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ORIGINAL ARTICLE

Left Ventricular Long-Axis Function During Dobutamine Stress Echocardiography for the Prediction of Post- Revascularization Recovery: Comparison with SPECT Thallium Scintigraphy

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ABSTRACT

Aim: To compare echocardiographic left ventricular (LV) long axis function and single photon emission computed tomography (SPECT) thallium-201 scintigraphy for the prediction of recovery of LV dyssynergies after revascularization.

Methods: Thirty patients with a history of previous myocardial infarction and LV dysfunction underwent a transthoracic echocardiographic study before and after successful revascularization (101±14 days), in order to evaluate post-revascularization recovery of asynergic myocardial walls. In these patients and in 25 age- and sex-matched healthy subjects, an additional study during dobutamine infusion was also performed. All subjects also underwent SPECT thallium-201 scintigraphy. Prior and during dobutamine infusion the LV systolic atrioventricular (AV) plane displacement was recorded from the apical four and two chamber views, by M-Mode, at four LV sites, corresponding to the septal, lateral, anterior and inferior walls.

Results: Healthy subjects showed a significant increase in AV displacement at all LV sites during dobutamine infusion ($p<0.001$). However, patients exhibited a significant increase in AV displacement during dobutamine infusion, only in the asynergic sites, with functional improvement in the post-revascularization echocardiogram ($p<0.001$). In the remaining asynergic sites, the AV displacement did not change ($p>0.05$). Selecting a maximum LV systolic AV displacement increase of >2 mm, the method proved to have a sensitivity of 91%, specificity of 83%, positive predictive value of 88% and negative predictive value of 87%. When SPECT thallium scans were used, the above indices were 86%, 65%, 74% and 79% respectively.

Conclusion: The assessment of LV long axis function with the measurement of left systolic AV plane displacement during dobutamine infusion constitutes a simple and accurate method, better than SPECT thalium images, for the prediction of recovery of LV asynergy after revascularization.

INTRODUCTION

Dysfunctional but viable myocardium will resume contraction following revascularization[1], with a net gain of an improvement of left ventricular (LV) function and furthermore, a decrease in overall mortality[2]. The important role of hibernating myocardium in functional recovery, following a revascularization procedure, is well known[3]. Clinical studies have provided evidence that low dose dobutamine infusion combined with a two dimensional echocardiography study, is a simple method with significant accuracy, that can identify areas of myocardial viability[4,5]. However, dobutamine stress echocardiography (DSE) remains a method which mainly relies on subjective interpretations. Measurement of the left atrioventricular (AV) plane displacement during systole with M – Mode echocardiography, provides a simple and more objective assessment of LV function on the long axis[6]. Evaluation of LV function on the long axis has recently been used for the detection of viable myocardium, applying new echocardiographic techniques, which, however, have many limitations[7].

The aim of this study was to compare the value of a novel but simple method of evaluation of LV function on the long axis such as assessment of left AV plane systolic displacement during dobutamine infusion, with myocardial perfusion imaging using thallium – 201 scintigraphy. The latter constitutes a well established diagnostic method, in predicting functional improvement of asynergic, infarcted myocardial segments after revascularization.

MATERIALS AND METHODS

PATIENTS

Thirty seven patients with coronary artery disease and resting regional LV dysfunction due to a previous transmural myocardial infarction, who were scheduled to undergo a revascularization procedure, were screened prospectively for enrollment in the study. All patients provided an informed consent for their enrollment in the study. The study was approved by the Ethical Committee of Evagelismos Hospital. Inclusion criteria were: presence of at least one major epicardial coronary artery stenosis ≥70% according to coronary angiogram, and evidence of any LV wall motion asynergy at rest, present on prior echocardiography.

All the patients had already been scheduled to undergo revascularization (either coronary artery bypass grafting or percutaneous transluminal coronary angioplasty) and the present study did not influence the decision to perform or not the revascularization.

Exclusion criteria were unstable angina pectoris, recent myocardial infarction (<1 month), previous revascularization, contraindication to perform dobutamine stress echocardiography, and primary or secondary heart valve disease. Patients with poor endocardial imaging during echocardiography study were also excluded from our study.

