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Original Article

Exercise Echocardiography and Dobutamine Stress Echocardiography in The Assessment of Suspected or Known Coronary Artery Disease

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ABSTRACT

Exercise echocardiography has become a significant tool of non-invasive valuation of coronary artery disease (CAD). The Exercise echocardiography and dobutamine stress echocardiography are widely applied methods with different clinical procedures and indications. **Objective:** The study was aimed for the Assessment of Suspected or Known Coronary Artery Disease in Assessment of Suspected or Known Coronary Artery Disease. **Methods:** Total 260 consecutive patients endured Stress Echocardiography in the Cardiology department of NICVD Karachi for one-year duration from January 2021 to December 2021. The treadmill was used for Exercise echocardiography applying the Bruce protocol. The standard method was applied for dobutamine stress echocardiography. The Stress Echocardiography was taken as positive on the basis of the appearance of worsening or new wall motion abnormalities. **Results:** Exercise echocardiography performed by 160 patients and DSE in 100 subjects with mean age of 47.21 and 53.10 years, correspondingly. Males were dominated in both groups. The both groups have similar risk factors. In the diagnosis of CAD, Exercise echocardiography was used more often than dobutamine stress echocardiography (61.5% vs 38.5%). The Viability tests have been carried out exclusively by DSE. The frequency of adverse events was 29% in dobutamine stress echocardiography and no one has side-effects in exercise echocardiography. Stress-related dysfunction of left ventricle was much communal in dobutamine stress echocardiography. **Conclusions:** Exercise Echocardiography is a better and safer non-invasive imaging method among subjects who can execute exercise, but DSE is further beneficial for pre-operative evaluation, viability and patients who are disabled physically for ergometer and treadmill exercise test.

INTRODUCTION

Exercise echocardiography (SE) is an extremely useful, modern, non-invasive tool of diagnosis for the valuation of suspected or diagnosed coronary artery disease (CAD patients)1-2. The most common types of SE used in clinical practice are treadmill echocardiography, exercise echocardiography, and dobutamine stress echocardiography (DSE)3-4. The indications and techniques differ in both tests. Published data on SE are scarce in our country, and no comparative study of these two sister modalities has ever been reported in Pakistan5-6. In this descriptive study, we will look at the indications, applicability, results and clinical applications of these two tests.

METHODS

260 consecutive patients endured Stress Echocardiography in the Cardiology department of NICVD Karachi for one-year duration from January 2021 to December 2021. Inclusion criteria were all patients referred for evaluation of known or suspected ischemic heart

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disease. Dobutamine stress echocardiography was accomplished in subjects with physical disabilities or unable to exercise. All other patients were included in the echocardiographic examination on the treadmill. The exclusion criterion was patients having contraindication to dobutamine and exercise echocardiography. Patients advised to do an overnight fast or at least 2½ hours fasting prior to stress echocardiography. In stable patients, medication was withdrawn 48 hours prior to the study, while unstable patients were assessed with continuing treatment. Clinical data on risk factors, pre-existing ischemic heart disease, revascularization, and cardiac medications were recorded on pre-designed forms. A history and a brief physical examination were performed to rule out any known contraindications for exercise / dobutamine SE.

Equipment: The tests were conducted using echocardiography machine and the integrated operating system for stress testing and a multi-frequency probe (2.5, 3.7 and 5 MHz). Studies recorded simultaneously on magnetic optical disk (MOD's), video tapes and a hard disk. In order to facilitate imaging from the apex of the heart, an echocardiographic bed with cut-out window was used. The 12-lead ECG is recorded at rest, at the end of each phase, and during recovery. A downward or flat depression of the ST segment 1 mm from the J point is considered positive for stress induced ischemia. The rhythm was continuously monitored for any arrhythmias. Dobutamine infusion given with an automatic infusion pump. Blood pressure and heart rate are recorded at each stage. During the examination, a fully equipped resuscitation trolley was located at the patient's bedside. The ETT was performed on a standard treadmill. The authors himself performed all echocardiographic examinations and their interpretation. A trained charge nurse took the pulse and blood pressure. An ECG technician recorded a 12-lead ECG and operated the monitoring system. Clinical data collected by a trained computer assistant.

Exercise Treadmill Echo: The Resting images taken from the standard digitized technique and stored. The chest electrodes have been used in a modified way to facilitate the visualization of the apex and the parasternal space, i.e., one intercostal space above for V2, V3 and one space below for V4, V5, V6. The Bruce protocol was adopted in most patients and a minority of patients exercised according to the modified Bruce protocol. The exercise was carried out in accordance with the proposed criteria. The patient was placed on the imaging bed in the left lateral decubitus position immediately later to the finish of exercise (without a cooling-down period). Post-stress imaging is performed in 60-90 seconds. The stress and rest images are demonstrated side by side on quad screen format in cine loop. Work saved on the MODS and hard drive for future use.

Dobutamine Stress Echo: Resting imagesof echocardiography taken from the apical and parasternal windows. 4 typical images were obtained, 1 = parasternal short axis, 2 = parasternal long axis, 3 = apical 4-chambers, 4 = apical 2-chambers were obtained. In addition, images of the apical short and long axis were frequently recorded. Images captured at the end of each stage (resting, low, average and peak dose). All images were digitized online and demonstrated side by side for compairing still images in a continuous film loop. Four independent quad screens were used, 1 quad screen for all 2-chamber apical view, 1 for all 4-chambers apical views, etc. The upper left quadrant of each quad screen showed baseline images, lower left quadrant for mid dose, lower right quadrant for peak dose images and the upper right quadrant for low dose.

