Case Report

Cardiac Magnetic Resonance Detection and Typical Appearance of Microvascular Obstruction Following Myocardial Infarction

Emmanouil N. Karatzis[1], Athanassios G. Pipilis[2], Konstantinos Malios[2], John Andreou[1], Arkadios Roussakis[1], Fotios Tsertos[1], Peter G. Danias[1,2,3]

[1]Cardiac MR Center, [2]Cardiology Clinic, "Hygeia" Hospital, Maroussi, Athens, Greece; [3]Tufts University Medical School, Boston USA

Key words:
Microvascular obstruction, myocardial viability, CMR imaging, myocardial infarction.

We report the case of a 58-year-old man with a recent anterior myocardial infarction, for which he did not receive prompt reperfusion therapy. The patient underwent cardiac magnetic resonance (CMR) imaging, for the assessment of left ventricular function and myocardial viability, and coronary angiography, two weeks after the acute cardiac event. The CMR study demonstrated a moderately dilated left ventricle, with impaired systolic function and wall motion abnormalities in the anterior, apical and inferior left ventricular walls. The T1-weighted images obtained early after contrast administration demonstrated a dark rim in the endocardial region of the interventricular septum and apex. The delayed-enhanced images demonstrated complete absence of signal at the same rim, adjacent to a hyper-enhanced region that corresponded to the wall motion abnormalities. These findings are suggestive of microvascular obstruction in the distribution of the left anterior descending coronary artery. Microvascular obstruction has been reported to correlate positively with the size of the infarction and the left ventricular end-diastolic volume, and inversely with the left ventricular ejection fraction. Furthermore, it has been reported as an independent predictor of future major cardiovascular events. Microvascular obstruction should be routinely checked for in patients presenting in the peri-myocardial infarction period for CMR assessment of myocardial viability.

Manuscript received:
November 17, 2008;
Accepted:
December 10, 2008.

Address:
Peter G. Danias

Hygeia Hospital
4 Erythrou Stavrou & Kifissias Ave.
15123 Maroussi
Athens, Greece
e-mail:
peter.danias@tufts.edu
pdanias@hygeia.gr

Microvascular obstruction is a not uncommon finding following myocardial infarction, even when revascularization has been performed. Here we report a case in which cardiac magnetic resonance (CMR) imaging revealed microvascular obstruction two weeks after the acute event.

Case presentation

A 58-year-old man with multiple coronary risk factors sought medical attention at an outside facility 3 days after the onset of persistent typical anginal pain. He was diagnosed with myocardial infarction, based on abnormal electrocardiogram, resting echocardiogram and elevated cardiac-specific enzymes. The patient transferred to our institution several days later. He was hospitalized, and assessment of myocardial viability and coronary angiography were recommended.

Two weeks after the acute cardiac event the patient underwent CMR imaging to assess left ventricular systolic function and myocardial viability. A functional study with cine images to cover the left and right ventricles, as well as early and delayed contrast-enhanced images were obtained. The CMR study demonstrated a moderately dilated left ventricle (indexed end-diastolic volume 140 ml/m^2, normal <80ml/m^2)[1] with moderately decreased ejection fraction (39%,

