Coronary MRA on 3.0T

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3.0T has been shown to be a promising platform for coronary MRA. The SNR gain from 1.5T to 3.0T can be traded for improved spatial resolution and/or reduced imaging time. Nevertheless, the SSFP imaging technique that has gained wide acceptance at 1.5T is prone to imaging artifacts at 3.0T because of the increased magnetic field inhomogeneities and RF distortions at higher field strengths. In addition, energy deposition is increased by a factor of 4 from 1.5T to 3.0T.

Various measures have been developed to address the problems with SSFP imaging at 3.0T. These include: frequency adjustment to alleviate local B_0 field inhomogeneity induced image artifacts [1]; optimized phase encoding order to reduce flow and eddy current effects [2], localized shimming [3]; improved magnetization preparation schemes to ensure homogeneous excitation across the off-resonance range [3,4]; B_1-insensitive T2-preparation using an adiabatic refocusing sequence for uniform background suppression [5]; more power and time efficient RF pulses such as variable-rate selective excitation [6]. However, various compromises exist with these solutions, and SSFP coronary MRA at 3.0T has not yet achieved the same success as it has at 1.5T.

A recent study has demonstrated the feasibility of whole-heart coronary MRA at 3.0T with slow infusion of a high relaxivity clinical contrast media Gd-BOPTA [7]. Spoiled gradient-echo imaging is less sensitive to static and RF field inhomogeneities, and reduces RF power deposition and TR as compared to SSFP imaging. Contrast-enhanced data acquisition improves SNR and CNR. In a recent clinical study, sixty-two consecutive patients with suspected coronary disease underwent 3.0T contrast-enhanced whole-heart coronary MRA and x-ray angiography [8]. An ECG-triggered, navigator-gated, inversion-recovery prepared, segmented gradient-echo sequence was used to acquire isotropic whole-heart coronary MRA with slow infusion of 0.2 mmol/kg Gd-BOPTA. The diagnostic accuracy of MRA in detecting significant stenoses (≥50%) was evaluated on a per-segment, per-vessel, and per-patient basis, using x-ray angiography as the reference. In a subset of 25 patients who underwent both MRA and CTA, the diagnostic accuracies of MRA and CTA were compared. The MR examinations were successfully completed in 56 patients. Imaging time was 9.2 ±1.9 minutes. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of coronary MRA for detecting significant stenoses were 93% (85-97%), 97% (94-98%), 84% (75-91%), 99% (97-100%), 96% (94-98%), respectively, on a per-segment basis; 97% (84-100%), 87% (66-97%), 91% (77-98%), 95% (76-100%), and 93% (83-98%), respectively, on a per-patient basis. In the 25 patients imaged with both MRA and CTA, the sensitivity, specificity, and accuracy were 95% vs 98%, 96% vs 95%, and 96% vs 95%, respectively, on a per-segment basis. This study demonstrated that 3.0T contrast-enhanced whole-heart coronary MRA provides high sensitivity and specificity for detecting significant stenosis in patients with suspected coronary artery disease. The high negative predictive value suggests that MR can potentially be used to rule out significant coronary artery disease, similar to CT.

Further reduction in imaging time can be achieved by greater acceleration factors with 32-channel cardiac coils and/or echo-planar imaging. Improvement in spatial resolution is also required for better visualization of distal or branch vessels.

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