Prevalence and relevance of a septal diastolic notch during dobutamine stress echocardiography


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Background Dobutamine stress echocardiography has become an accepted simple and inexpensive method of detecting coronary artery disease. In this pharmacological stress test, particular attention has been paid to transient systolic wall motion abnormalities. Our group has noted an abnormal diastolic ventricular septal motion, a ‘diastolic notch’, during dobutamine stress echocardiography that has not been previously described.

Methods and Results To find out whether this anomalous septal motion is related to coronary artery disease we have analysed the stress studies of 125 patients (69 men, age 61 ± 9 years) with chest pain, no previous myocardial infarction and no left bundle branch block, who underwent a dobutamine stress test. Dobutamine was infused up to 40 μg. kg.⁻¹ min⁻¹ in 3 min stages. A positive stress test was defined as the appearance of transient asynergy. Dobutamine time was the time from the infusion of dobutamine to the appearance of transient asynergy. The diastolic notch time was the time at which diastolic notch was first detected. Diastolic notch was detected in 21 patients with single coronary artery disease, 19 of whom had a severe left anterior descending artery stenosis. Diastolic notch was present in 19 out of 27 patients (70%) with single left anterior descending stenosis. Twenty-six out of 44 patients with multivessel coronary artery disease had evidence of a diastolic notch and 20 of these 26 had severe stenosis of the left anterior descending artery. Finally, all three patients with left main coronary artery disease had a diastolic notch while no patient with angiographically normal coronary arteries had this sign. In patients with a diastolic notch and a positive dobutamine stress test, diastolic notch time was shorter than dobutamine time (9 ± 4 min vs 11 ± 3 min, P < 0.05).

Conclusions In patients without previous myocardial infarction and without left bundle branch block (1) the appearance of a septal diastolic notch during dobutamine stress echocardiography is very specific for the presence of coronary artery disease; (2) the detection of diastolic notch is mostly related to the existence of severe left anterior descending artery stenosis; (3) diastolic notch precedes the development of ventricular asynergy.

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Key Words: Septal diastolic notch, dobutamine stress echocardiography.

Introduction

The development of two-dimensional imaging has made it possible to assess segmental contraction abnormalities in coronary artery disease using echocardiography. In patients with coronary artery disease, transient wall motion abnormalities induced by different forms of physiological or pharmacological stress can be detected by means of two-dimensional echocardiography. As a result, stress echocardiography has become an accepted simple and inexpensive alternative to the regular exercise stress test for the diagnostic and prognostic evolution of patients with coronary artery disease[1–3]. During stress echocardiography, analysis of the ischaemic response has mainly addressed systolic wall thickening and systolic wall motion abnormalities[4]. Our group has noted an abnormal diastolic ventricular septal motion, ‘diastolic notch’, during dobutamine stress echocardiography that has not been previously described (Fig. 1). The present study was undertaken to evaluate specifically the prevalence and relevance of this new abnormal diastolic ventricular septal motion during dobutamine stress echocardiography in order to determine possible enhancement of the diagnostic power of this pharmacological stress test.
Methods

Study patients

Our study group comprised 125 consecutive patients (69 men and 56 women; mean age 61 ± 9 years) with chest pain and no previous history of coronary artery disease who had undergone a dobutamine-atropine stress echocardiogram for anginal syndrome evaluation. All patients were in sinus rhythm. Patients with left bundle branch block, cardiomyopathy, unstable angina not controlled with medical treatment, Q wave on ECG or evidence of valvular disease were excluded. Most patients were treated with cardioactive drugs: nitrates (70%), β-adrenergic blockers (70%), calcium channel blockers (30%). All patients underwent coronary angiography by the Judkins’ technique within 10 days of stress echocardiography. The decision to perform coronary angiography was part of the protocol and not based on the results of stress echocardiography. Significant coronary artery stenosis was defined as ≥70% reduction of the luminal diameter of any of the three coronary arteries or their primary branches, or ≥50% reduction of the luminal diameter of the left main coronary artery. Informed consent was obtained in all patients.