ECHOCARDIOGRAPHY

Before revascularization, all patients had a two dimensional basic echocardiographic study for the evaluation of regional LV wall motion with a 2.5 MHz focused transducer. The endocardial border imaging was poor in 7 out of 37 patients, who were thus excluded from the study. In the remaining 30 patients, apart from basic echocardiography, a two dimensional dobutamine stress echocardiography was also performed, with continuous ECG monitoring, during a 5-minute period of dobutamine infusion of 5 μg/kg/min, followed by another 5–minute period of infusion of 10 μg/kg/min. The parasternal long- and short-axis, as well as the apical two- and four-chamber view imaging, were recorded on a video tape, at the end of each 5–minute period of dobutamine infusion. Baseline regional LV wall motion score, ranging from 1 (normal) to 4 (dyskinesia), was estimated in a corresponding 16 ventricular segmental model[8,9]. Total wall motion score index was derived from the sum of all 16 segmental wall motion scores, divided by the total number of segments considered. Improvement of a segmental contractile function during dobutamine infusion was defined either as an apparent systolic myocardial thickening of a prior to revascularization akinetic or dyskinetic segment (reduction of regional wall motion score from 4 or 3 to 2 or 1) or as a restoration of systolic myocardial thickening and motion to normal levels, of a previously severely hypokinetic segment. A patient was considered to have significant myocardial viability when an improvement in regional contractility occurred in at least two contiguous segments or in at least one segment, when only two segments were of abnormal thickening at rest. All studies recorded in video tapes were analyzed by two separate and blindly selected experienced echocardiographers. Interobserver and intraobserver variability in our echocardiography laboratory have been previously estimated to be <5%. Decision was reached in 460 (95.8%) out of 480 scored segments, whereas in the remaining segments a split decision was resolved by consensus.

Furthermore, LV systolic AV plane displacement during the cardiac cycle was also recorded on videotape. These recordings were obtained using the M-mode technique, directed from apical views, before and during dobutamine echocardiography, at the end of each 5-minute stage of continuous dobutamine infusion (5-10 μg/kg/min). Initially, the M-mode cursor was oriented towards the septal margin of the left AV plane and then, towards its lateral margin, from the apical four chamber view. Following that, the M-mode cursor was placed at the anterior and inferior borders of the left AV plane in the apical two chamber view. Thus, recordings of the septal, lateral, anterior and inferior margins of the LV systolic AV plane displacement reflected wall motion of the basal, mid and apical, septal, lateral, anterior and inferior segments respectively. On each side, the echocardiographic beam was oriented, so as to be perpendicular to the motion of the left AV plane. Using the leading edge of echoes, the total systolic excursion of the left AV plane motion was measured by the same two independent experienced echocardiographers. A mean value of the measurements of three consecutive cardiac cycles was used for the calculation of the left systolic AV plane displacement, regarding the corresponding four segmental sites.

Twenty five age-matched healthy subjects, without a history of heart disease and with normal findings on physical examination, rest and exercise electrocardiography, were used as control group for the assessment of the effect of dobutamine on LV systolic AV plane displacement.

SPECT THALLIUM-201 IMAGING PROTOCOL

Within 3 days after the echocardiographic study and following an overnight fasting, all patients underwent single photon emission computed tomography (SPECT) thallium- 201 scintigraphy, while exercising on a bicycle, according to a standardized, multistage, exercise test protocol. During exercise test, a continuous ECG and blood pressure monitoring was taking place. Forty patients achieved more than 85% of the maximal age-predicted heart rate during exercise. At peak exercise, a dose of 3 mCi thallium-201 was injected intravenously, while the patients continued exercising for one additional minute. Redistribution images were obtained 4 hours later, while patients were resting. Moreover, following an additional 1mCi of thallium – 201 injection, a third set of images was obtained 10 minutes later (reinjection imaging). Images were acquired using a circular orbit over an 180^0 range, starting at the 45^0 left posterior oblique projection and ending at the 45^0 right anterior oblique projection. Each one of the thirty two projections was acquired using a 64X64 matrix at 40s/image. Short axis slices at the apical, mid and basal levels were selected. Basal and mid slices were divided into six segments (anterior, lateral, posterior, inferior, septal, anteroseptal), whereas apical slices were divided into 4 segments (anterior, lateral, inferior, septal), thus creating 16 segments per patient per study, in order to match the echocardiographic LV segmentation. Post-exercise, rest and reinjection images were interpreted by two experienced observers without knowledge of the results of cardiac catheterization or echocardiography. All images were scored using a four point scale, where 0=normal, 1=equivocal, 2= moderate and 3= severe reduction of perfusion. A perfusion defect was considered present when a segment had an initial post-exercise score≥ 2. A segmental perfusion defect was considered reversible if the 4 hours post- exercise score was <2. The 4 – hour non – reversible segments were further categorized as reinjection - reversible when the corresponding reinjection score was <2 or reinjection – non – reversible when the relevant score was ≥2.

