Does left ventricular dyssynchrony immediately after acute myocardial infarction result in left ventricular dilatation?

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BACKGROUND Reverse remodeling of the left ventricle (LV) is one of the advantageous mechanisms of cardiac resynchronization therapy (CRT). Substantial LV dyssynchrony seems mandatory for echocardiographic response to CRT. Conversely, LV dyssynchrony early after acute myocardial infarction may result in LV dilatation during follow-up.

OBJECTIVE The purpose of this study was to evaluate the relation between LV dyssynchrony early after acute myocardial infarction and the occurrence of long-term LV dilatation.

METHODS A total of 124 consecutive patients presenting with acute myocardial infarction who underwent primary percutaneous coronary intervention were included. Within 48 hours of intervention, two-dimensional echocardiography was performed to assess LV volumes, LV ejection fraction (LVEF), and wall motion score index (WMSI). LV dyssynchrony was quantified using color-coded tissue Doppler imaging (TDI). At 6-month follow-up, LV volumes and LVEF were reassessed.

RESULTS Patients with substantial LV dyssynchrony (≥65 ms) at baseline (18%) had comparable baseline characteristics to patients without substantial LV dyssynchrony (82%), except for a higher prevalence of multivessel coronary artery disease ($P = .019$), higher WMSI ($P = .042$), and higher peak levels of creatine phosphokinase ($P = .021$). During 6 months of follow-up, 91% of the patients with substantial LV dyssynchrony at baseline developed LV remodeling, compared with 2% in the patients without substantial LV dyssynchrony. LV dyssynchrony at baseline was strongly related to the extent of long-term LV dilatation at 6 months of follow-up.

CONCLUSION Most patients with substantial LV dyssynchrony immediately after acute myocardial infarction develop LV dilatation during 6 months of follow-up.

KEYWORDS Myocardial infarction; Echocardiography; Left ventricular dyssynchrony; Remodeling; Ventricle

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Introduction

Nowadays, a substantial proportion of patients with moderate to severe ischemic heart failure, despite optimal medical therapy, are treated with cardiac resynchronization therapy (CRT).[1–5] The presence of left ventricular (LV) dyssynchrony seems to be of considerable importance for response and prognosis after CRT.[6–8] Importantly, reverse remodeling of the LV more frequently occurs in those patients with substantial LV dyssynchrony at baseline. In addition, patients with LV-reverse remodeling after CRT have a better prognosis than those without LV reverse remodeling.[6–8]

Presumably, LV dyssynchrony after acute myocardial infarction (MI) results in LV dilatation. However, no study thus far has systematically examined this potential relationship. Tissue Doppler imaging (TDI) is established for the assessment of myocardial velocities and the detection of LV dyssynchrony and has been used in patients who had an MI.[9] This study evaluates the relation between LV dyssynchrony at baseline, assessed with TDI, and the occurrence of long-term LV dilatation in patients after acute MI.

Methods

Patients

A total of 135 consecutive patients who were admitted with an acute MI were screened. Patients who were treated conservatively (n = 4) or who underwent thrombolysis (n = 3) or coronary artery bypass grafting (n = 1) in the acute setting were excluded from the study to obtain a homogenous study group. Three patients died during follow-up and therefore did not have the follow-up assessment. These patients were excluded from the study. The final study population was made up of 124 patients who all underwent primary percutaneous coronary intervention.

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Protocol

Two-dimensional echocardiography was performed within 48 hours of admission (baseline) and at 6-month follow-up. At baseline, conventional echocardiography was used to assess LV volumes, LV ejection fraction (LVEF), and wall motion score index (WMSI). LV dyssynchrony was quantified using color-coded TDI. LV volumes and LVEF were reassessed at 6-month follow-up.[10] The study was approved by the institutional ethics committee, and informed consent was obtained from all patients.

