THE ROLE OF NITRATE ECHOCARDIOGRAPHY AND TI - 201 SPECT IN DETERMINATION OF MYOCARDIAL VIABILITY AFTER ACUTE ANTERIOR MYOCARDIAL INFARCTION AND COMPARISON WITH POST CORONARY REVASCULARIZATION FINDINGS

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SUMMARY

Purpose: *The aim of this study was to evaluate nitroglycerine induced contractile reserve as detected by transthoracic echocardiography for determination of myocardial viability after acute anterior myocardial infarction and to compare the results with thallium-201 single photon emission computed tomography (Tl-201 SPECT) data taking post revascularization echocardiographic improvement as the gold standard for myocardial viability.* ***Methods:*** *Thirteen patients with acute myocardial infarction underwent transthoracic echocardiography with nitroglycerine infusion (0.4 -2 mg/kg body weight per min.) and Tl-201 SPECT. Regional wall motion and regional thallium activity were analyzed by using a 16- segment model. At NE, on segments which have two or more contiguous dysfunction, determining at least one degree of wall motion recovery, was evaluated as viability. At Tl - 201 SPECT, on segments which have perfusion defect, identifying at least one degree of perfusion recovery was evaluated as viability. The wall motion score index (WMSI) was derived by summation of individual segment scores (1:normal;4:dyskinetic) divided by the number of interpreted segments.* ***Results:*** *At baseline echocardiography, 75 myocardial segments were judged as dyssynergic. Regional wall motion improved by one grade or more during nitroglycerine infusion in 42(56%) segments. TI-201 SPECT showed a reversible defect in 53 (70%) segments. After coronary revascularization, follow-up rest echocardiography showed the functional recovery in 57 (76%) myocardial segments. At both NE and follow-up rest echocardiography, WMSI decreased in according to baseline echocardiographic score index ($p < 0.05$). At baseline echocardiography, NE and follow-up rest echocardiography, WMSI was 1.73±0.37, 1.51±0.22 and 1.44±0.31, respectively. When the functional recovery due to coronary revascularization was taken as a gold standard, it was observed that at segments level, the sensitivity of NE was 70% and specificity was 88%; the sensitivity of Tl-201 SPECT was 84% and specificity was 72%.*
Conclusions: *In determination of myocardial viability after acute anterior myocardial infarction, we can say that NE is an alternative method to Tl-201 SPECT, and can be used in the medical centers without Tl-201 SPECT.*

Key Words: *Myocardial Revascularisation, Coronary Disease, Thalium Radioisotopes, Myocardium, Echocardiography, Nitroglycerin.*

INTRODUCTION

Left ventricular dysfunction can be caused by myocardial necrosis, stunned or hibernating myocardium after acute myocardial infarction or in chronic coronary artery disease (1-3). It has been thought that myocardium may be viable if there is a reversible functional disorder in the segments of myocardium (3). Various methods (for example; rest and exercise electrocardiography, low dose dobutamine echocardiography, dipyridamole echocardiography, dobutamine transesophageal echocardiography, dobutamine magnetic resonance imaging, nitrate echocardiography, myocardial contrast echocardiography, post-extrasystolic potentiation, thallium-201 imaging, technetium-99m imaging, positron emission tomography, collateral circulation and tissue Doppler echocardiography) have been used to detect myocardial viability after acute myocardial infarction (1-17). However, none of the above methods are ideal. The thallium-201 single photon emission tomography (TI-201 SPECT) is one of the most common methods used. Nevertheless, the importance of nitrate echocardiography (NE) in determining myocardial viability has not been determined, as far as we know from the literature, taking echocardiographic recovery in the left ventricle function after coronary revascularization as the gold standard.

The purpose of this study was to evaluate nitroglicerine induced contractile reserve as detected by echocardiography for determination of myocardial viability,and to compare the results with TI-201 SPECT data taking post revascularization echocardiographic improvement as the gold standard for myocardial viability.

METHODS

Study patients:

We studied 13 patients with recent (<3 weeks) anterior myocardial infarction (11 men, 2 women; mean age 50.15±7.14 years)in the Department of Cardiology at Gazi University Medical Faculty. The diagnosis of a previous anterior myocardial infarction was based on hospital records, serial ECG recording, serum enzyme determinations and echocardiographic findings.Functional status was assessed in all as class II or III (New York Heart Association criteria).Within the same week , but on different days NE and TI-201 SPECT imaging were performed in the patients. There was no acute cardiac event during the procedures. Patients were excluded if any of the following were present: Unstable angina, history of sustained ventricular tachycardia, atrial flutter, atrial fibrillation, uncontrolled cardiac failure, valvular heart disease and technically inadequate echocardiogram. Informed consent was obtained from all patients before the investigations.

