Continuous Gd versus Non Contrast for Coronary MRA
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Over the past 15 years, substantial advances have been made in the field of coronary MR angiography (CMRA). However, for successful CMRA imaging, sufficient contrast between the coronary lumen and the surrounding tissues is needed.

It is natural to generate contrast between coronary luminal blood and the surrounding tissue based on refreshing of the inflow blood with gradient echo techniques. The signal intensity on SSFP sequence is primarily determined by the T2/T1 ratio which makes it intrinsically beneficial for coronary MRA images without the need for MR contrast medium. SSFP sequences permit acquisition of large 3D axial volume that encompasses whole heart without losing arterial contrast in a few minutes. SSFP whole heart coronary MRA has become the method of choice for coronary imaging at 1.5T. However, the balanced gradient structure accumulates phases in each readout train, making it sensitive to phase error from complex flow in region with stenosis or local field inhomogeneities. Furthermore, due to increased image artifacts at 3.0-T with SSFP technique, further SNR gain has not been directly translated into improved coronary artery delineation.

Vessel contrast for CMRA can be further improved by administering a paramagnetic T1-shortening contrast agent to generate “bright blood” images. The blood signal becomes largely flow independent, which is important for the depiction of slow-flowing blood and the reliable detection of coronary artery stenosis. In order to assure adequate T1-shortening of blood, CMRA needed to be acquired during slow injection of the contrast agent. The major advantage of slow-injection, respiratory-gated coronary artery imaging is the relative flexibility in choosing TR, spatial resolution, and coverage. One major limitation is the reduced contrast-agent concentration in the blood pool, resulting in longer T1 as compared with dynamic scans with faster injection. In order to overcome the inherent limitations of these agents, MR blood pool agents have been developed due to the much higher T1 relaxivity and longer half-life in the blood pool. Several researchers have demonstrated that combining with an inversion prepulse to suppress myocardial signal intravascular agent allows for improved arterial contrast on 3D gradient echo CMRA with thick 3D volume.

Slow infusion of a high relaxivity agent allows prolonged blood enhancement time required for whole-heart MRA. Gadobenate dimeglumine (Gd-BOPTA, Bracco Imaging SpA, Milan, Italy) has a roughly twofold higher T1 relaxivity in blood compared to other clinical extracellular contrast agents currently in widespread use. The higher in vivo relaxivity and
prolonged half-life of Gd-BOPTA make it more suitable for 3.0T whole-heart CMRA\textsuperscript{4}.

Ultra-short TR and high acceleration factor allows significantly reduced acquisition time using contrast-enhanced CMRA at 3.0-T. Previous comparison study performed in the same volunteers has proved that contrast-enhanced CMRA at 3.0-T provides higher coronary artery CNR, better vessel depiction, and shorter imaging time than the SSFP approach at 1.5-T\textsuperscript{5}. In a later study, the blood-pool contrast agent gadofosveset was shown to improve the overall CNR and the delineation of distal coronary segments for contrast-enhanced CMRA at 3.0-T in comparison to non-contrast SSFP CMRA at 1.5-T\textsuperscript{6}.

Single-center study has proved that 1.5T whole heart CMRA can eliminate the need for diagnostic coronary catheterization in many patients at risk of coronary artery disease (CAD)\textsuperscript{7}. Very recently Sakuma has reported the first national multicenter trial with a 3-dimensional, navigator gated SSFP whole-heart CMRA sequence at 1.5-T\textsuperscript{8}. In this trial, sensitivity was 88%, specificity was 72%, and positive predictive value and negative predictive value were 71% and 88%, respectively. These results are in line with their published single-center studies.

Contrast-enhanced whole-heart CMRA at 3.0-T has emerged as a means of improving the CNR compared with non contrast-enhanced 1.5-T whole-heart CMRA. The diagnostic accuracy of 3.0-T contrast-enhanced whole-heart coronary MRA was evaluated in 69 patients with suspected CAD\textsuperscript{9}. The sensitivity, specificity, and accuracy of whole-heart CMRA for detecting significant stenoses were 94%, 82%, 89%, respectively, on a per-patient basis.

Due to the use of contrast agent and the inversion recovery pulse, high resolution 3D late Gadolinium enhancement images can be reconstructed from the same high spatial resolution CMRA images. This facilitates the 3D reformation in any slice orientation as well as precise quantification of the damaged tissue, thrombus and the direct association of the infracted territory to the respective coronary artery lesion.

References


