Chapter 8

Scar tissue on delayed contrast-enhanced magnetic resonance imaging predicts left ventricular remodeling after acute infarction
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TA Kaandorp, HJ Lamb, EP Viergever, D Poldermans, E Boersma, EE van der Wall, A de Roos, JJ Bax
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Introduction
Coronary artery disease is the leading cause of death in the Western world and the annual incidence of acute myocardial infarction in the USA is 865,000. A substantial percentage of patients develop left ventricular (LV) dilatation (remodeling) after acute myocardial infarction, resulting in heart failure, which is associated with high morbidity and mortality. Aggressive medical therapy may prevent or halt LV dilatation, and early, accurate identification of patients at risk for LV dilatation is essential.

Quantification of infarct size may be useful for identification of patients after acute myocardial infarction at risk for LV dilatation. Delayed contrast-enhanced magnetic resonance imaging (MRI) is a reliable and reproducible technique that allows precise quantification of the amount of scar tissue; moreover, the spatial resolution of MRI permits delineation of the transmurality of the infarction. Accordingly, the value of delayed contrast-enhanced MRI to predict LV dilatation after acute myocardial infarction was evaluated in a consecutive cohort of patients after acute myocardial infarction.

Methods
The study population consisted of 29 consecutive patients with a first acute myocardial infarction, documented by typical chest pain lasting >30 minutes, elevated creatine kinase-MB protein and/or troponin-T and typical electrocardiographical changes. All patients had sinus rhythm; patients with pacemakers and intracranial clips were not included. The study protocol consisted of a cine MRI at rest performed within 1 week after acute myocardial infarction (6 ± 3 days), to evaluate LV volumes and left ventricular ejection fraction (LVEF). Next, delayed contrast-enhanced MRI was performed to evaluate scar size (expressed in grams as well as percentage of the LV). LVEF and volumes were re-assessed by cine MRI at 9 months follow up. Each patient gave informed consent to the study protocol that was approved by the local ethics committee.

A 1.5-Tesla MRI system (Philips Medical Systems, The Netherlands) with 5-element synergy coil and vector electrocardiographic gating were used. The entire heart was imaged in short-axis view during multiple 15-second breath-holds, using a Steady-State Free-Precession (field of view 400 x 400 mm, matrix size 256 x 256, slice thickness 10.00 mm). MRI images were analyzed on a remote workstation. Left
ventricular end-systolic volume (LVESV) and left ventricular end-diastolic volumes (LVEDV) were calculated using MASS software (Medis, The Netherlands). Clinically meaningful dilatation was defined as >10% increase in LVEDV at 9 months follow up as compared to baseline values. Delayed contrast-enhanced images were acquired approximately 15 minutes after bolus intravenous injection of Gadolinium-DTPA (Magnevist, Schering/Berlex, Germany, 0.15 mmol/kg) with an inversion-recovery gradient echo sequence (inversion time of 220 to 280 ms, field of view 400 x 400 mm, matrix size 256 x 256, slice thickness 5.00 mm); inversion time was determined using real time planscan. To quantify the precise amount of scar tissue, hyperenhanced areas were manually traced on the short-axis images. Scar tissue was expressed in grams and as percentage of the LV.

Continuous data were expressed as mean ± standard deviation and compared using the two-tailed Student’s t test for paired data when appropriate. Relations were determined using linear regression analysis. Receiver operating characteristic (ROC) curve analysis was performed to assess the optimal cut-off value for the amount of scar to predict LV dilatation (>10% increase in LVEDV). Multivariate analysis was performed to identify the predictors of LV remodeling. A p-value <0.05 was considered statistically significant.

Results
A total of 29 patients (27 men, mean age 47 ± 11 years) with acute myocardial infarction were included; 48% patients exhibited pathological Q waves on the electrocardiogram (ECG). According to the ECG and regional wall motion abnormalities on cine MRI, the location of infarction was anterior in 45%, inferior in 52% and lateral in 3%. Treatment for acute myocardial infarction included percutaneous coronary intervention and/or thrombolysis in 80%, whereas 20% of patients were treated conservatively. Medication after acute myocardial infarction included β-blockers in 94%, angiotensin-converting enzyme inhibitors/ angiotensin-receptor blockers in 83%, statins in 97% and aspirin/ oral anti-coagulants in 93%.

The LVEDV increased significantly from 200 ± 29 ml to 207 ± 37 ml (p<0.01); conversely, LVESV decreased from 104 ± 27 ml to 97 ± 30 ml (p<0.01) with a resultant increase in LVEF from 48 ± 8% to 54 ± 9% (p<0.01). A strong relation existed between the extent of scar tissue and the change in LVEDV (Figure 1).
Figure 1. The relation between scar tissue (A, in grams; B, as percentage of left ventricle) and change in left ventricular end-diastolic volume (LVEDV).

ROC curve analysis revealed that a cut-off value of 36 gram scar tissue on delayed contrast-enhanced MRI yielded a sensitivity of 100% with a specificity of 95% to detect an increase in LVEDV >10%. Next, ROC curve analysis revealed that a cut-off value of 23% scar in the LV, yielded a sensitivity of 95% and specificity of 95% to detect an increase in LVEDV >10% (Figure 2). Multivariate analysis identified the extent of scar tissue on delayed contrast-enhanced MRI as the single best predictor of LV remodeling.
Figure 2. ROC curve analysis on the detection of left ventricular dilatation (>10% end-diastolic volume). (A). Scar tissue in grams; (B). Scar tissue as percentage of left ventricle on delayed contrast-enhanced MRI.
Discussion
The available studies in the literature have focused on prediction of functional recovery, and demonstrated that patients with large scar do not improve in function after acute myocardial infarction. The present data extend these earlier observations and demonstrate that scar tissue on delayed contrast-enhanced MRI permits prediction of LV dilatation after acute myocardial infarction with high accuracy. It has recently been stressed that the LV dilatation may be preferred as an end-point after acute myocardial infarction. Still, the prognostic value of the findings remains to be determined.

References