Dobutamine stress test protocol

Dobutamine infusion was administered intravenously using an infusion pump, starting at a dose of 10 μg·kg⁻¹·min⁻¹ for 3 min, and increasing by 10 μg·kg⁻¹·min⁻¹ every 3 min to a maximum dose of 40 μg·kg⁻¹·min⁻¹ and maintained steady for 6 min. At this point, atropine (1 mg) was administered if the test was negative and 85% of the maximum predicted heart rate had not been reached by the patient. The electrocardiogram was continuously monitored. A 12 lead ECG and cuff blood pressure were available at baseline, every 3 min during the infusion and when required by the echocardiographer. Two-dimensional echocardiography was continuously monitored during the drug infusion and up to 10 min after the infusion was stopped. Echocardiographic examinations were performed with a commercially available Toshiba SSH-160A machine using a 2.5 MHz transducer. Parasternal long- and short-axis and apical four- and two-chamber views were obtained to search for new wall motion abnormalities. The images were continuously recorded on VHS videotape. Situations that led to premature termination of the dobutamine infusion were: (1) achievement of maximal heart rate; (2) new wall motion abnormalities; (3) systolic blood pressure above 220 mmHg; (4) diastolic blood pressure above 120 mmHg; (5) sustained ventricular arrhythmias; (6) symptomatic hypotension; (7) severe angina; (8) more than 3 mm ST depression or more than 2 mm ST elevation. The appearance of the septal diastolic notch was not an end-point for test cessation. Propranolol (0.5–1 mg) was intravenously administered if a positive echocardiographic response appeared. Intravenous nitroglycerine was infused when needed.

In addition to assessment of echocardiographic images during acquisition, additional assessment was also performed by two experienced investigators after acquisition. Both on- and off-line assessments were done without knowledge of the patients’ coronary anatomy. When there was disagreement between the two off-line assessors, a third investigator viewed the images without knowledge of the previous assessments and a majority decision was achieved.

For purposes of analysis, the left ventricle was divided in seven segments: proximal septum; distal septum; apical; anterolateral; posterolateral; posterobasal and inferior. This is a simplified classification based on that proposed by the American Society of Echocardiography in which the coronary anatomy is taken into account[14]. Regional myocardial contractile function was graded as normal, hypokinesis, akinesis, or dyskinesis for each myocardial segment; particular attention
was paid to the presence of an abnormal diastolic septal motion ‘diastolic notch’ (sudden anterior displacement followed by a posterior rebound) (Fig. 2). The following definitions were used in this study: positive dobutamine stress echocardiography (appearance of areas of transient systolic asynergy that were absent or of lesser degree before drug infusion; dobutamine time (time from the infusion of dobutamine to the appearance of systolic asynergy; diastolic notch time (time from the infusion of dobutamine to the appearance of a diastolic septal notch).

**Statistical analysis**

Data are presented as mean ± standard deviation. A P value <0.05 was considered significant. Sensitivity was defined as the percentage of patients with disease in whom the test was positive. Test specificity was defined as the percentage of patients with no disease in whom the test was negative. Accuracy was then defined as the percentage of patients in whom the result of the test (positive in patients with disease and negative in patients with no disease) was correct.

**Results**

**Coronary angiography**

Significant coronary artery stenoses were found in 99 patients. Fifty-two patients had single-vessel disease, 44 multi-vessel disease, and three had left main disease. Non-significant coronary artery disease was found in 26 patients.

**Dobutamine stress echocardiography**

The test was successfully completed in all patients and no major complications occurred. The test was considered positive (transient systolic asynergy) in 79 patients, thus rendering a sensitivity of 79%. The sensitivity for detection of coronary artery disease increased as the extent of coronary stenoses increased, 71% (37 of 52) in patients with single-vessel disease, 88% (39 of 44) in patients with multi-vessel disease, and 100% (3 of 3) in those with left main disease.

