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Feasibility Study of Dobutamine Stress Transesophageal Echocardiography

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Dobutamine 부하 경식도초음파도의 임상적 유용성

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= 국문초록 =

연구목적 : 경흉심초음파도소견이 부적절했던 15명(남자 12명, 여자 3명)의 관동맥질환자들에 대한 심근허혈의 유발과 진단을 위하여 Dobutamine 부하와 경식도심초음파도를 동시에 시행하였다. 다섯명의 환자에서는 별개의 경식도심초음파도의 적응증이 있었다.

연구방법 : Dobutamine은 표준투여방식에 의하여 최대 40㎍/kg/min까지 투여하였다. Dobutamine 투여도중 각 단계에서 투여용량을 증가시키기 전에 각종 영상면의 심초음파도영상을 녹화하고 이를 4개화면분할방식으로 다지탈화하여 국소심실벽운동이상을 분석관찰하였다.

연구결과 : 협심증과 심실성기외수축이 각 1명에서 관찰되었으나 다른 부작용이나 합병증은 없었다. 심초음파도영상(midesophageal four-and two-chamber views, transgastric short-and long-axis views)들은 14명에서 만족스러웠다. 한명의 환자에서는 심첨부가 적절히 보이지 않았다. 3명(20%)의 환자에서 새로운 국소심실벽운동이상이 관찰되었으며, 2명(13%)에서는 기존의 국소심실벽운동이상이 심화되었다. 8명의 환자에서는 정상의 Dobutamine부하 심초음파도소견을 보였다. Dobutamine 부하 심초음파도 양성인 환자 2명에서 시행한 관동맥조영술 소견에서 Dobutamine 부하시 발생한 국소심실벽운동이상부위와 일치하는 위치에 의미있는 관동맥협착소견을 보였다.

결론 : Dobutamine 부하 경식도심초음파도는 경흉심초음파도소견이 부적절한 환자에서 심근허혈의 유발 및 진단에 있어 안전하고 유용한 검사방법으로 사료된다.

중심 단어 : Dobutamine 부하 · 경식도심초음파도 · 심근허혈 · 국소심실벽운동이상.

Stress echocardiography has been accepted as a reliable technique for the evaluation of coronary artery disease[1-3]. In a small but important group of patients, transthoracic echocardiography does not provide images that are adequate for evaluating regional wall motion abnormalities.

Because imaging from the esophagus reliably permits the acquisition of high-quality cardiac images,

the use of transesophageal echocardiography (TEE) in conjunction with stress testing has been advocated[4,5]. Stress TEE has been performed with atrial pacing[5] and dipyridamole[4]. Since the time that dobutamine stress echocardiography was introduced at our institution, we have used dobutamine stress TEE in 15 selected patients. This report reviews logistic and technical problems, indications, limitations, and feasibility of dobutamine stress TEE.

Clinical Experience with Dobutamine Stress TEE

Patients

From September 1990 to January 1994, 15 patients (12 men and 3 women) underwent dobutamine stress TEE, which represents 1% of all the dobutamine stress echocardiographic studies performed at the Mayo Clinic during this period. The mean age of these 15 patients was 70±13 years (range, 40 to 94 years) and the mean body surface area was 2.1±0.4 m^2 (range, 1.7 to 2.9 m^2). Three patients had undergone coronary bypass grafting previously and one had undergone percutaneous transluminal coronary angiopla-sty 8 years ago. In all 15 patients, the indication for dobutamine stress TEE was evaluation of symptoms of chest pain or exertional dyspnea. In nine of the patients, the test was used for preoperative risk assessment before noncardiac operations. In all patients, transthoracic imaging was techincally inadequate for assessing regional wall motion. Eight patients were obese (> 95kg), and this included one patient in whom radionuclide angiography was unsuccessful because of large body habitus (patient 5, 199kg). one ventilator-dependent patient had a flail chest and left diaphragmatic tear after a motor vehicle accident ; stress testing was performed at the bedside in the intensive care unit. In another patient, transthoracic imaging was inadequate because of severe chronic obstructive lung disease. In five patients, additional indications for TEE were present : assessment of source of embolism (two patients), endocarditis (one patient), flail segment of aortic valve (one patient), and rule out atrial septal defect (one patients).

