Whole-Heart Coronary Angiography at Isotropic Spatial Resolution: High SENSE Acceleration at 3T Utilizing a 32 Element Cardiac Receive Coil

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Introduction

Recently, dedicated cardiac phased array coils utilizing up to 32 independent receive channels have been introduced as prototypes [1,2] into cardiovascular imaging research. A possible paramount application arises in the field of reduction of image acquisition times by applying high parallel imaging factors [3,4]. The objective of this work was to evaluate the performance of a 32-element product cardiac coil for rapid whole-heart coronary angiography at isotropic spatial resolution using high parallel imaging acceleration.

Methods

Eight volunteers (mean age 39 +/- 7, 4 female, 6 male) underwent a whole-heart, respiratory navigator gated and corrected, T2-prepared cardiac triggered, segmented gradient-echo coronary MR-angiography. Acquisition parameters were as: TE/TR = 2.0ms/4.5ms, spatial resolution x,y,z = 1.3x1.3x1.3mm³, field-of-view (AP/RL/FH) = 270x270x120mm³, navigator acceptance window 6mm, excitation angle = 20°, T2-prep time 50ms. The diastolic rest phase was individually assessed to adapt the trigger delay and shot lengths (80-120ms) accordingly. All acquisitions were performed with a dedicated cardiac 32-element receive coil (4x4x2, InVivo, Gainesville, USA). In all volunteers parallel imaging undersampling was applied into phase-encoding (AP) and slice-encoding (FH) direction. The following combination of acceleration factors were tested AP/FH = (2/1.5),(2.5x2),(3x2.5),(3x3) and in one volunteer additionally (2.5x4). Resulting acquisition times were between 90s and 450s for a heart rate of 60bpm. All data were reformatted along the course of the proximal RCA, the left main, the proximal LAD and LCX. Quality of the resulting images was assessed by two readers on a 1-4 scale, where 1 indicates excellent IQ and 4 indicates poor image quality.

Results

Imaging could be successfully completed in all subjects. Example images for the different acceleration factors and the respective geometry factors are provided in Figure 1. In all volunteers sufficient image quality (mark 1 and 2) was achieved for all investigated segments applying an acceleration factor of up to 5. Acceleration factors of 7.5 yielded acceptable image qualities (mark 3). Even higher acceleration factors yielded insufficient image quality (mark 4) in those regions where the location of the coronary arteries coincides with those of poor geometry factors, which especially appeared limiting for volunteers with a thoracical AP extension exceeding 25cm.

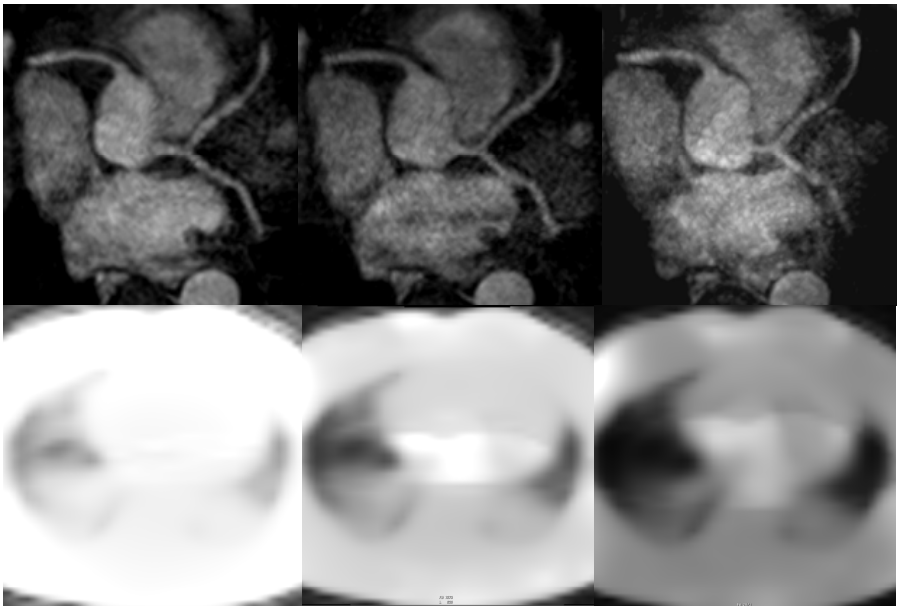

Figure 1: Images obtained with (AP/FH) – acceleration factors of (2/1.5) left, (2.5/2) middle, (3/2.5) and the respective geometry factors (bottom line)

Discussion

The application of a 32-element cardiac coil for whole-heart coronary angiography enables the use of high parallel image acquisition factors. Acquisition time reduction is limited by the increasing image degradation due to increasing geometry factors especially towards the center (see figure) between the anterior and posterior segment. Maximal possible reduction factors are limited by the coil geometry. Along AP direction a factor of 2 appears to be the limit especially for larger patients. In RL direction higher factors may be possible, but due to the larger extent of the patient the overall acquisition time can hardly be further reduced. Along FH direction, the factors appear to be limited to 3 or at most 3.5 depending on the field of view. For the 120mm used in this work, a factor of three provided reproducible image quality, whereas higher factors caused severe image degradation.

References

[1] Hardy et. al., MRM 2006;55:1142-1149 [2] Wintersperger et. al, JMRI 2006;23:222-227 [3] Niendorf et. al.; MRM 2006; 56:167-176 [4] Niendorf et. al. Eurp Radiol 2007