CARDIAC CATHETERIZATION

Coronary angiography was performed in all patients using standard techniques. Multiple views of each coronary artery were filmed. A coronary stenosis was considered significant if the vessel diameter was narrowed by ≥70%. Contrast left ventriculography was performed in the right anterior oblique projection. Average LV ejection fraction was calculated using the area - length method.

REVASCULARIZATION

Successful revascularization, based on coronary arteries' anatomy, was achieved through a coronary artery bypass grafting (CABG) procedure in 16 patients and by percutaneous intervention (PCI) in 14, following a 16±5 and 9±4 days period respectively, after the echocardiographic study. The surgeons and the invasive cardiologists who performed the revascularization procedures were not aware of the results of imaging techniques. Periprocedural success was validated by serial ECGs and measurements of cardiac enzymes twice a day for a period of five days. Following discharge, all patients were followed up every 10 days and none of them reported any symptoms indicative of myocardial ischemia. Moreover myocardial ischemia was excluded in all cases by submitting all patients to a treadmill stress test within two weeks before post-revascularization basic echocardiographic study, which took place 101±14 days after the revascularization procedure in order to be used as the gold standard method for the assessment of functional recovery of asynergic infarcted myocardial segments. Moreover, the success of revascularization was proven within one month after basic echocardiographic study accurately with coronary angiography. Successful result of the revascularization procedure was documented in all cases.

STATISTICAL ANALYSIS

Data are presented as mean values ± standard deviation. Rest and stress values within each study group were compared with paired Student's t test. A p value less than 0.05 was considered to be statistically significant. Sensitivity, specificity and predictive values of the tests were estimated.

RESULTS

The main clinical and angiographic data are shown in Table 1. The left anterior descending artery was revascularized in 25 patients, while the left circumflex and right coronary artery in 14 and 17, respectively.

DOBUTAMINE INFUSION

Two – dimensional dobutamine stress echocardiography: None of the patients achieved a statistically significant increase of heart rate (from 67±10 beats/min to 73±16 beats/min, p>0.05) or of systolic blood pressure (from 125±10 mmHg to 130±15 mmHg, p>0.05), from baseline to peak dobutamine infusion. Side effects such as chest pain, dyspnea, palpitations, thatching

TABLE 1. Clinical and angiographic findings of the 30 studied patients.

Mean age	(yr)	= 56.7 ± 9.1
Sex	(M/F)	= 25/5
EF		= 42 ± 5.8%
Anterior	MI	= 7 (23.3%)
Inferior	MI	= 9 (30%)
Lateral	MI	= 3 (10%)
Inferior + Lateral	MI	= 1 (3%)
Anterior + Inferior	MI	= 6 (20%)
Anterior + Lateral	MI	= 4 (13.3%)
1 - vessel disease		= 6 (20%)
2 - vessel disease		= 18 (60%)
3 - vessel disease		= 6 (20%)
PTCA		= 14 (46.6%)
CABG		= 16 (53.3%)

M = Male, F = Female, EF = Left ventricular ejection fraction, MI = Myocardial infarction, PTCA = Percutaneous transluminal Coronary Angioplasty, CABG = Coronary Artery Bypass Grafting

or headache were observed in five patients (16.1%) during the infusion. All side effects were mild and reversible after discontinuation of dobutamine infusion, so that no patient was unable to tolerate the maximum infused dobutamine dose of 10 μg/kg/min.