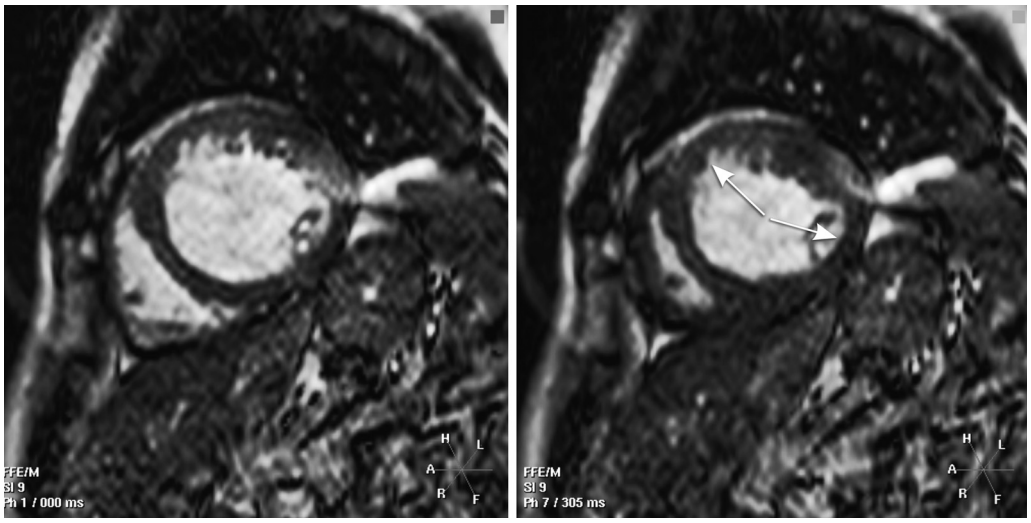

Figure 1. Diastolic (left) and systolic (right) frames from the functional cardiac magnetic resonance study in the short-axis orientation. The arrows demonstrate wall motion abnormalities in the interventricular septum and inferolateral walls.

normal >61%).[1] Severe hypokinesis of the mid and apical interventricular septum, apical dyskinesis and severe hypokinesis of the inferior wall were noted (Figure 1). The T1-weighted images obtained early after contrast administration demonstrated a dark rim in the endocardial region of the interventricular septum and apex (Figure 2). The delayed-enhanced images demonstrated complete absence of signal at the same rim, adjacent to a hyperenhanced region that corresponded to the wall motion abnormalities (Figure 3). Subendocardial enhancement was also evident in the inferior wall. These findings are suggestive of microvascular obstruction in the distribution of the left anterior descending coronary artery, with scar from myocardial infarction in the hyperenhanced regions (anterior wall, interventricular septum, apex and inferior wall). The differential diagnosis of the CMR findings also includes the presence of a thin laminated thrombus lining the endocardial surface of the scar.

Subsequent coronary angiography demonstrated total occlusion of the right coronary artery and subtotal occlusion of the left anterior descending coronary artery after the origin of the first diagonal branch.

Based on the findings of the CMR and coronary angiography, coronary revascularization was recommended.