Nitrate Echocardiography:

General Electric RT6800 echocardiographic unit with 2.5 and 3.5 mHz probes was used in NE. Blood pressure and a three- lead ECG were monitored for each patient before NE. Prior nitroglycerine infusion, a complete baseline two-dimensional transthoracic echocardiographic and Doppler assessment was performed for each patient. Images in the parasternal long -and short - axis and apical four -and two - chamber views were acquired before the start of nitroglycerin infusion and at the end of each dose interval , and were recorded.

Nitroglycerine was administered intravenously beginning at a dose of 0.4 mg/ kg/ min . NE protocol involves the use five 3-minute stages of nitroglycerine infusion, at doses of 0.4, 0.8, 1.2, 1.6, and 2 mg/ kg/min. The infusion was terminated when the patient devoleped more than a 20 mmHg decline in systolic blood pressure from baseline, significant side effects, or arrhythmia.

Identical left ventricular segments at baseline and during administration of 0.4, 0.8, 1.2, 1.6, and 2 mg/kg per min. of nitroglycerine were analyzed blind for regional wall motion with use of a standard 16 segment model by two experienced observers. A third observer was asked in cases of disagreement and a majority decision was reached. Wall motion was assessed by visual analysis of endocardial motion and wall thickening and each segment was classified as normal, hypokinetic, akinetic or dyskinetic, each carrying a wall motion score of 1, 2, 3 or 4, respectively. The left ventricular wall motion score index was calculated as the ratio between the sum of all available segmental wall motion

scores and the number of segments visualized. On segments which have two or more contiguous dysfunctions, determining at least one degree of wall motion recovery, was evaluated as viability.

Thallium-201 SPECT:

Stress-redistribution-reinjection imaging was performed on seven patients with class II functional capacity. Rest- redistribution imaging was performed on 6 patients with class III functional capacity.

a) Stress-Redistribution - Reinjection Imaging:

Seven patients performed symptom limited exercise stress test (modified Bruce protocol) in the fasting state in the morning. 111 MBq (3 mCi) Tl- 201 were injected at 75 % of the age-predicted heart rate. This effort was maintained for one minute. Scintigraphic imaging was started within five minutes of the injection of thallium. Redistribution imaging was taken three hours later. Reinjection imaging was assessed by a third series of scintigraphies 30 minutes after reinjection of 37 MBq (1 mCi) of Tl-201.

b) Rest-Redistribution Imaging:

On fasting, 111 MBq (3 mCi) of Tl-201 were injected intravenously at rest. Rest-redistribution Tl -201 SPECT images were started within 20 minutes after the injection and repeated three hours later.

Evaluation of Tl -201 SPECT

The image of Tl-201 SPECT was performed with a dual head gamma camera (General Electric Optima), which is suitable for cardiac imaging. Thirty two projections were acquired over a 180- degree arc, from left posterior oblique. The interpretation of the images was made on the basis of short- axis, vertical, and horizontal long-axis slices. The interpretation of the images were made by two blinded investigators who had no knowledge of the results of nitrate echocardiography. A third observer was asked in cases of disagreement, and a majority decision was reached. Regional thallium activity scores ranged from 0 (severe reduction in activity) to 3 (normal activity). At Tl-201 SPECT, on segments which have a perfusion defect in initial images, showing at least one degree of perfusion recovery in late images, was evaluated as viable tissue.

Cardiac Catheterization:

Selective coronary angiography and left ventriculography were performed with the Judkins technique. Left ventriculography was performed in the 30 right anterior oblique and 60 left anterior oblique views.

The left and right coronary arteries were imaged in multiple views. A lesion was considered significant when it reduced coronary diameter by 50 %[3] . All patients had significant LAD artery lesion.

Follow-up studies:

All patients underwent complete coronary revascularization (coronary by-pass grafting in 12 patients, intracoronary stenting in one patient) at a mean of 28±10 days after onset of acute anterior myocardial infarction. Follow-up rest echocardiography was performed in all patients at a mean of 45±14 days after coronary revascularization. A regional improvement of left ventricular function was defined as a decrease of wall motion score [3]1 grade according to baseline echocardiography.

Statistics:

In this study Wilcoxon Matched-Pairs Signed- Ranks Test and Mann Whitney U-Wilcoxon Rank Sum W Test were used for statistical analysis. Continuous data are presented as mean ± SD. P value<0.05 was considered significant.

RESULTS

A total of 208 myocardial segments were analysed in baseline echocardiography of 13 patients with anterior myocardial infarction. At baseline echocardiography, 10 segments were judged as dyskinetic, 50 akinetic, 15 hypokinetic, and 133 normal. Each patient had two or more contiguous dyssynergic segments.

Nitrogycerine infusion was well tolerated in all patients. Regional wall motion improvement was observed by one grade or more during nitroglycerine infusion in 42 segments (Table 1).

TI-201 SPECT showed a reversible defect in 53 segments and fixed defect in 22 segments among the baseline echocardiographic dyssynergic segments (Table 2).

