LOW DOSE GADOBENATE DIMEGLUMINE IN DELAYED ENHANCEMENT CARDIAC MRI

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Introduction
Identification of myocardial viability utilizing delayed enhancement cardiac MRI (DE-MRI) is an established technique in the workup of patients with myocardial infarction. DE-MRI sequences have been routinely performed following the intravenous administration of 0.2mmol/kg of gadolinium based contrast agents (GBCA) and imaged after a typical time delay between 10 and 20 minutes. Recent data however, has shown diagnostic efficacy of using low-dose gadobenate dimeglumine (Gd-BOPTA) at 0.1mmol/kg compared to Gd-DTPA at 0.2mmol/kg following a time delay of 15 minutes (1). The reduction of effective total dose of GBCA is an increasingly important objective due to mounting evidence of the role of GBCA in the development of nephrogenic systemic fibrosis (NSF) in patients with renal insufficiency (2). The goal of this study was to determine the minimal efficacious post contrast delay times using low-dose contrast administration (0.1-0.05 mmol/kg Gd-BOPTA) and to evaluate parameters, which can modulate these results.

Methods
We retrospectively reviewed DE-MRI studies obtained for myocardial viability during 2008. Only patients with new onset of chest pain within 14 days of admission and electrocardiogram findings suspicious for myocardial infarction were included. The MRI studies were performed on a 1.5 Tesla magnet utilizing a multichannel cardiac surface coil. DE-MRI was performed with breath-hold 2D inversion-recovery T1-weighted gradient-echo sequences (TR=3.8 msec., TE 1.6 msec., Flip angle=15 degrees, Voxel size=1.3x1.3x10mm). Patients with glomerular filtrations rates (GFR) greater than 60 ml/min/1.73m2 were administered 0.1mmol/kg Gd-BOPTA whereas patients with GFR between 30-60 ml/min/1.73m2 were sometimes administered 0.05mmol/kg Gd-BOPTA. Following the intravenous administration of contrast, a short axis view of the mid left ventricle was obtained with a range of inversion times. The optimal inversion time was selected when signal of the majority of the myocardium was nullified. This was followed by a set of short axis viability images from the base of the left ventricle to the apex, and was defined as the early data set. At the completion of this first data set, the optimal inversion time was re-determined and second of set of delayed viability images were obtained which was defined as the late data set. The presence of contrast enhancement, which involved the subendocardium was defined as an infarct pattern and was further classified as transmural versus non-transmural. The degree of signal suppression of normal myocardium was graded: 1=complete suppression, 2=partial suppression and 3= non-suppression on all data sets. Coronary arteriogram findings, Troponin T levels and ejection fraction was recorded for each subject.

Results
A total 37 patients met inclusion criteria (24 males, 13 females, average age =59 years). 32 patients completed both early and late DE-MRI data sets. 5 patients completed only a late DE-MRI data set. The early data set was acquired between 3 and 14 minutes (ave. =5.7±2.4) (see black arrow Chart 1) and the late data set was acquired between 9 and 29 minutes (ave.=15.2±4.5) (see blue arrow Chart 1). A total of 31 patients had transmural infarcts and 6 patients had non-transmural infarcts. The electrocardiogram matched the location of significant infarct in 34 patients (92%). In 2 of the remaining patients there was 100 % vessel occlusion in the matching coronary artery distribution. Only 1 patient (3%) did not confirm the location of the infarct on either angiography or electrocardiogram. The grade of myocardial suppression was significantly different (p=0.0006) between the early data set (ave.=2.2) and late data set (ave.=1.4). Only 1 non-transmural infarct (17%) was visualized in the early data set compared to 22 of the transmural infaracts (69%). All DE-MRI sequences obtained in the late data set had complete delineation of the infarct whereas 10 studies (31%) obtained in the early data set were not visualized (see Chart 1). A total of 17 patients (46%) had Troponin-T levels above 1.0ng/mL. 12 patients (71%) with Troponin T levels above 1.0ng/mL had visualization of infarction on the early data set compared to only 11 patients (55%) with Troponin T below 1.0 ng/mL see (Chart 2) which trended toward significance (p=0.014). There was no significant difference (p=0.53) of ejection fractions between the infarct positive early (49±10.1%) and late data sets (46.8±11.0%) (see Chart 3). Transmural and non-transmural infarcts were visualized in the late data set in 2 patients who received only 0.05 mmol/kg Gd-BOPTA.

Discussion/Conclusion
The use of relatively high dose of GBCA to achieve adequate CE-MRI studies is being supplanted by protocols utilizing lower amounts of GBCA due to concerns over the association NSF with high doses of GBCA (2). Our results show that 0.1mmol/kg of Gd-BOPTA DE-MRI studies can be performed reliably after a minimum time delay of 10 minutes from injection, which is earlier than previously described (1). Although further studies will need to be performed, initial data suggests that DE-MRI with 0.05mmol/kg Gd-BOPTA may also be effective in visualizing both transmural and non-transmural infarctions further reducing contrast dose in at risk patients for NSF. Evaluation of potential modulating factors has shown that optimizing inversion times to suppress myocardial signal was problematic in early data sets due to non-uniform contrast enhancement of normal myocardium, which resolved in the later data set. This inhomogeneous enhancement tended to obscure non-transmural infarctions in the early data set. Cardiac function as measured by ejection fraction did not have any significant effect on visualizing infarctions at shorter time delays. Elevated Troponin-T levels greater than 1.0ng/mL was the only parameter, which indicated a potential trend towards detection of infarction at shorter time delays.

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