Quantitative assessment of right coronary artery MRI using quadrature RF coils at 7 Tesla, incorporating a direct comparison of results to those acquired at 3 Tesla.

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Introduction. Several studies showing the feasibility of high-field (7T and above) cardiac imaging have been demonstrated within the past year [1-5]. Many used sophisticated, custom-built transmit arrays with B1-shimming capabilities [1-3], but the use of relatively simple surface coils has also been shown to be practical [4,5]. To date, no quantitative analysis of high field cardiac images has been performed. The aim of this study was to perform right coronary angiography at 7T with quantitative analysis of several parameters important for clinical assessment. In addition, the same subjects were also scanned at 3T, using identical data acquisition parameters, and a statistical comparison was performed.

Methods. Ten healthy adult subjects (mean age 23 ± 3 years, 7 male) were studied at both 7 T and 3 T Philips Achieve systems (Philips Healthcare, Best, The Netherlands). A previous feasibility study of right coronary artery (RCA) angiography at 7T [5] used a single loop coil. This present study uses a quadrature double-loop transmit/receive surface coil, with the element diameter (13 cm) optimized to enable a 2D selective respiratory navigator to be reliably located at the lung-heart interface. At 3T, the body coil was used to transmit, with a commercial 6-element cardiac phased array coil used for signal reception. Sequence parameters at 3T and 7T were as similar as possible and were based on an established 3T protocol [6]: both used a 3D segmented k-space gradient echo imaging technique with a spectrally selective adiabatic inversion-recovery (SPAIR) module for fat saturation. The standard RCA protocol at 3T uses a T2-preparation module to increase image contrast [6], but this was not used at 7T due to conservative specific absorption rate (SAR) constraints: therefore, the 3T comparison scans contained one sequence with T2-preparation and one without. For visualization, curved reformatting with the 'Soapbubble' tool was utilized.

Results. Figure 1 shows curved reformats of an RCA obtained in a healthy subject at both 7T and 3T. Both the visual vessel delineation and the contrast between the coronary blood-pool and the surrounding fat are enhanced on the 7T image (Figure 1a) compared to the equivalent 3T image (Figure 1b). As expected the T2-prep sequence at 3T has the highest blood-pool/myocardium contrast, at the price of reduced SNR. Quantitative parameters from all subjects studied are listed in Table 1. There was no statistical difference between the SNR and vessel lengths or diameters, and the navigator efficiency (and hence total acquisiton time) was also the same. However, the measured vessel sharpness was significantly higher ($p<0.05$) at 7T.

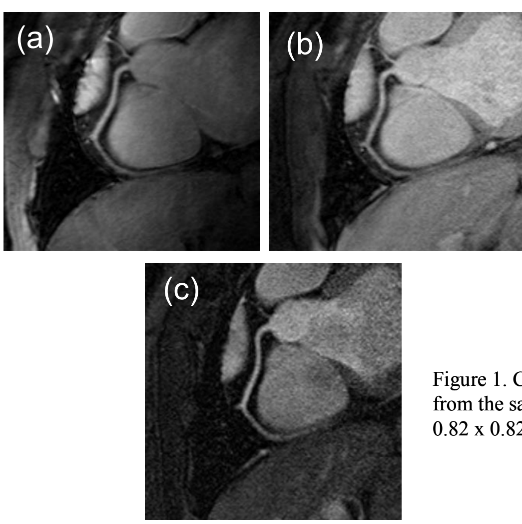

Table 1
(* signifies statistically significant difference from 7T)

	7 T	3 T(no T2prep)	3 T (T2prep)
SNR blood	44.8 ± 29.3	40.9 ± 11.4	26.9 ± 12.9
RCA vessel length (cm)	7.23 ± 2.34	7.99 ± 2.73	8.05 ± 1.64
RCA diameter, (mm)	2.94 ± 0.26	3.07 ± 0.37	2.76 ± 0.50
Vessel sharpness (%)	59.1 ± 8.7	48.9 ± 7.5*	66.1 ± 3.8

Figure 1. Comparison of (a) 7T, (b) 3T no T2-prep and (c) 3T with T2-prep RCAs from the same subject. TR/TE/FA 4.3/1.38/15°, data matrix 512x312, resolution 0.82 x 0.82 x 2 mm, 30 slices, TI for SPAIR 200 ms (7T), 150 ms (3T).

Conclusions. Within a relatively short period of development time, and using non-array RF technology, this quantitative study shows that 7T RCAs can already be acquired with image quality comparable to, and in some cases superior to, those using much more sophisticated RF coils at 3T. In the future, the use of transmit array technology [1-3] should allow not only improved coverage, but also reduced SAR to expand the range of imaging sequences and contrast enhancement mechanisms that can be performed.

References. [1] Vaughan J.T. et al. Magn.Reson.Med., 61, 244-248, 2009. [2] Snyder C. et al., Magn.Reson.Med. 61, 517, 2009. [3] Maderwald S. et al. Proc ISMRM, p 821, 2009. [4] van Elderen S. et al. Magn.Reson.Med., 2009, DOI: 10.1002/mrm.22168. [5] Versluis M et al. J.Magn.Reson., 200, 161, 2009. [6] Nezafat R et al. Magn.Reson.Med. 55, 858, 2006.