A total number of 480 segments adequately visualized during baseline echocardiographic study were examined in 30 patients, and included in the analysis. A total of 339 out of 480 segments were characterized as normal, while 141 were considered asynergic. Following dobutamine infusion, an improvement of segmental contractility was found in 69, while 72 segments did not respond, even to the maximum dose of dobutamine. Seventy – six out of 141 asynergic segments showed contractile improvement, while 65 remained asynergic after the revascularization procedure. Dobutamine stress echocardiography showed 81.5% sensitivity, 87.5% specificity, 90% positive predictive value and 78% negative predictive value for the detection of reversible myocardial dysfunction.

Study of left ventricular systolic function on the long axis with assessment of left ventricular systolic AV plane displacement: In the control healthy subjects a statistically significant increase was demonstrated, compared to baseline measurements, of the left AV plane displacement at the four recorded sites following dobutamine infusion (Table 2). In the group of patients with previous myocardial infarction, a statistically significant increase of left systolic AV plane displacement after dobutamine infusion was also detected (Table 2). The data concerning LV systolic AV plane displacement, before and after dobutamine infusion in the remaining asynergic sites, with or without any functional improvement after revascularization, are shown in Table 3. Analyzing each patient separately in terms of changes of LV systolic AV plane displacement after dobutamine infusion, we assessed intra- and inter-observer variability of the

TABLE 2. Comparison of left atrioventricular plane displacement at baseline and after dobutamine infusion, in healthy subjects (A) and in 30 patients (B).

Healthy Subjects		**LAVPD-S (mm) (n=25)**	**LAVPD-A (mm) (n=25)**	**LAVPD-L (mm) (n=25)**	**LAVPD-I (mm) (n=25)**
	Baseline	13.4 ± 1.6 11.1 – 15	13.2 ± 3.3 10.7 – 20	14.6 ± 2.4 12 - 19.3	13.7 ± 3.3 10 - 20
	After dobutamine Infusion	16.6 ± 2.1 14 – 20	16.7 ± 2.5 11.8 - 21.6	17.2 ± 2.5 13 - 22.2	16.4 ± 2.7 11.3 - 21.5
	P value	<0.001	<0.001	<0.001	<0.001
Patients		**LAVPD-S (mm) (n=30)**	**LAVPD-A (mm) (n=30)**	**LAVPD-L (mm) (n=30)**	**LAVPD-I (mm) (n=30)**
	Baseline	9.2 ± 2.3 5.6 – 14	11.0 ± 2.3 6.3 - 13.4	12.4 ± 3 7.7 - 16	10.0 ± 3.2 5.6 – 17.5
	After dobutamine Infusion	10.9 ± 3.4 7.7 – 20	13.4 ± 2.3 9.4 – 18	15.3 ± 3.2 9 - 19	12.5 ± 4.7 4.9 - 22
	P value	<0.001	<0.001	<0.001	<0.001

LAVPD = left atrioventricular plane displacement, S = septal, L = lateral, A = anterior, I = inferior wall of the left ventricle, LAVPD-mean = mean value of the LAVPD, RE = revascularization.

TABLE 3. Comparison of left atrioventricular plane displacement at baseline and after dobutamine infusion in asynergic sites, which improved (A) or did not improve (B) after revascularization

A) Asynergic sites improved after Re		**LAVPD-S (mm) (n=9)**	**LAVPD-L (mm) (n=9)**	**LAVPD-A (mm) (n=5)**	**LAVPD-I (mm) (n=12)**	**LAVPD-mean (mm) (n=35)**
Baseline	Mean ± SD: Range:	9 ± 1.1 7.5 - 10.5	11.6 ± 0.9 9.8 - 13	9.3 ± 1.3 7.9 - 11	9.8 ± 1.3 7.7 - 11.3	9.9 ± 1.6 7.2 - 13
After dobutamine Infusion	Mean ± SD: Range:	11.5 ± 1 10.5 – 13	13.7 ± 1.6 12 - 16	12.1 ± 1 10.7 - 13.8	13 ± 1.3 11 - 15.3	12.6 ± 1.5 10.5 - 16
P value		<0.001	<0.001	<0.006	<0.001	<0.001
B) Asynergic sites not improved after Re		**LAVPD-S (mm) (n=12)**	**LAVPD-L (mm) (n=4)**	**LAVPD-A (mm) (n=2)**	**LAVPD-I (mm) (n=12)**	**LAVPD-mean (mm) (n=30)**
Baseline	Mean ± SD: Range:	9.2 ± 1.9 6.7 - 11.9	10.4 ± 1.6 7.8 - 12.3	10 ± 0.2 9.8 - 10.3	8.5 ± 2.2 5.6 - 11.3	9.1 ± 2 5.6 - 12.3
After dobutamine Infusion	Mean ± SD: Range:	9.3 ± 1.6 7.7 - 12.3	10.9 ± 1.4 9 - 13	10.8 ± 0.2 10.6 - 11	8 ± 1.8 4.9 - 9.3	9.1 ± 1.9 4.9 – 13
P value		NS	NS	NS	NS	NS