Examination Procedure

In each instance, dobutamine stress TEE was performed after at least a 4-hour fast. The TEE procedure was performed as described previously[6]. To achieve local anesthesia and to diminish the gag reflex, the hypopharynx was sprayed with 10% lidocaine (Xylocaine) before introduction of the TEE probe. Midazolam (Versed) given intravenously was used for mild sedation (1 to 10 mg) in 10 patients. An anticholinergic agent, glycopyrrolate (Robinul), was administered intravenously at a dose of 0.2 mg to decrease salvation. Dobutamine was administered intravenously by an infusion pump at a starting dose of 5 μg/kg per minute, and at 3-minute intervals, the dosage was increased to 10, 20, 30, and 40 μg/kg per minute[7]. continuous three-channel electrocardiographic monitoring was performed for rhythm analysis. Heart rate and 12-lead electrocardiograms were recorded every minute. Blood pressure was recorded every third minute. Criteria for termination of the dobutamine infusion were ventricular tachycardia or sustained supraventricular tachycardia, severe hypertension (systolic blood pressure greater than 200 mmHg or diastolic blood pressure greater than 110 mmHg), decrease in systolic blood pressure of 20mmHg from the previous level, target heart rate (85% of the age-predicted maximum heart rate), new regional wall motion abnormalities, electrocardiographic evidence of ischemia, or adverse effects from the infusion. Although a short-acting β-blocker was available to reverse the effect of dobutamine, it was not required for any of our patients.

Wall motion was assessed with a 16-segment model [8]. A biplane or multiplane imaging probe was used in nine patients, and a single-plane imaging probe was used in the six other patients. The midesophageal four-and two-chamber views, the transgastric short-axis view of midventricle, and the transgastric long-axis view (in nine patients with longitudinal views) were digitized in quad screen format[9]. Wall motion was assessed at each stage of dobutamine infusion. Baseline, low dose (10μg/kg per minute), peak dose, and recovery images were digitized. In addition, a videotape of the study, including images from each lev-

el of dobutamine infusion, was available for comparison. Ejection fraction was determined by visual estimation[10]. Left ventricular outflow tract obstruction was based on 2-dimensional and color flow imaging, not Doppler. The development of hyperkinesis during dobutamine infusion was considered normal. Failure to develop hyperdynamic function or development of new regional wall motion abnormalities(hypokinesis, akinesis, or dyskinesis) was interpreted as an ischemic response. Segments with resting wall motion abnormalities that did not change with dobutamine were considered to represent infarcted tissue[7].

Results

The peak dose of dobutamine in our patients ranged from 20 to 40 μg/kg per minute, with the mean dose of 33±6 μg/kg per minute, which is similar to the peak dose during transthoracic dobutamine stress echocardiography (mean 34±9 μg/kg per minute) in our laboratory. Mean resting blood pressure was 152±21/85±16 mmHg, and mean blood pressure at peak dose was 130±38/66±16 mmHg. Mean resting heart rate was 77±19 beats per minute, and mean heart rate at peak dose was 126±21 beats per minute. Mean resting ejection fraction was 55%±13%, and mean ejection fraction at peak dose was 65%±19% (Table 1).

Visualization of all myocardial segments was satisfactory in 14 patients. In one patient in whom single-plane imaging was performed, images of the apex were suboptimal.

Five patients (33%) showed resting wall motion abnormalities, three (20%) had new regional wall motion abnormalities (Fig. 1), and two (13%) showed worsening of regional wall motion abnormalities during peak infusion.

There were no major complications. Left shoulder pain developed in one patient. No other cardiac symptoms were reported. An increase in simple ventricular ectopy was noted in one patient. Dynamic left ventricular outflow tract obstruction[7] developed in two patients (13%) (patients 3 and 13) and was associated with a decrease in blood pressure. One patient showed an increase in the extent of mitral regurgitation by color flow, from trivial at rest to severe at the peak

Table 1. Hemodynamic features and ejection fraction response of 15 patients during dobutamine stress transesophageal echocardiography