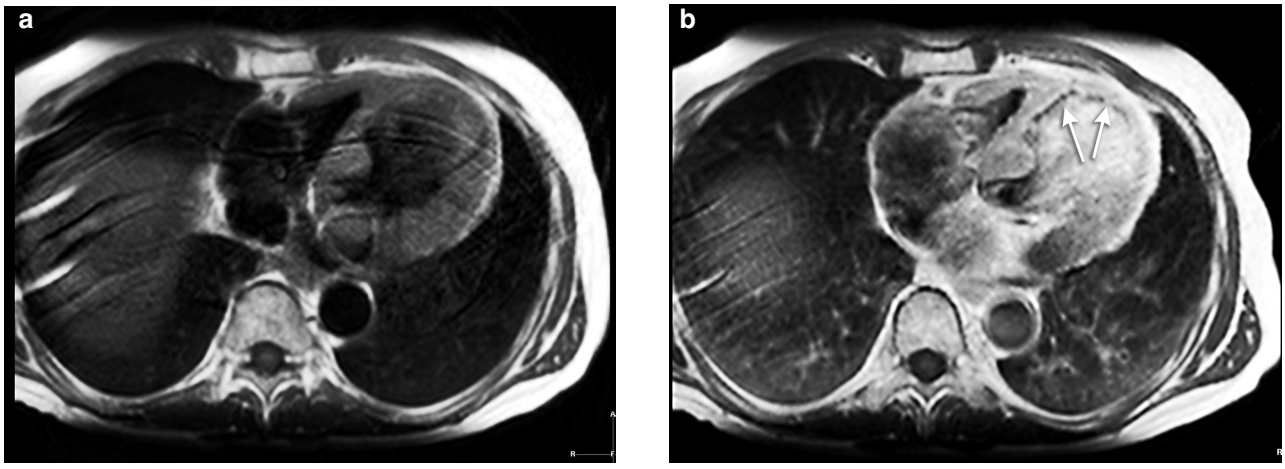

Figure 2. T1-weighted images before (a) and after (b) intravenous administration of paramagnetic contrast (Gadodiamide, 0.2 mmol/kg). The arrows indicate the thin dark line at the endocardial border that represents the obstructed microcirculation zone.

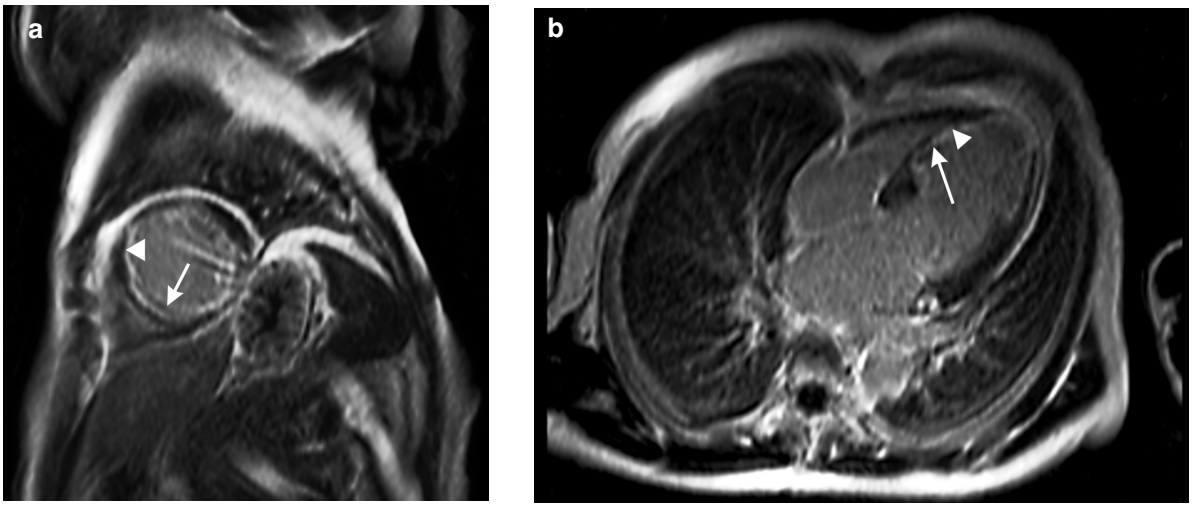

Figure 3. Myocardial viability study with delayed gadolinium-enhanced images in the (a) short-axis and (b) four-chamber orientations. The bright hyperenhanced regions (arrowheads) represent the infracted territories. The arrows indicate the zone of microvascular obstruction, a thin dark line at the endocardial border, adjacent to the hyperenhanced region.

Discussion

Microvascular obstruction is found in a large proportion of patients 4-16 days after myocardial infarction,[2-4] including those who have undergone timely revascularization.[3] The reported prevalence varies considerably (from 25% to >65%). The mean volume of microvascular obstruction has been reported to be 2 ± 3% of the left ventricular mass[2,5] and the extent of microvascular obstruction correlates positively with the size of the infarction and the left ventricular end-diastolic volume, and inversely with the left ventricular ejection fraction.[3,6,7] The 'no-reflow' phenomenon, a pathophysiologically similar process complicating coronary interventions, also adversely correlates with left ventricular remodeling and leads to greater infarct expansion.[8] Microvascular obstruction has been reported to be an independent predictor of future major cardiovascular events, including death, myocardial infarction and repeat hospitalizations.[2,4,5]