LAVPD = left atrioventricular plane displacement, S = septal, L = lateral, A = anterior, I = inferior wall of the left ventricle, LAVPD-mean = mean value of the LAVPD, RE = revascularization

corresponding measurements and they were found to be 4.8% and 5.2% respectively.

A critical increase of LV systolic AV plane displacement more than 2 mm, after dobutamine infusion at the site of the relevant asynergic wall, was considered indicative of viability. In 75% of cases with a critical increase of LV systolic AV plane displacement after dobutamine, we identified improved post-revascularization contractility in at least two segments of the corresponding wall. In 16% of the relevant cases, we found an improvement of contractile function after the revascularization in only one segment of the corresponding LV wall, while in the remaining 9% of cases, no improvement regarding contractile function was observed in any segment of the corresponding wall. Considering a cutoff point of 2 mm of increase, compared to baseline measurements, in LV systolic AV plane displacement after dobutamine infusion, we estimated a sensitivity of 91%, a specificity of 83%, a positive predictive value of 88% and a negative predictive value of 87%, in predicting myocardial viability of the corresponding involved asynergic segments.

SPECT THALLIUM –201 IMAGING

Four hundred eighty segments were analyzed in 30 patients. There was a complete agreement between the two observers in 474 (99%) out of 480 segments, while in the remaining 6 (1%) segments a consensus was reached. Eighty five (38%) out of 226 myocardial segments, which were found to be abnormal on stress imaging, were considered to be completely normal (score = 0) on the 4- hour redistribution imaging. The remaining 141 (62%) were found to have persistent defects. Twenty two segments with persistent abnormalities on stress imaging, were found partially reversible after redistribution imaging (score = 1), while 119 remained non- reversible (score >2). Sixty six (17%) of these non-reversible segments, proved to be reversible after reinjection imaging (score <2). Thus, 88 out of 141 segments with persistent defect demonstrated enhanced thallium uptake on redistribution or reinjection imaging and were considered infarcted but viable. Twenty six (87%) out of 30 patients had redistribution or reinjection reversible infarcted regions, while 4 (23%) did not. Assuming basic echocardiographic study before and after revascularization as the gold standard for myocardial viability, SPECT thallium-201 scintigraphy was found to have 86% sensitivity, 65% specificity, 74% positive predictive value and 79% negative predictive value.

DISCUSSION

Previous studies[10,11] have established the evaluation of intermediate metabolism, assessed by positron emission tomographic (PET) techniques, as a reliable method for the assessment of myocardial viability. This technique additionally offers the opportunity of a quantitative analysis. Of course, evaluation of cell membrane integrity, reflected by thallium-201 uptake, is an alternative equivalent method for the detection of viable myocardium, almost as reliable as PET[12]. However, both of the above mentioned methods, have certain limitations[2,11]. Although, magnetic resonance imaging has been used as an accurate method in identification of myocardial viability, as it can assess systolic thickening quantitatively[13], it is not available in all centers. Moreover, all these methods are time consuming and expensive, in contrast with two dimensional dobutamine stress echocardiography (DSE) which has acquired significant value in the identification of viable myocardium[5,14]. Nowadays, new echocardiographic techniques are continuously being developed and applied in clinical practice. Harmonic imaging is a new echocardiographic modality which has facilitated endocardial border detection during stress echocardiography, while the use of contrast agents has further increased its applicability[15,16]. However even so, DSE still depends on subjectively determined wall motion scores, while arisen discrepancies are still being resolved by consensus[17].