A diastolic notch was detected in 21 patients with single coronary artery disease (19 with left anterior descending artery stenoses and two with a right coronary artery lesion) (Table 1). This sign was present in 19 of 27 patients with a single left anterior descending artery stenoses (70%). Twenty-six of 44 patients with multi-vessel coronary artery disease had evidence of this septal notch and 20 of these 26 had a severe stenoses of the left anterior descending artery. Diastolic notch was present in 20 of 28 patients with a left anterior descending artery lesion and multi-vessel coronary artery disease (71%; Table 1). All three patients with left main disease had a septal diastolic notch, but no patient with non-significant coronary artery disease had this sign. This abnormal diastolic notch was seen in 50 of 99 patients with coronary artery disease (50%) in this series. Forty-five of these 50 patients also had a positive dobutamine
stress echocardiogram. The five patients who had a septal notch with a negative stress test had a stenosed left anterior descending coronary artery (four as a single lesion and one with a marginal branch). In the present study, a diastolic notch as a sign of significant left anterior descending coronary artery disease had the following statistical values: sensitivity 72%; specificity 88%; accuracy 80%; positive predictive value 84%; negative predictive value 78%. When the diastolic notch sign coexisted with a positive dobutamine stress test (45 patients), diastolic notch time was shorter than dobutamine time (9 ± 4 min vs 11 ± min, P <0·05). A septal diastolic notch appeared before systolic ventricular asynergy in 41 patients.

**Discussion**

The results of this study underline the value of dobutamine stress echocardiography in the clinical evaluation of patients with coronary artery disease, but most importantly, our findings have unique implications for the diagnosis of patients with a stenosed left anterior descending coronary artery and left main disease. We have observed the appearance of a diastolic septal notch during dobutamine stress echocardiography (Fig. 3). Among the numerous previous reports related to the use of dobutamine stress echocardiography for the detection and assessment of patients with coronary artery disease none have described an abnormal ventricular septal diastolic motion in patients with stenosed coronary arteries. From the results of the present investigation we can point out that the appearance of a septal notch during dobutamine stress echocardiography is very specific for the presence of coronary artery disease and it is mostly related to the existence of severe left anterior descending artery stenosis. Another important aspect of this study is the fact that this septal notch precedes the development of systolic ventricular asynergy. This is not surprising because in humans the prolongation of the time constant of the early relaxation phase is the earliest haemodynamic marker of myocardial ischaemia[5]. Hopefully, the knowledge of this new sign and its precocity will enhance the diagnostic power of this stress test. The identification of this sign could be of particular importance in those tests that are inconclusive because the patient does not reach 85% of the maximum predicted heart rate. It must be acknowledged that the present report does not include patients with previous myocardial infarction or left bundle branch block because in these cases the analysis of ventricular septal motion is more difficult. We have also observed this septal notch during dipyridamol stress echocardiography although less frequently; therefore, we believe that this abnormal septal motion is secondary to ischaemia induced by dobutamine and not to the drug itself.

**Table 1 Prevalence of septal diastolic notch during dobutamine stress echocardiography**

<table>
<thead>
<tr>
<th></th>
<th>LAD</th>
<th>DN</th>
<th>no LAD</th>
<th>DN</th>
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<tbody>
<tr>
<td>One vessel</td>
<td>27</td>
<td>19 (70%)</td>
<td>25</td>
<td>2 (8%)</td>
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<tr>
<td>(n=52)</td>
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<tr>
<td>Multi-vessel</td>
<td>28</td>
<td>20 (71%)</td>
<td>16</td>
<td>6 (37%)</td>
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<td>(n=44)</td>
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</tr>
<tr>
<td>Left main</td>
<td>3</td>
<td>3 (100%)</td>
<td>—</td>
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<tr>
<td>(n=3)</td>
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DN =diastolic notch; LAD =left anterior descending coronary artery.

Figure 3 Left panel: M-mode echocardiogram (parasternal long-axis view) during dobutamine stress echocardiography from a patient with a severe, proximal left anterior descending stenosis. A septal diastolic notch is visible. Right panel: after dobutamine the septal notch has disappeared and septal motion is normal.
It is possible that this anomalous diastolic septal motion is related to one or more of three mechanisms: (a) abnormal septal relaxation induced by ischaemia, (b) abnormal diastolic pressure-volume relations induced by ischaemia, and (c) change in the early diastolic intraventricular flow pattern induced by ischaemia.

Conclusions

On the basis of the results of this study, we conclude that in patients without previous myocardial infarction and without left bundle branch block: (1) the appearance of a septal diastolic notch during dobutamine stress echocardiography is very specific for the presence of coronary artery disease; (2) the detection of a diastolic notch is mostly related to the existence of severe left anterior descending artery stenosis; and (3) diastolic notch precedes the development of ventricular asynergy.

References