Patient	Age, yr	Sex	Blood pressure, mmHg		Heart rate, beats/min		Ejection fraction, %	
			Rest	Peak	Rest	Peak	Rest	Peak
1	59	M	130/ 85	92/ 55	67	140	55	45
2	75	M	157/ 58	NA	74	125	40	45
3	85	M	179/ 83	143/ 69	63	88	65	80
4	78	M	150/ 70	116/ 69	103	150	30	30
5	40	M	140/ 89	207/ 74	82	130	55	75
6	67	M	188/ 97	150/ 63	63	132	60	75
7	77	M	132/ 97	116/ 71	85	152	55	65
8	70	M	182/ 93	119/ 68	60	130	75	85
9	94	M	148/ 70	170/ 70	64	89	65	75
10	53	F	140/ 88	NA	98	144	60	70
11	66	M	169/106	170/100	122	140	55	65
12	66	F	154/113	141/ 83	59	93	60	80
13	78	F	110/ 60	75/ 40	75	110	55	75
14	67	M	140/ 68	96/ 38	77	128	65	85
15	68	M	155/ 93	98/ 60	59	141	25	30
Mean± SD			152±21/ 85±16	130±38/ 66±16	77±19	126±21	55±13	65±19

NA, not available ; SD, standard deviation.

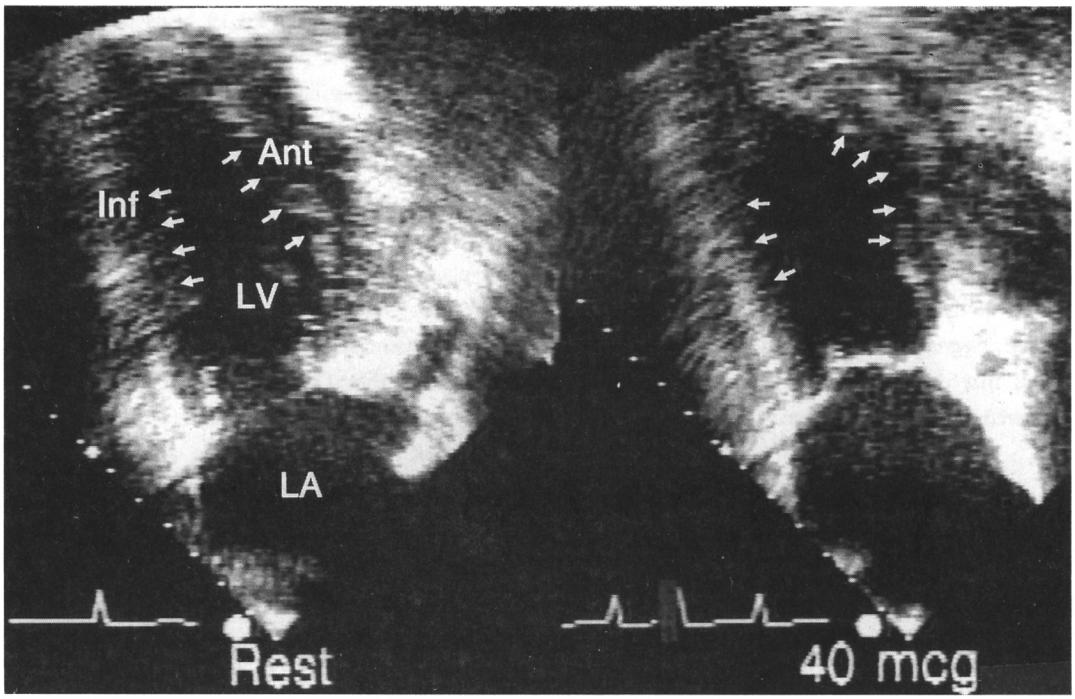

Fig. 1. (patient 1). Midesophageal longitudinal two-chamber end-systolic views at rest and at peak dose (40mcg) dobutamine infusion (right). Note the increased end-systolic volume and hypokinetic anterior wall and inferior wall at peak dose dobutamine infusion (Ant, anterior wall ; Inf, inferior wall ; LV, left ventricle, LA, left atrium). The anterolateral wall was also hypokinetic. Coronary angiography showed 70% of the middle left anterior descending coronary artery, 90% stenosis of the proximal and 60% stenosis of the distal right coronary artery, and 90% stenosis of the first obtuse marginal branch.

dose. This worsening was associated with marked systolic anterior motion of the mitral valve (Fig. 2).

In nine patients, dobutamine stress TEE was performed to evaluate perioperative risk for noncardiac operations. The test results were negative for ischemia in seven of these patients. In one patient (patient 11), mild regional wall motion abnormalities developed, including basal and mid-inferior septal hypokinesis. However, the end-systolic volume decreased and ejection fraction increased at peak dose. The patient in whom the study was markedly positive for ischemia (patient 1) (Fig. 1) underwent coronary bypass grafting before a noncardiac operation. All the patients underwent the noncardiac operations uneventfully.

