Magnetic Resonance Coronary Angiography Using an Intravascular Contrast Agent: T1 Time Course of Normal Myocardium and Blood

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Introduction:

Non-invasive magnetic resonance coronary angiography (MRCA) has become feasible using either breath-hold or navigator gated sequences. However, the diagnostic accuracy of current approaches remains insufficient for broad clinical use. Contrast-enhanced MRCA may overcome some of these limitations, but extracellular contrast agents provide improved signal-to-noise und contrast-to-noise ratios only for a short period of time following injection. Recently, intravascular contrast agents have been introduced, and several studies have shown that these compounds improve the diagnostic accuracy of MRCA. Due to the long plasma half-life time after a single injection, these compounds allow for multiple breath-hold or even multiplenavigator scans covering the entire coronary tree. To optimize the contrast between coronary arteries and myocardium, inversion recovery sequences are used with an inversion time set to null the signal intensity of the normal myocardium. The correct setting of the inversion time (TI) requires knowledge of the T1 times of the different tissues. To our knowledge, these T1 times have not been systematically investigated so far. The purpose of our study was to measure the T1 times of normal myocardium and blood following injection of an intravascular contrast agent (Gadomer, Schering AG, Berlin, Germany) in volunteers and patients.

Materials and Methods:

28 healthy volunteers (17 male, 11 female, mean age 28±4 years) and 6 CAD (6 male, mean age 61±9 years) patients were included in this study. All examinations were performed on a 1.5T MR scanner (Sonata, Siemens medical solutions, Erlangen, Germany). Long axis views were collected with a segmented inversion recovery steady state free precession sequence ("TI-Scout", TR 2.5ms, TE 1.1ms, FA 50°) generating images of a single slice with different inversion times 1, 5, 10, 15, 20, 25, 30, 35 and 40 minutes after injection of Gadomer (0.15 mmol Gd/kg body weight). Signal intensity measurements were performed in the LV cavity (cav) and the normal myocardium (myo) to define the inversion times resulting in the minimum signal intensity (TI_{min}). T1 values of myocardium and blood were calculated based on the standard formula $T1 = TI_{min} / \ln(2)$ for all time points. Additionally, breath-hold MRCA was performed using inversion recovery fast low angle shot sequences up to 40 minutes after injection.

Results:

Up to 15 minutes after injection, T1 times of blood (T1 cav) were below 100ms. Thereafter, T1 values increased over time from 125.3±9.8ms at 20min post injection (p.i.) to 204.1±12.3ms at 40min p.i. (Fig 1). The T1 time of normal myocardium (T1 myo) was 240.8±34.0ms 1 minute after injection followed by a minimum value of 190.1±19.8ms 10min (p.i.). Thereafter, T1 myo continuously increased over time (40min p.i. 281.7±18.3ms) (Fig 1). High quality MRCA data sets could be acquired within the first 15 minutes after injection, whereas thereafter image quality slightly decreased due to lower CNR values and blurring of the vessel walls.

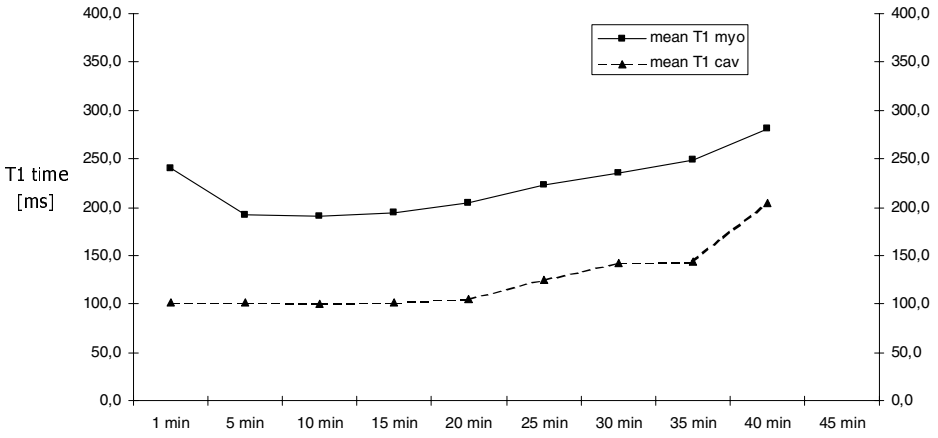

Fig 1: T1 time course for myocardium and blood pool.

Discussion:

The suppression of the myocardial signal is mandatory for 3D inversion recovery gradient echo MRCA and optimizes the contrast between blood and myocardium. Therefore, the correct setting of the inversion time is a prerequisite for diagnostic image quality. Our data show that a single injection of Gadomer results in low T1 times and, therefore, high vessel signal for about 15 minutes after injection. However, the T1 time of the myocardium changes significantly within the first 15 minutes after injection. Therefore the inversion time has to be individually adjusted to optimize the image quality. More than 15 minutes after injection, the T1 time of blood increases due to renal excretion and blurring of the contours occurs. This may be explained by enhancement of the vessel wall or extravasation of the contrast agent. We conclude that high quality MRCA can be acquired within the first 15 minutes after injection of a single dose of Gadomer.