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ORIGINAL ARTICLE

Relationship between restrictive Doppler mitral inflow pattern and myocardial viability after a first acute myocardial infarction

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Abstract Objective: This study was designed to evaluate the relation between restrictive Doppler mitral inflow pattern and echocardiographic indices of myocardial viability in patients with first acute myocardial infarction undergoing dobutamine stress echocardiography to determine the extent of infarct zone viability.

Methods: Fifty-six consecutive patients were studied 7 days after first ST-elevation acute myocardial infarction with high dose dobutamine stress echocardiography. A score model based on 16 segments and four grades was used to assess the left ventricular function. Viability was defined as an improvement in wall motion by at least one grade in two or more dysfunctional segments during any stage of the dobutamine infusion compared with the baseline. Pulsed-wave Doppler mitral inflow velocity was obtained at baseline (prior to dobutamine infusion) and restrictive pattern defined as E/A ratio ≥ 2 and E-wave deceleration time ≤ 140 ms.

Results: Restrictive mitral inflow pattern was detected in 25 (45%) patients. Seventeen (68%) patients in restrictive group received thrombolytic therapy while 26 (84%) in the non-restrictive group received this therapy ($P = 0.001$). Viability in the infarcted territory was detected in 17 (54%) out of 31 patients in non-restrictive group, while only 3 (12%) out of 25 patients in restrictive group showed evidence of contractile reserve ($P = 0.0001$).

Conclusions: This study showed a strong association between restrictive Doppler mitral inflow pattern and lack of myocardial contractile reserve during dobutamine stress echocardiography in patients with a first acute myocardial infarction.

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1. Background

Marked changes in the diastolic properties of the left ventricle (LV) can occur in the presence of ischemic heart diseases. Acute myocardial ischemia slows ventricular relaxation and increases myocardial wall stiffness, while acute myocardial

infarction (AMI) causes more complex changes in ventricular pressure–volume relationship, depending on the size of the infarction and the time following infarction at which the measurements are made.¹

The mitral Doppler inflow pattern accurately predicts LV filling pressures, allows identification of patients at high risk for progressive LV dilatation and can provide independent prognostic information over that of the assessment of LV systolic function.² Moreover, in patients with ischemic cardiomyopathy, the mitral inflow pattern has been found to be a potential predictor of echocardiographic and scintigraphic indices of myocardial viability and functional recovery after revascularization.³

Dobutamine stress echocardiography (DSE) has been used to determine the extent of infarct zone viability, because the degree of contractile reserve elicited during dobutamine infusion provides an excellent assessment of myocardial necrosis coexisting with post-ischemic myocardial dysfunction.^{4,5}

We postulated that in patients with AMI, the mitral Doppler inflow pattern is critically dependent on the amount of viable myocardium, and we sought to evaluate the relation between the restrictive mitral inflow pattern and the echocardiographic indices of myocardial viability during DSE.

2. Methods

2.1. Patients

We studied patients admitted with a first acute ST-segment elevation myocardial infarction to the Coronary Care Unit in Suez Canal University Hospital. The diagnosis of myocardial infarction was made by the acute typical ST-T wave changes and typical increase and decrease in serum creatine kinase (CK) and the MB isoenzyme of creatine kinase (CK-MB) enzyme levels in the clinical setting of sustained precordial chest pain.⁶ We excluded patients with previous myocardial infarction, atrial fibrillation, severe valvular heart diseases, intraventricular conduction defects, congestive heart failure, and technically difficult Doppler echocardiographic studies for quantitative analysis.

2.2. Two dimensional and Doppler echocardiography

Two dimensional and Doppler echocardiography were performed on average 7 days after onset of symptoms (ranged from 5 to 9 days) and prior to DSE. Images were obtained in the standard parasternal and apical views with the patient in left lateral position.

Regional function assessment was performed according to the 16-segment model of the American Society of Echocardiography and graded from 1 to 4 (1 = normal, 2 = hypokinesia, 3 = akinesia, and 4 = dyskinesia). Wall motion score index (WMSI) was calculated by summing the scores for each segment and divided by the number of segments analyzed.⁷ Ejection fraction (EF) was calculated by Simpson method from the apical 2- and 4-chamber views.

Pulsed-wave Doppler mitral inflow velocity was obtained by placing the Doppler sample volume at the tips of mitral valve leaflets in the apical 4-chamber view to measure the following: Peak early filling velocity (E), peak velocity at atrial contraction (A), E/A ratio, deceleration time of the E velocity (DTE).

Patients were assigned to one of two groups based on Doppler mitral inflow pattern: a restrictive group with E/A ratio ≥ 2 or E/A between 1–2 and DTE ≤ 140 ms (Fig. 1), and non-restrictive group with E/A ratio ≤ 2 and DTE ≥ 140 ms.^{8,9}

2.3. Dobutamine stress testing

Patients underwent DSE while taking all prescribed medications on average 7 days after onset of symptoms (between 5–9 days) and before discharge. Dobutamine was administered intravenously by an infusion pump at the initial dosages of 2.5, 5 and 10 $\mu\text{g/kg}$ per minute for 3 min each, followed by increments of 10 $\mu\text{g/kg}$ per minute every 3 min, up to a maximal dose of 40 $\mu\text{g/kg}$ per minute. The infusion was stopped in the presence of one of the following end points: achieving the target heart rate (85% of maximum predicted heart rate), angina, 2 mm or more ST-segment depression compared with baseline, new or worsening wall motion abnormalities, significant arrhythmias, severe hypertension (blood pressure $> 230/120$ mm Hg), or hypotension (decrease in systolic blood pressure > 30 mm Hg below the baseline measurement).¹⁰

Echocardiographic monitoring was performed continuously and digital acquisition of images was obtained at rest, at low dobutamine dose (10 $\mu\text{g/kg}$ per minute); at peak dose, and during recovery. Blood pressure was manually measured at each stage by arm-cuff sphygmomanometer.

2.4. Echocardiographic analysis

Improvement of contractile function in a segment during dobutamine infusion was defined when systolic myocardial thickening became apparent in an akinetic segment (from score 3 to 2 or 1) or when systolic thickening and wall motion comparable with those observed in the normal segments was observed in a previously hypokinetic segment (from 2 to 1). A patient was considered to have contractile reserve on dobutamine echocardiography if wall thickening improved in 2 or more contiguous segments. The development of new or worsening regional dyssynergy during dobutamine stress was considered to indicate ischemia.^{10,11}

Four different echocardiographic responses were identified (1) Sustained improvement throughout the study, indicating contractile reserve with no ischemia (stunning), (2) Initial improvement followed by subsequent worsening at a higher dose, considered to represent a biphasic response (viable and ischemic), (3) Ischemia of the adjacent area, defined by the development of new dyssynergy in 2 or more segments adjacent to the infarcted zone, with no change in the affected segments (non-viable with ischemia at a distance), (4) No change in basal dyssynergy throughout dobutamine infusion (non-viable).^{10,11}

2.5. Statistical analysis

All continuous data are expressed as mean $\pm$ SD. Unpaired *t*- or χ^2 -tests were used to compare the clinical and echocardiographic data between the two groups of patients as divided by restrictive or non-restrictive filling patterns. Univariate and multivariate logistic regression analyses were performed to identify variables' correlates with lack of myocardial viability detected by DSE after AMI. A value of $P < 0.05$ was considered to be statistically significant.

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