Among the other six patients, the results of dobutamine stress TEE were negative for ischemia in four. Mild anteroseptal hypokinesis developed in one patient (patient 2), but this was accompanied by a decrease in end-systolic volume and appropriate increase in ejection fraction at peak dose. Worsening of resting wall motion abnormalities at anterior and apical segments developed in another patient (patient 15). Coronary angiography showed 80% stenosis of the middle left anterior descending artery and 50% stenosis of the distal right coronay artery. Percutaneous transluminal coronary angioplasty of the middle left anterior descending artery was performed. There were no cardiac events during the follow-up period of 1 to 36 months.

Discussion

In 1990, Lambertz el al.[11] reported the results of simultaneous atrial pacing during TEE using a specially designed TEE transducer capable of atrial pacing. They reported an overall sensitivity of 93% and a specificity of 100% in 50 patients. Also, they compared stress TEE with bicycle stress ergometry and stress pacing. The sensitivity and specificity of stress

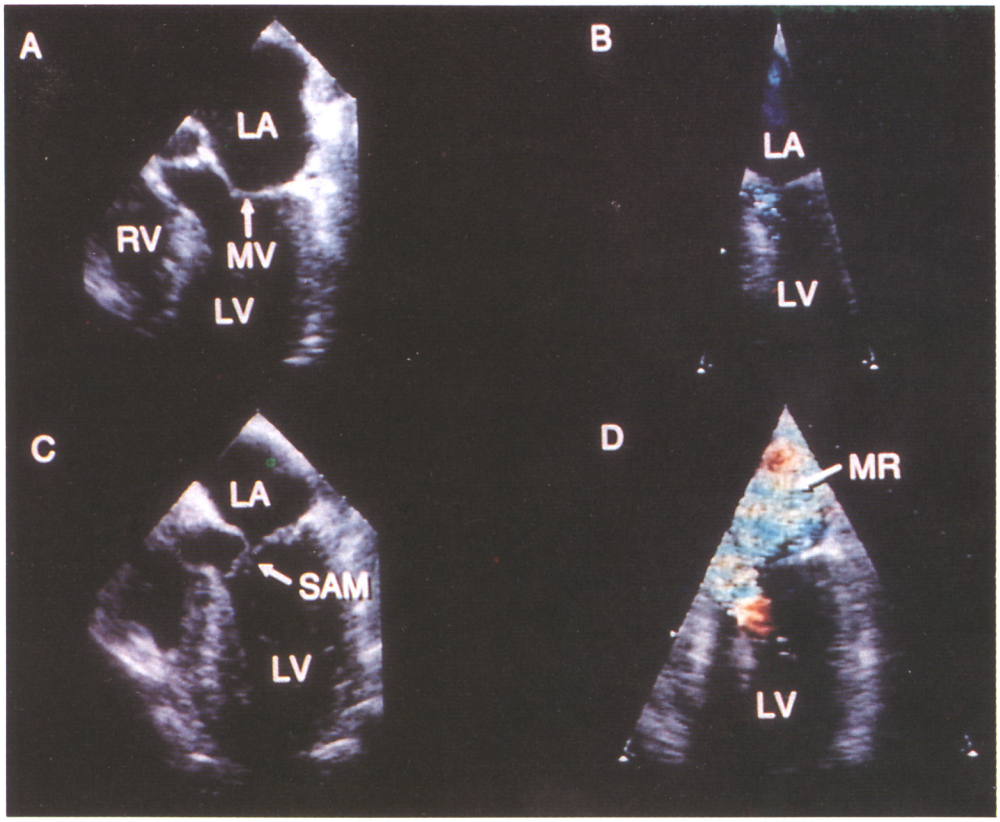

Fig. 2. (patient 13). Normal mitral valve with no mitral regurgitation present at rest (A, B). At peak dose, systolic anterior motion of mitral valve (C) developed in association with severe mitral regurgitation (D). (LA, left atrium ; LV, left ventricle ; MR, mitral regurgitation ; MV, mitral valve ; RV, right ventricle ; SAM, systolic anterior mo-

TEE were superior to those of the other stress tests. However, two patients experienced unacceptable chest discomfort because of the pacing and the test was stopped prematurely. TEE pacing also allowed only one view of the heart to be analyzed during the entire pacing procedure. Any movement of the TEE probe resulted in loss of pacing capture[11,12].