After coronary revascularization, follow-up rest echocardiography showed functional recovery in 57 myocardial segments (Table 1,2).

Table 1 : Concordance between nitrate echocardiography and follow-up rest echocardiography results in the 75 baseline myocardial dyssynergic segments.

		Follow-up Rest Echocardiography		
		Wall-motion improvement	**No wall-motion improvement**	**Total**
Nitrate Echocardiography	Wall-motion improvement	40	2	42
	No wall-motion improvement	17	16	33
	Total	57	18	75

Table 2 : Concordance between Thallium -201 SPECT and follow-up rest echocardiography results in the 75 baseline myocardial dyssynergic segments.

		Follow-up Rest Echocardiography		
		Wall-motion improvement	**No wall-motion improvement**	**Total**
Thallium-201 SPECT	Reversible defect	48	5	53
	Fixed defect	9	13	22
	Total	57	18	75

When the functional recovery after coronary revascularization was taken as a gold standard, the sensitivity and specificity of NE was 70% and 88% respectively, the sensitivity and specificity of Tl-201 SPECT was 84% and 72% respectively (Table 3).

Table 3 : Comparison of sensitivity and specificity of nitrate echocardiography and Thallium-201 SPECT.

	Nitrate Echocardiography	**Thallium-201 SPECT**
Sensitivity (%)	70	84
Specificity (%)	88	72

At both NE and follow-up rest echocardiography WMSI decreased in according to baseline echocardiographic score index ($P<0.05$). At baseline echocardiography, NE and follow-up rest echocardiography WMSI was 1.73 ± 0.37, 1.51± 0.22 and 1.44 ± 0.31, respectively.

DISCUSSION

Myocardial hibernation is a term first used by Rahimtoola to describe chronic systolic dysfunction as a result of sustained ischemia,which can be corrected by coronary revascularization (18). Important factors that may affect improvement of left ventricular function after coronary revascularization include the presence and degree of preoperative myocardial hibernation or stunning, coronary anatomy, complete revazcularization, presence and degree of perioperative necrosis, graft patency, reliable method to detect improvement, left ventricle size, presence of concommitant primary cardiomyopathy (19).

Prognosis strongly correlates with myocardial viability in patients with left ventricular dysfunction due to coronary artery disease (20). Many studies suggest that patients with severe coronary artery disease and myocardial viability may be at high risk for recurrent cardiac events (20, 21) Early and accurate identification of myocardial viability may identify patients who are most likely to benefit from early revascularization after acute MI.

In our study, complete coronary revascularization were performed successfully in all patients. Echocardiographic recovery of global and regional left ventricular function after revascularization is a universally accepted functional gold standard for myocardial viability. After coronary revascularization, we demonstrated echocardiographic recovery in 76% baseline dyssynergic segments.

In this study, we evaluated nitroglycerine induced contractile reserve as detected by echocardiography with findings on TI-201 SPECT in patients with acute anterior myocardial infarction, and investigated concordance between them and follow-up rest echocardiography. Nitrates have been shown to increase the regional coronary blood flow to ischaemic myocardial regions (15, 17). Thus, nitrates can stimulate the

myocardial contractility. Untill now, NE has rarely beew used for evaluation of myocardial viability (15, 17). When TI-201 SPECT was taken as a gold standard, Pontillo et al. have demonstrated that the sensitivity of NE was 86 % and specificity was 83% (15). However, the importance of NE in determination of myocardial viability has never been researched, as far as we know. When the functional recovery after coronary revascularization was taken as a gold standard, we found that the sensitivity of NE was 70 % and specificity was 88 %.

Up to date, TI-201 SPECT is the most commonly used method to detect myocardial viability (1, 2, 5, 7). However, TI-201 SPECT is more expensive, time-consuming and not available in all medical centres. Previously, studies have shown that TI-201 SPECT reinjection imaging, in conjunction with nitrates, improves detection of reversible perfusion defect (9, 22). Medrano et al. suggested that this improvement might be due to enhanced collateral blood flow (22). We did not use nitrates before TI-201 reinjection for evaluation of myocardial viability in our study. When the function recovery after coronary revascularization was taken as a gold standard, we found that the sensitivity of TI-201 SPECT was 84 % and specificity was 72 %.

In our study, the WMSI of left ventricle was significantly reduced in both NE and follow- up rest echocardiography. This may be an indirect finding of the myocardial viability.

In conclusion, in determination of myocardial viability after acute anterior myocardial infarction, sensitivity of NE was lower than TI-201 SPECT (70% and 84%), but specificity of NE was higher than TI-201 SPECT (88% and 72%). NE is easily applicable and cheaper than TI-201 SPECT. We suggest that NE is an alternative method to TI-201 SPECT, and can be used in the medical centers without TI-201 SPECT. However, further studies will be necessary to support our hypothesis.

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