxation demands high temporal and spatial resolution. Therefore any significant improvement in imaging speed, without sacrificing image quality is welcome since more volume can be covered in the same time. In this contribution kt-Blast [1] was applied to accelerate phase contrast velocity-encoded black-blood functional imaging of the heart. The quantitative results of the motion analysis were compared to the results from the conventional technique.

Materials and Methods

14 adult volunteers (7 females, 7 males, age 34 ± 10 yrs, heart rate 70 +/- 10 bpm) underwent kt and non kt accelerated segmented velocity-encoded black-blood functional imaging of the heart. All data was acquired at a whole body scanner (Achieva 3.0T, Philips, Netherlands) applying a vector ECG for cardiac triggering and respiratory gating by a conventional navigator approach. With either technique one short-axis view was acquired with a segmented gradient echo sequence at medial location. Acquisition parameters were: TE/TR = 3.9ms/ 6.1ms, resolution: 2x2x8mm^3, FOV 380mm, flip angle = 15°, 3 k-lines/segment, velocity encoding 30cm/s in all three spatial dimensions. For the kt-accelerated acquisitions, a kt-factor of 3 was applied. Black-blood contrast was achieved by the incorporation of saturation pulses located superior and inferior of the imaged slice [2]. For reduction of the SAR and hence for the acquisition of an adequate number of heart phases, the saturation pulses were applied alternating during subsequent cardiac phases and the maximum B1amplitude was reduced to 8 µT. The maximum number of heart phases ranges from 18 – 24 for a heartbeat range of 60 – 80 bpm. The scan duration for a single slice of the conventional sequence is 190s. Kt-appliance shortens the scan duration to 73s. Thus about 3 times more slices can be acquired. For comparison, the mean motion of the entire myocardium as well as the segmental motion was analyzed. For the segmental analysis, the myocardium was divided into four segments of 90° each.

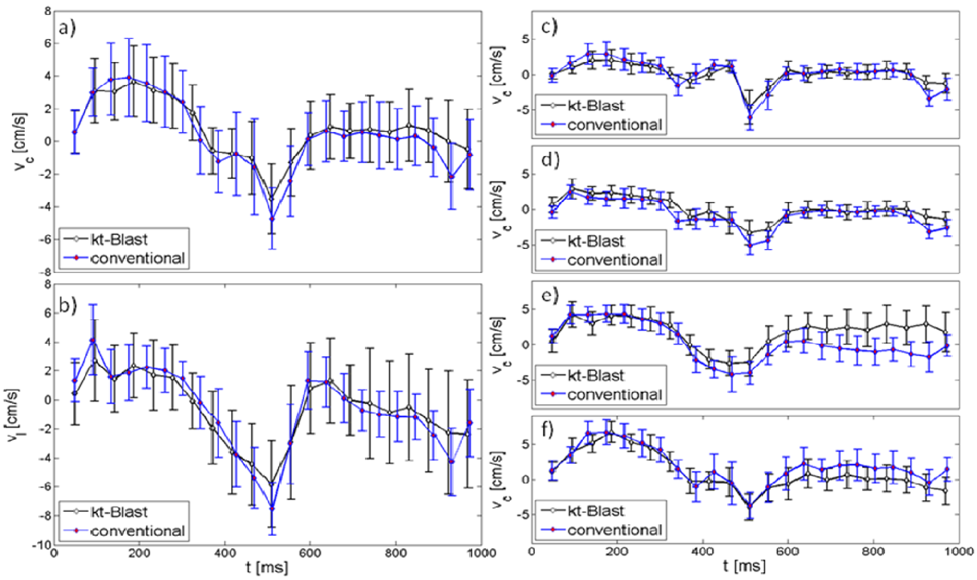

Figure 1: *Mean central movement v_c [cm/s] (a) and longitudinal movement v_l [cm/s] (b) versus time t [ms] and the respective segmental analysis of the central movement (c-f) for kt (black lines) and the conventional technique (blue lines).*

Results

Figs. 1a, b) show the central (a) and the longitudinal (b) velocity of the heart v_l and v_c [cm/s] relative to the R-wave [ms] exemplarily for one volunteer. Direct comparison of the resulting shape reveals an excellent agreement of the kt-technique with the conventional approach. The high standard deviations are introduced by the dependency of the myocardial velocity on its location on the myocardium. Segmental analysis substantially reduces the standard deviation as shown in Figs.1 c-f and clearly indicates the similar performance of the two investigated techniques for myocardial velocity assessment.

Discussion

The application of kt-accelerated black-blood velocity-encoded imaging for the assessment of myocardial motion is possible. Although some deterioration in image quality could be observed, the resulting quantitative information appears similar to the conventional approach. By applying kt-acceleration, an approximately 64% decrease in scan duration or a 2.6 fold increase in volume coverage respectively, could be obtained without loss of temporal resolution.

References

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