# Three-dimensional Breath-hold Coronary MRA: A Comparison Between 1.5T and 3.0T Using SSFP Sequence

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**Introduction:**

A preliminary study had showed the feasibility of coronary MRA using a conventional gradient-echo sequence at 3.0 T[1]. In theory, the signal-to-noise ratio (SNR) is doubled at 3.0T as compared to 1.5T, which can potentially benefit coronary MRA for improved spatial resolution or reduced imaging time. However, $B_0$ and $B_1$ field inhomogeneities tend to be more severe at 3.0T[2]. In addition, alterations in tissue $T_1$ and $T_2$ values deflect the linear relationship between SNR and the field strength. Steady-state free precession (SSFP) sequence has recently become the method of choice for coronary artery imaging[3]. Coronary MRA at 3.0T is particularly challenging because of its sensitivity to $B_0$ field inhomogeneity and the requirement for high flip angles. The purpose of this study was to assess the feasibility of coronary MRA at 3.0T and compare the SNR and contrast-to-noise ratio (CNR) of coronary MRA between 3.0T and 1.5T using a 3D breath-hold SSFP sequence.

**Methods:**

Eight healthy volunteers were scanned at both 1.5T (Sonata) and 3.0T (Trio) Siemens scanners. Both the left anterior descending (LAD) coronary artery and right coronary artery (RCA) were imaged in each study. At 1.5T, two 3D acquisitions were obtained for each volunteer, using the cardiac phased array coil and body coil as signal receiver, respectively. At 3.0T, five volunteers were imaged using the whole body coil only. The remaining three studies were done using a phased array cardiac coil when it became available for our 3.0T imaging system.

Coronary artery images were acquired using a segmented 3D, cardiac gated, breath-hold, SSFP sequence. The same imaging parameters were used at 1.5T and 3.0T, including: TR/TE = 4.1/1.7 msec, flip angle = 70°, readout bandwidth = 810 Hz/pixel, FOV = 237 × 380 $mm^2$, 31 – 45 lines/segment, matrix size = (122-179) × 512, slab thickness = 18 mm, number of partitions = 6 (12 after sinc-interpolation). Total imaging time for acquiring one slab was 24 cardiac cycles. Synthesizer frequency was adjusted when necessary to reduce obvious off-resonance artifacts[4].

Coronary artery SNR and CNR were measured and data were presented as mean ± standard deviation. Comparisons between different data sets were performed using a paired t-test.

**Results:**

Good quality coronary artery images were acquired at both scanners (Figure 1). SNR and CNR were significantly enhanced at 3.0T under the same coil configurations (Figure 2). Using the whole body coil as signal receiver, the coronary SNR and CNR at 3.0T (18.9 ± 6.7 and 9.7 ± 3.8) were significantly higher than those at 1.5T (10.1 ± 3.4 and 5.3 ± 1.8) (SNR: $P < 0.001$; CNR: $P < 0.001$). Using the phased array cardiac coils, SNR and CNR at 3.0T (34.8 ± 8.1 and 21.4 ± 6.7) were also markedly improved as compared to those at 1.5T (23.5 ± 4.5 and 11.1 ± 4.5) (SNR: $P = 0.004$; CNR: $P = 0.018$). Although it did not affect the delineation of coronary arteries, the signal distribution tended to be less homogeneous at 3.0T than at 1.5T, especially when the body coil was used. In summary, the overall improvements of coronary blood SNR at 3.0T over 1.5T were 86% using the whole body coil and 48% using the cardiac phased array coil.

**Conclusions:**

A direct comparison between 1.5T and 3.0T showed that coronary MRA is feasible at 3.0T using a 3D breath-hold SSFP sequence. Imaging at 3.0T substantially improved coronary SNR and CNR compared to 1.5T, although by a factor of less than 2. This study shows imaging at 3.0T has potential benefits to coronary MRA using SSFP, which warrants further technical improvements and clinical evaluation.

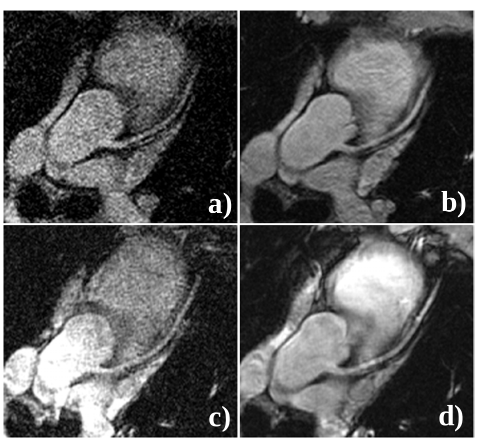


**Figure 1**: Example LAD images from one healthy volunteer at 1.5T and 3.0T.
**a)** 1.5T using body coil, **b)** 1.5T using phased array coil, **c)** 3.0T using body coil, **d)** 3.0T using phased array coil. Note the signal intensity and vessel delineation were improved at 3.0T under the same settings.

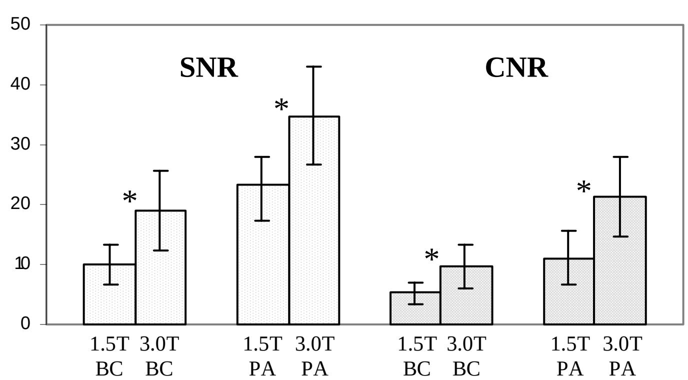


**Figure 2**: Results of SNR and CNR measurements from eight volunteers. Both SNR and CNR showed substantial enhancements from 1.5T to 3.0T using the same coil and protocol settings.
BC represents the whole body coil, PA represents the phased array cardiac coil.
***** Using the same coil and protocol settings, SNR and CNR were markedly improved at 3.0T.

**References:**

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