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Correlation between ECG and myocardial perfusion after mechanical reperfusion of acute myocardial infarction☆

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Abstract

The identification of viable myocardium after myocardial infarction (MI) carries major prognostic impact. Due to myocardial stunning early after successful mechanical reperfusion of acute myocardial infarction, analysis of myocardial perfusion but not of contractile function can be used to differentiate between necrotic and viable myocardium. Although being widely regarded as an indicator of infarct transmurality, the relation between post-infarct Q-wave formation and the amount of viable myocardium has not been studied. We hypothesized that there was a correlation between the extent of Q-wave formation and the extent of perfusion abnormalities on myocardial contrast echocardiography early after successful mechanical reperfusion of first acute myocardial infarction and that the extent of post-infarct Q-wave formation might therefore be used as a simple estimate of the amount of viable myocardium.

Methods and results: 47 patients with first MI and treated by direct PCI were enrolled. Patients were divided into 3 groups according the presence and number of abnormal Q waves (group A—no abnormal Q wave; group B—≤2 abnormal Q waves, group C—≥3 abnormal Q waves). Left ventricular pumpfunction was defined by ejection fraction (EF) on ventriculography and wall motion score index (WMSI) on echocardiography. Myocardial perfusion was defined by perfusion score index (PSI) on myocardial contrast echocardiography. Patients in group A had significantly better LV function than patients in other groups [EF 57±5 vs. 48±11% (group B) and 47±10% (group C); $p<0.05$], also WMSI was the best in this group [1.34±0.22 vs. 1.67±0.39 (group B) and 1.68±0.31 (group C); $p<0.01$].

Myocardial perfusion assessed by PSI was best in group A (1.2±0.3, $p<0.05$). With respect to PSI, there was a significant difference between group B and C (1.41±0.21 vs. 1.56±0.29; $p<0.05$), even though EF and WMSI did not differ in these groups. The amount of perfused segments with severe wall motion abnormality was higher in group B compared to group C (47% vs. 25%; $p<0.05$).

Conclusion: In patients after successful mechanical reperfusion of first MI, the extent of Q-wave formation on ECG may be regarded as a corollary of the amount of myocardial microvascular damage and may, therefore, be used to estimate the amount of viable myocardium post-infarct.

Keywords: Contrast echocardiography; Acute myocardial infarction; ECG

1. Introduction

LV dysfunction after acute myocardial infarction (AMI) may occur as a result of myocardial necrosis or stunning. Necrotic tissue is subject to infarct expansion and promotes LV dilatation, whereas stunned myocardium is viable and can improve contractile function which is an important prognostic factor.

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In clinical practice, the two most frequently used diagnostic methods, conventional analysis of myocardial contractile function on 2-dimensional resting echocardiography and ECG, are not considered particularly informative with respect to assessment of viable myocardium. Although Q-wave formation on ECG is often interpreted as indicator of infarct transmurality, studies using radionuclide tracers have demonstrated no correlation between the extent of myocardial radionuclide uptake abnormalities and extent of Q-waves or QRS score on ECG [1,2]. In distinction, the demonstration of preserved myocardial microvascular perfusion using MCE has been demonstrated to be a corollary of viability in the experimental and clinical setting [3–6]. Recently, real-time myocardial contrast echocardiography (MCE) has been introduced to simultaneously assess contractile function and microvascular status after injection of second-generation contrast agents [7]. The aim of the present study was to elucidate the relation between myocardial contractility, perfusion and Q-wave formation on ECG after successful mechanical reperfusion of first MI using this new technique. We hypothesized that a correlation between myocardial microvascular perfusion on MCE and the extent of Q-wave formation on electrocardiogram (ECG) could be demonstrated, i.e. that little extent of Q-waves formation would represent more myocardium with preserved myocardial microvascular perfusion known to reflect preserved viability.

2. Methods

2.1. Study population

50 patients with first acute myocardial infarction (MI), successfully treated with direct PCI and without diameter stenosis of $\geq$70% of other coronary arteries were enrolled in the study. Myocardial contrast echocardiography (MCE) was performed between 24 and 78 h after MI and Q-wave formation on ECG was analysed approximately 10 days after reperfusion. The study protocol was approved by the institutional review board and all patients gave written informed consent.

2.2. Myocardial contrast echocardiography

Optison (Amersham Health, Oslo, Norway), a second-generation ultrasound contrast agent consisting of perfluoropropane-filled albumin microspheres (mean diameter 3.9 μm, concentration $5-8\times10^8$/mL), was used. For each echocardiographic view, 1.5 mL of Optison was injected intravenously over 30 s through a multidirectional stopcock and 5 mL of 0.9% saline were simultaneously injected to prevent microbubble floating.

A HDI-5500 ultrasound system (ATL Philips Medical Systems, Bothell, WA, USA) equipped with a 1.7 MHz transducer was used. Real-time MCE was performed using power pulse inversion (PPI) imaging. The dynamic range of this system was set to the high level and the frame rate during real-time imaging was 15 Hz. The gain settings were optimized at the beginning of each study and held constant throughout. The focus was set at the level of the mitral valve. Mechanical indices between 0.12 and 0.18 were used. Two and four-chamber views were stored on S-VHS videotape.

2.3. Image interpretation

Four- and two-chamber apical views using a 12-segment model of the left ventricle were used for the analysis of wall motion (WM) and MCE [8]. Regional WM was graded as 1=normal, 2=hypokinetic, and 3=akinetic in the standard manner. Wall motion score index (WMSI) (WMSI=sum of the segment scores/number of segments scored) was calculated. Myocardial opacification during MCE was assessed in each of the 12 myocardial segments and graded as 1=normal, 2=mildly reduced, 3=severely reduced. Perfusion score index (PSI) was calculated (PSI=sum of the segment scores/number of segment scored). Regional WM and MCE were interpreted by 2 observers blinded to both clinical and ECG data. Differences in opinion were resolved by consensus.

2.4. Electrocardiography

Electrocardiograms were obtained until ST-segment changes had stabilised approximately 10 days after reperfusion. All ECGs were analysed by a separate investigator blinded to echocardiographic, clinical and invasive findings. The presence and number of abnormal Q-waves on the surface 12-lead ECG was assessed in each patient. Abnormal Q-wave was defined by any Q wave in leads V1 through V3, or Q wave>0.03 s in leads I, II, III, aVL, aVF,V4, V5 or V6.

Patients were divided into 3 groups according the presence and the number of abnormal Q-waves (group A: no abnormal Q-wave, group B: <2 abnormal Q-waves; group C: $\geq$3 abnormal Q-waves). Differences in myocardial wall motion and perfusion between the three groups were studied.

2.5. Statistical analysis

Continuous variables are expressed as mean±standard deviation; nominal variables are expressed as counts and percentages. Continuous variables were compared using the unpaired Student's *t*-test, nominal variables were compared using χ^2 test. A *p*-value of $p<0.05$ was considered significant.

3. Results

3.1. Patient characteristics

50 patients were enrolled in the study. In 3 patients, inadequate image quality on MCE prevented meaningful