Agati et al.[4] reported the results of dipyridamole TEE for the diagnosis of coronary artery disease in 32 patients who underwent correlative coronary angiography. The overall sensitivity and specificity and the sensitivity for the diagnosis of single-vessel disease were 92%, 100% and 67%, respectively. Transthoracic echocardiography was not feasible because of inadequate images (29 patients) or ambiguous results (3 patients).

Recently, Panza et al.[13], in an abstract, reported on the evaluation of coronary artery disease with dobutamine stress TEE in 50 unselected patients. According to their brief report, TEE provided better endocardial visualization than transthoracic echocardiography, and the sensitivity, specificity, and positive predictive value for the diagnosis of coronary artery disease were 88%, 100%, and 100%, respectively. They reported no complication, although the test was stopped because of intolerance to the probe by two patients.

In our series, dobutamine stress TEE was a safe and feasible alternative to transthoracic stress echocardiography. Dobutamine stress TEE is an alternative diagnostic tool in the evaluation and detection of myocardial ischemia in patients with technically inadequate transthoracic echocardiographic studies or in patients who cannot perform conventional exercise testing. In addition, dobutamine stress TEE may be considered in patients who have a specific indication for TEE as well as an indication for stress echocardiography.

Dynamic left ventricular outflow tract obstruction developed in two patients (13%) and was associated with a decrease in systolic blood pressure. in one of these two patients (patient 13), systolic anterior motion of the mitral valve and increased magnitude of mitral regurgitation were noted (Fig. 2). This patient had no evidence of intracavitary obstruction at rest ; the systolic anterior motion of the mitral valve and obstruction resulted from the hyperdynamic response of the ventricle to dobutamine infusion. Left ventricular outflow tract obstruction during dobutamine infusion was best recognized by a late-peaking left ventricular Doppler velocity profile that exceeded the basal maximum velocity by at least 1m/second ; this has been reported to occur in 21% of patients during dobutamine infusion and may be associated with a decrease in systolic blood pressure[7].

Test Considerations and Limitations

Because TEE examination can be performed at the bedside, it is well suited for patients who cannot be easily transported. It may also be used effectively in patients who have another indication for TEE. Satisfactory visualization of all myocardial segments is possible in nearly all patients, especially if biplane or multiplane imaging is used.

Despite the above advantages, dobutamine stress TEE has several shortcomings. Because of the transesophageal probe and the sedation, patients may not be able to verbalize their symptoms ; thus, the examiner should be alert to nonverbal signs of a patient's discomfort during the test.

Also, it may be difficult to obtain the identical tomographic images at the various stages of dobutamine infusion, especially with a monoplane imaging probe, for the purpose of comparing regional wall motion abnormalities. Other contraindications for routine stress testing[7] and TEE[14] apply to dobutamine stress TEE. For these reasons and because the published experience with dobutamine stress TEE is limited, the test currently should not be considered a substitute for other, more conventional testing.

Conclusion

Dobutamine stress TEE is safe and feasible means for evaluating patients with known or suspected coronary artery disease. As opposed to pacing stress TEE, multiple tomographic views of the heart can be obtained. In the small group of patients in whom transthoracic echocardiographic images are inadequate, dobutamine stress TEE provides superior quality images and may be considered an alternative to conventional stress echocardiography.

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= Abstract =

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Transesophageal echocardiography (TEE) was performed during pharmacologic stress with dobutamine for evaluation of coronary artery disease in 15 patients (12 men, 3 women ; mean age, 70 years) with inadequate transthoracic echocardiographic images. In five patients, additional indications for TEE were present. Dobutamine was administered according to a standard protocol with a maximum dose of 40 μg/kg per minute. Angina and an increase in simple ventricular ectopy were noted in one patient each, but no other complication or side effect was noted. Images (midesophageal four-and two-chamber views ad transgastric short-and long-axis views) were satisfactory for interpretation in 14 patients. In one patient, the apex could not be optimally visualized. Five patients (33%) had resting wall motion abnormalities. Wall motion abnormality developed in three patients (20%) and worsened in two (13%). Dobutamine stress TEE findings were normal in eight patients. Coronary angiography in two patients revealed significant stenosis corresponding to stress-induced wall motion abnormalities. Dobutamine stress TEE is a safe, feasible, well-tolerated alternative to conventional stress echocardiography for detecting myocardial ischemia.

KEY WORDS : Dobutamine · Feaibility study · Myocardial ischemia · Transesophageal echocardiography · Wall motion abnormality.