Our case illustrates the typical imaging characteristics of post-infarct microvascular obstruction with CMR.[9] Gadolinium-based contrast agents are extracellular macromolecules that have a short serum half-life, and their tissue delivery depends on both regional blood flow and capillary permeability.[10] Following myocardial infarction, early hypoenhancement is due to the impaired flow in the infarct zone.[11] With obstructed microcirculation, contrast arrival remains minimal over time, accounting for the failure to hyperenhance on delayed imaging. Contrast echocardiography[12] and multislice computed tomography[13] can also demonstrate the zone of microvascular obstruction and correlate well with CMR findings. Assessment for microvascular obstruction is performed visually and does not add time to the CMR examination and analysis. Thus, microvascular obstruction should be routinely checked for in patients presenting in the peri-myocardial infarction period for CMR assessment of myocardial viability.

References

1. Salton C, Chuang M, O'Donnell C, et al. Gender differences and normal left ventricular anatomy in an adult population free of hypertension. A cardiovascular magnetic resonance study of the Framingham heart study offspring cohort. J Am Coll Cardiol. 2002; 39: 1055-1060.
2. Bruder O, Breuckmann F, Jensen C, et al. Prognostic impact of contrast-enhanced CMR early after acute ST segment elevation myocardial infarction (STEMI) in a regional STEMI network: results of the "Herzinfarktverbund Essen". Herz. 2008; 33: 136-142.
3. Nijveldt R, Beek AM, Hofman MB, et al. Late gadolinium-enhanced cardiovascular magnetic resonance evaluation of infarct size and microvascular obstruction in optimally treated patients after acute myocardial infarction. J Cardiovasc Magn Reson. 2007; 9: 765-770.
4. Wu KC, Zerhouni EA, Judd RM, et al. Prognostic significance of microvascular obstruction by magnetic resonance imaging in patients with acute myocardial infarction. Circulation. 1998; 97: 765-772.
5. Hombach V, Grebe O, Merkle N, et al. Sequelae of acute myocardial infarction regarding cardiac structure and func-

tion and their prognostic significance as assessed by magnetic resonance imaging. Eur Heart J. 2005; 26: 532-533.
6. Tarantini G, Razzolini R, Cacciavillani L, et al. Influence of transmurality, infarct size, and severe microvascular obstruction on left ventricular remodeling and function after primary coronary angioplasty. Am J Cardiol. 2006; 98: 1033-1040.
7. Lund GK, Stork A, Muellerleile K, et al. Prediction of left ventricular remodeling and analysis of infarct resorption in patients with reperfused myocardial infarcts by using contrast-enhanced MR imaging. Radiology. 2007; 245: 95-102.
8. Ito H, Maruyama A, Iwakura K, et al. Clinical implications of the 'no-reflow' phenomenon: a predictor of complications and left ventricular remodeling in reperfused anterior wall myocardial infarction. Circulation. 1996; 96: 223-228.
9. Pamboucas C, Schmitz S, Nihoyannopoulos P. Magnetic resonance imaging in the detection of myocardial viability: The role of delayed contrast hyperenhancement. Hellenic J Cardiol. 2005; 46: 108-116.
10. Pamboucas CA, Rokas SG. Clinical safety of cardiovascular magnetic resonance: cardiovascular devices and contrast agents. Hellenic J Cardiol. 2008; 49: 352-356.
11. Laddis T, Manning WG, Danias PG. Cardiac MRI for assessment of myocardial perfusion: current status and future perspectives. J Nucl Cardiol. 2001; 8: 207-214.
12. Wu K, Kim R, Bluemke D, et al. Quantification and time course of microvascular obstruction by contrast-enhanced echocardiography and magnetic resonance imaging following acute myocardial infarction and reperfusion. J Am Coll Cardiol. 1998; 32: 1756-1764.
13. Nieman K, Shapiro M, Ferencik M, et al. Reperfused myocardial infarction: contrast-enhanced 64-Section CT in comparison to MR imaging. Radiology. 2008; 247: 49-56.