Contraction of the longitudinal fibers of the left ventricle during systole, causes shortening of this chamber longitudinally and descent of the AV plane towards the cardiac apex[18,19]. Although longitudinally-orientated myocardial fibers compose only a small portion of the total myocardial mass -these fibers dominate in subepicardial and subendocardial layers as well as in papillary muscles- several studies have shown that systolic displacement of the AV plane towards the apex is an important component of the systolic performance of the left ventricle. From this point of view, quantification of this movement can provide important information concerning LV systolic function[19]. Although cardiac disorders can affect both longitudinal and radial myocardial fibers, it has been suggested that long axis myocardial contractile function is impaired first[20].

Regarding coronary artery disease, Alam et al[19] demonstrated a reversible decrease in left systolic AV plane displacement in ischemic patients following exercise, which correlated well with the location of coronary artery stenosis. Similarly, Mishra et al[21], studying LV long axis function by simple M - Mode echocardiography, found that the normal increase in systolic amplitude, occurring with dobutamine infusion, is attenuated in patients with ischemic heart disease. This method appeared particularly promising in patients with single vessel disease. Subendocardial fibers, which mainly contribute to LV long axis function, are more prone to ischemia than circumferential fibers, the main component of normal myocardial thickening[21]. A reversible increase of the left systolic AV plane displacement might take place at any asynergic, but viable myocardial site of the left ventricle, during low dose dobutamine infusion, due to a probable improvement of myocardial longitudinal contractile function of the left ventricle, after inotropic stimulation. Measurement of LV systolic AV plane displacement at rest and during dobutamine infusion has been demonstrated to be a reliable method for the detection of viable myocardial tissue[22] with quite high accuracy. Echocardiographic study of LV function along longitudinal axis with the application of new techniques, has been used for the evaluation of myocardial viability with an accepted accuracy[23,7]. Doppler tissue imaging[23] has also been introduced in clinical settings as a new method of quantifying both segmental and global LV function. The measurement of both systolic and diastolic wall motion accelerations and velocities, as well as myocardial displacement, can offer a rapid assessment of the dynamics of the heart. Matsuoka et al[23] performed a study with the use of pulsed tissue Doppler imaging, in order to investigate a possible relationship between viability of a myocardial wall and the corresponding regional systolic mitral annular motion velocity response to dobutamine infusion, in patients with previous myocardial infarction. An increase of peak first systolic mitral annular motion velocity during dobutamine infusion in low dosage, was evidence of viable myocardium regarding the corresponding akinetic myocardial walls in baseline study. However, the point velocity of a specific LV region cannot discriminate between active contraction and passive drawing motion and rotation of the whole heart or contraction of adjacent segments.

Strain rate imaging[7] is another new echocardiographic modality which can be applied for the assessment of the rate of myocardial deformation, i.e. how quickly myocardial tissue shortens or lengthens per fiber length. Strain rate seems to be independent of passive tethering effects exerted from other regions and therefore appears to be a promising method for the quantification of myocardial contraction. In the study by Hoffmann et al[7], strain rate imaging study was performed from apical long axis views, which allowed determination of a baso–apical velocity gradient in each myocardial segment. The authors concluded that an increase of peak systolic strain rate during low - dose dobutamine infusion can discriminate between different myocardial viability states and that strain rate imaging is a method superior to two - dimensional dobutamine stress echocardiography and tissue Doppler imaging for the assessment of myocardial viability. However, current technology of strain rate imaging is characterized by too much noise in the strain rate signal. Furthermore, noise in the strain rate signal is proportional to heart rate and reduced imaging quality. Additionally, the analysis of strain by Doppler echocardiography is significantly angle - dependent[24].

