SCIENTIFIC LETTER

Scar tissue on contrast-enhanced MRI predicts left ventricular remodelling after acute infarction

Theodorus A M Kaandorp, Hildo J Lamb, Eric P Viergever, Don Poldermans, Eric Boersma, Ernst E van der Wall, Albert de Roos, Jeroen J Bax

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Coronary artery disease is the leading cause of death in the Western world, and the annual incidence of acute myocardial infarction (AMI) in the US is 865 000.¹ A substantial percentage of patients develop left ventricular dilatation (remodelling) after AMI, resulting in heart failure, which is associated with high morbidity and mortality. Aggressive medical treatment may prevent or halt left ventricular dilatation, and early, accurate identification of patients at risk for left ventricular dilatation is essential.

Quantification of infarct size may be useful for identification of patients after AMI at risk for left ventricular dilatation. Contrast-enhanced MRI is a reliable and reproducible technique that allows precise quantification of the amount of scar tissue^{2,3}; moreover, the spatial resolution of MRI allows delineation of the transmural extent of the infarction. Accordingly, the value of contrast-enhanced MRI to predict left ventricular dilatation after AMI was evaluated in a consecutive cohort of patients after AMI.

METHODS

The study population consisted of 29 consecutive patients with a first AMI, documented by typical chest pain lasting >30 min, raised concentration of creatine kinase-MB protein and/or troponin T and typical ECG changes. All patients had sinus rhythm; patients with pacemakers and intracranial clips were not included. The study protocol consisted of a resting cine MRI performed within 1 week after AMI (mean 6 (SD 3) days), to evaluate left ventricular volumes and left ventricular ejection fraction. Next, contrast-enhanced MRI was performed to evaluate scar size (expressed in grams and in percentage of the left ventricle). Left ventricular ejection fraction and volumes were reassessed 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 T MRI system (Philips Medical Systems, Amsterdam, The Netherlands) with a five-element synergy coil and vector-ECG gating were used. The entire heart was imaged in short-axis view during multiple 15-second breath-holds, using a Steady-State Free-Precession sequence (field of view 400×400 mm², matrix size 256×256, slice thickness 10 mm). MRI images were analysed on a remote workstation. Left ventricular end-systolic volume (ESV) and left ventricular end-diastolic volumes (LVEDVs) 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 with baseline values. Contrast-enhanced images were acquired approximately 15 min after bolus intravenous injection of gadolinium-diethylenetriamine-pentaacetate (Magnevist, Schering/Berlex, Germany, 0.15 mmol/kg) with an inversion-recovery gradient echo sequence (inversion time 220–280 ms, field of view 400×400 mm², matrix size 256×256, slice thickness 5 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 left ventricle.

Continuous data were expressed as mean (SD) and compared using the two-tailed Student's *t* test for paired data when appropriate. Relationships 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 left ventricular dilatation (>10% increase in LVEDV). Multivariate analysis was performed to identify the predictors of left ventricular remodelling. A *p* value <0.05 was considered significant.

RESULTS

A total of 29 patients (27 men, mean (SD) age 47 (11) years) with AMI were included; 48% of patients exhibited pathological Q waves on the 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 AMI included percutaneous coronary intervention and/or thrombolysis in 80%, whereas 20% of patients were treated conservatively. Drugs after AMI included β -blockers in 94%, ACE inhibitors/angiotensin-receptor blocker in 83%, statins in 97% and aspirin/oral anticoagulants in 93%.

Figure 1 Relationship between scar tissue (in gram (A) and as a percentage of the left ventricle, (B)) and change in left ventricular end-diastolic volumes (EDVs).

Abbreviations: AMI, acute myocardial infarction; LVEDV, left ventricular end-diastolic volume; ROC, receiver-operating characteristic

Figure 2 Receiver-operating characteristic curve analysis on the detection of left ventricular (LV) dilatation (>10% end-diastolic volume) by the extent (in grams, (A)) and percentage of scar tissue on contrast-enhanced MRI (B).

The LVEDV increased significantly from 200 (29) to 207 (37) ml ($p < 0.01$); conversely, left ventricular end-systolic volume decreased from 104 (27) to 97 (30) ml ($p < 0.01$) with a resultant increase in LVEF from 48% (8%) to 54% (9%) ($p < 0.01$). A strong relationship existed between the extent of scar tissue and the change in LVEDV (fig 1). ROC curve analysis showed that a cut-off value of 36 g scar tissue on contrast-enhanced MRI yielded a sensitivity of 100% and a specificity of

95% to detect an increase in LVEDV >10%. Next, ROC curve analysis showed that a cut-off value of 23% scar in the left ventricle yielded a sensitivity of 95% and a specificity of 95% to detect an increase in LVEDV >10% (fig 2). Multivariate analysis identified the extent of scar tissue on contrast-enhanced MRI as the single best predictor of left ventricular remodelling.

DISCUSSION

The available studies in the literature have focused on prediction of functional recovery, and showed that patients with large scar do not improve in function after AMI.⁴ The present data extend these earlier observations and show that scar tissue on contrast-enhanced MRI allows prediction of left ventricular dilatation after AMI with high accuracy. It has recently been emphasised that left ventricular dilatation may be preferred as an end point after AMI.⁵ However, the prognostic value of the findings remains to be determined.

Authors' affiliations

Theodorus A M Kaandorp, Hildo J Lamb, Albert de Roos, Department of Radiology, Leiden University Medical Center, Leiden, The Netherlands
Eric P Viergever, Ernst E van der Wall, Jeroen J Bax, Department of Cardiology, Leiden University Medical Center, Leiden, The Netherlands
Don Poldermans, Eric Boersma, Thorax Center Rotterdam, Rotterdam, The Netherlands

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Correspondence to: Dr T A M Kaandorp, Department of Radiology C2-S, Leiden University Medical Center, Albinusdreef 2, 2300 RC Leiden, The Netherlands; t.a.m.kaandorp@lumc.nl

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