Echocardiography

Patients were imaged in the left lateral decubitus position using a commercially available system (Vivid Seven, General Electric-Vingmed, Milwaukee, WI). Standard images were obtained using a 3.5-MHz transducer at a depth of 16 cm in the parasternal (long and short axis) and apical (two- and four-chamber) views. Standard two-dimensional and color Doppler data, triggered to the QRS complex, were saved in cine-loop format. LV volumes (end-systolic and end-diastolic) and LVEF were calculated from the conventional apical two- and four-chamber images using the biplane Simpson's technique.[11] LV remodeling at 6 months of follow-up was defined as an increase in LV end-systolic volume (LVESV) $\geq$15%.[6,12,13]

The LV was divided into 16 segments. A semiquantitative scoring system (1 = normal; 2 = hypokinesia; 3 = akinesia; 4 = dyskinesia) was used to analyze each study. Global WMSI was calculated by the standard formula: sum of the segment scores divided by the number of segments scored.[14,15]

All echocardiographic measurements were obtained by two independent observers without knowledge of the clinical status of the patient. Inter- and intra-observer agreement for assessment of LV volumes were 90% and 93% for LVESV and 92% and 93% for LV end-diastolic volume (LVEDV), respectively.

Tissue Doppler imaging

Color Doppler frame rates were >80 fps, and pulse repetition frequencies were between 500 Hz and 1 KHz, resulting in aliasing velocities between 16 and 32 cm/s. TDI parameters were measured from color images of three consecutive heartbeats by offline analysis. Data were analyzed using commercial software (Echopac 6.01; General Electric-Vingmed). To determine LV dyssynchrony, the sample volume (6 $\times$ 6 mm) was placed in the LV basal portions of the anterior, inferior, septal, and lateral walls (using the two- and four-chamber views), and, per region, the time interval between the onset of the QRS complex and the peak systolic velocity was obtained. LV dyssynchrony was defined as the maximum delay between peak systolic velocities among these four LV regions.[6] Substantial LV dyssynchrony was defined as LV dyssynchrony $\geq$65 ms.[6] Inter- and intra-observer agreements for assessment of LV dyssynchrony were reported elsewhere (90% and 96%, respectively).[16]

Statistical analysis

Most continuous variables were not normally distributed (as evaluated by Kolmogorov-Smirnov tests). For reasons of uniformity, summary statistics for all continuous variables are therefore presented as medians together with the 25th and 75th percentiles. Categorical data are summarized as frequencies and percentages.

Differences in baseline characteristics between patients who demonstrated substantial LV dyssynchrony versus those who did not were analyzed using Wilcoxon-Mann-Whitney tests, χ^2-tests with the Yates' correction or Fisher's exact tests, as appropriate. Linear regression analysis was used to evaluate the relations between baseline variables and the change in LVESV during follow-up. All statistical tests were two-sided. Unless otherwise specified, $P < .05$ was considered statistically significant.

Results

Baseline data of the study population

In the present study, 124 patients were included (99 men and 25 women; median age 61 [53, 71] years). During primary percutaneous coronary intervention, TIMI-III flow was achieved in all but 6 (5%) patients. Multivessel disease was observed in 67 (54%) patients. Median creatine phosphokinase (CPK) levels were 2469 (1023, 3702) U/L. Median WMSI was 1.50 (1.31, 1.63). Seven (6%) patients had a previous MI. At baseline, median LVESV and LVEDV were 65 (54, 83) mL and 129 (106, 151) mL, respectively, whereas the median LVEF was 48% (42%, 53%). Median LV dyssynchrony as measured by TDI was 10 (0, 40) ms.

Six-month follow-up

In the entire patient population, the mean LVESV remained unchanged at the 6-month follow-up (64 [51, 84] mL vs. 65 [54, 83] mL at baseline; $P = .11$). LVEDV increased significantly during follow-up (130 [110, 155] mL vs. 129 [106, 151] mL at baseline; $P = .007$). LVEF remained unchanged (49% [43%, 56%] vs. 48% [42%, 53%] at baseline; $P = .31$).

LV dilatation in patients with baseline LV dyssynchrony

Patients were subsequently divided into patients with substantial LV dyssynchrony (n = 22, 18%) and without LV dyssynchrony (n = 102, 82%) at baseline. Patients in the group with substantial LV dyssynchrony had a median dyssynchrony of 85 (80, 100) ms, whereas median dyssynchrony among those without substantial LV dyssynchrony was 10 (0, 20) ms ($P < .0001$, by definition). Clinical and echocardiographic patient characteristics of the two groups are summarized in Tables 1 and 2, respectively. Various baseline variables differed significantly between patients with and without substantial LV dyssynchrony at baseline. Patients with LV dyssynchrony more often had multivessel coronary artery disease. WMSI (as a reflector for infarct size) was higher among those patients with LV dyssynchrony. In addition, peak levels of CPK (reflecting enzy-