From this point of view, as the modern echocardiographic modalities have crucial limitations so far, the assessment of LV AV plane systolic displacement during dobutamine infusion with the use of M – mode technique may be a superior method for the evaluation of LV systolic function on the longitudinal axis, and subsequently for the detection of myocardial viability and the relevant post-revascularization recovery. Undoubtedly, imaging mitral annular displacement with the use of M – Mode, even during dobutamine infusion, is a simple echocardiographic technique, which can practically be applied in every patient, even in those with poor endocardial imaging. Moreover, mitral annular displacement, at the site of its conjunction with myocardial walls, reflects the systolic functional status of the corresponding myocardial region, thus providing important information regarding the contractility of all LV myocardial walls: anterior, posterior, inferior, lateral and interventricular septum. Intraobserver and interobserver variability of the assessment of systolic AV plane displacement with the use of M-mode technique is insignificant, as it has been documented by both a previous study[19] and the present study as well. An apparent disadvantage of this method is that M-mode echocardiography is considered an obsolete and out of date technique[25], which however does not reduce its value. Although M-mode echocardiography is really an old fashioned technique, evaluation of mitral annular displacement with the use of this technique is becoming fashionable, since it involves study of LV systolic function on the long axis, which is considered a modern approach of estimating its contractility with the application of novel techniques such as strain rate and tissue tracking[26].

In the present study, we avoided a comparison between M-mode assessment of LV systolic function on the long axis and its predictability regarding post-revascularization recovery of akinetic myocardial walls, with novel echocardiographic techniques, which however possess crucial limitations and drawbacks. On the contrary, we compared the M-mode technique with a well-established in clinical practice method for the evaluation of myocardial viability and post-revascularization recovery, such as SPECT thallium 201 scintigraphy.[12]

The significant increase of left systolic AV plane displacement with dobutamine infusion in normal subjects, which was identified in our study, is apparently due to the increase of contraction of the longitudinally oriented muscle fibers. Hoglund et al[27] documented changes in the LV long axis during systole in normal controls and suggested that this method could be applied for the assessment of LV function. In our group of patients, the significant increase in LV systolic AV plane displacement, only in a percentage of asynergic sites having viable tissue, as documented with dobutamine infusion, is apparently due to the restoration of contractility of hibernating myocardial fibers in the long axis, which are devoid of normal contractile function at rest. The high values of sensitivity and specificity of measuring LV systolic AV plane displacement in the prediction of post-revascularization recovery, which were documented in our study, are comparable to those identified by two dimensional echocardiography. Additionally, the 91% sensitivity of measuring left systolic AV plane displacement in the prediction of post-revascularization recovery, found in our study, is obviously superior to the sensitivity of two dimensional low-dose DSE which was only 51% in a recent study[28]. As the study of longitudinal myocardial function can help in the early diagnosis of cardiac dysfunction[20,29], this method with low-dose dobutamine infusion could additionally be useful for the early diagnosis of the post-revascularization restoration of myocardial contractility of infarcted zones. Furthermore, in comparison to two dimensional dobutamine stress echocardiography, measuring LV systolic AV plane displacement during dobutamine infusion offers a quantitative perspective. This measurement was also found in our study to possess better accuracy than SPECT thallium scanning, a method with known low specificity[12] in the detection of myocardial viability and the prediction of post-revascularization recovery. In our study, the combination of measuring LV systolic AV plane displacement and two dimensional echocardiography during dobutamine infusion, in other words, long and short axis DSE,[25] was proved an extremely accurate diagnostic tool in the foreseeing of post-revascularization recovery. This dual assessment combines the study of systolic function of both the longitudinal and the radial myocardial fibers of the left ventricle. The high accuracy of this method has particular importance, taking into consideration the accuracy of positron emission tomographic techniques in predicting improvement of LV function after successful coronary revascularization. Although this technique is considered the gold standard method for the detection of myocardial viability[11], unfortunately it was recently found to possess specificity 56% for the detection of viable myocardium, which is lower compared to the 89% specificity of two dimensional low-dose DSE.[28]

LIMITATIONS

In this study left atrial hemodynamics might influence mitral annular motion in coronary artery disease patients with markedly elevated LV end – diastolic pressure or left atrial dilatation[30]. Moreover, M – Mode echocardiography was performed at the level of the mitral annulus and the measured values might possibly reflect the net effect of both the infarcted area and the wall motion in the noninfarcted regions[23].

CONCLUSIONS

We have described an easy to apply and quite accurate echocardiographic method, which provides a rapid and simple non-invasive, quantitative means of predicting improvement of LV function after revascularization, with better accuracy than SPECT thallium scintigraphy. Further studies, applying novel echocardiographic techniques for the evaluation of LV systolic function on long axis, in predicting post-revascularization recovery, are needed and they are expected with great interest.

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