Echocardiographic interpretation: The 16-segment model suggested by the American Society of Echocardiography was used for analysis, and each segment was assessed on the basis of its systolic thickening and motion. 1 will be-normal 2 will be hypokinetic 3 will be akinetic 4 will bedyskinetic 5 have aneurysm. The Wall Motion Score index was determined by dividing the sum of the scores by the total numeral of segments displayed. WMSI comes from both rest and stress. A positive test result was determined when there is new abnormal motion in wall or when an existing abnormality worsened (from hypokinesia to akinesia). The lack of a hyperdynamic response to an appropriate stress level was also considered hypokinesis. In the case of viability, the biphasic response (improved at low dose and worsened at high dose) was found to be the most powerful indicator. However, sustained improvement in regional function up to the maximum dose for viable myocardium or cardiomyopathy has also been considered. Overall LV function was assessed by end systolic volume (ESV) and EF. Usually, during stress, EF increases and ESV decreases; otherwise, the test is considered positive for exercise-induced LV dysfunction.

RESULTS

Exercise echocardiography performed by 160 patients and DSE in 100 patients with mean age of 47.21 and 53.10 years, correspondingly. Males were dominated in both groups. The both groups have similar risk factors with the exception of hypertension and smoking, which are more common in men (Table 1).

	Ex.E	DSE
Males	102	70
Mean age	47.21	53
Hypertension	51.9%	36%
Diabetes Mellitus	28.8%	25%
Hypercholesteremia	21.2%	23%
Smoking	35.4%	20%

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Evaluation of known CAD	40.4%	37%
Diagnostic of chest pain, LV dysfunction or dyspnea	57.7%	23%
Follow up after CABG	5.8%	4%
Assessment of viable myocardium	3.8%	24%
Preoperative assessment for non-cardiac surgery	1.25%	4%
Follow up after atherectomy/ angioplasty	3.2%	2%
Rehab study after MI	0.6%	0
No of patients	160	100

Table 1: patient characteristics

In the diagnosis of CAD, Exercise echocardiography was used more often than dobutamine stress echocardiography (61.5% vs 38.5%). The frequency of adverse events was 29% in dobutamine stress echocardiography and no one has side-effects in exercise echocardiography. Stress-related dysfunction of left ventricle was much communal in dobutamine stress echocardiography. (Table 2)

Side-effects	Percentage
Palpitations	16
headaches	5
Lightedness	39
Tremors or chills	8
others	6
Complications	
Sustained V- tachycardia	3

Table 2: Side-effects in DSE

Most of the patients in both groups had satisfactory image quality, with the exception of 10% who had poor images after exercise in exercise echocardiography. The mean maximum heart rate was higher in exercise echocardiography than in DSE (148 Vs 102 mmHg). The maximum mean systolic blood pressure was almost the same(145 Vs 140 mmHg).

Vessel	Lesions detected by SE	Lesions detected by Coronary angiography
RCA	13	13
LAD	12	11
Lcx	10	12
Total	35	36

Table 3: Correlation with Coronary Angiography

The increase in end systolic volume (ESV) after stress and the decrease in EF occurred more frequently in DSE than in exercise echocardiography. Coronary angiograms of 16 patients were available for comparison. There was a 100% correlation with SE. LAD lesions were detected equally in both modes where RCA and LCx disease were diagnosed much higher in DSE than exercise echocardiography. (Table 4)

No of lesions detected by	LAD	RCA	Lcx
Ex.E	12	13	3
DSE	10	8	10
P-value	0.11	0.02	0.008

Table 4: Comparison of detection of lesions by Ex. E and DSE

DISCUSSION

Out of the studied cohort of 260 patients, Exercise echocardiography performed by 160 patients and dobutamine stress echocardiography in 100 patients. Patients undergoing DSE were elder and much frequently had a past of bypass surgery and myocardial infarction, more cardiac risk factors (hypertension, hyperlipidaemia, diabetes, family history of early coronary disease, smoking, higher peak WMSI, abnormal ECGs more frequent at rest, poorer LV systolic function, and therefore coronary angiography is not advised in these subjects5-6. With limited resources, a test with high predictive value is very useful in reducing costly invasive procedures such as coronary angiography. The diagnostic accuracy and predictive value of DSE is sophisticated than that of simple exercise ECG. Exercise echocardiography is superior to DSE because it is more physiological, has a better homodynamic profile, restores symptoms, and has fewer side effects7-8. In the current study, 29% of patients experienced some type of side effect with DSE, while none with Ex.E9-10. However, the exercise echo is technically more difficult due to hyperventilation, excessive movement of the chest wall, and tachycardia11-12. DSE is less demanding because the patient is comfortable in a good position for ultrasound imaging without hyperventilation or significant tachycardia, and has ample time for imaging. In contrast, a positive exercise echocardiogram and the extent of regional wall motion disorders are directly related to an increased risk of an event13-14. There was a 100% correlation between the exercise echo and coronary angiograms, and the distribution of the coronary vessels was almost identical to that found in the exercise echo in the ADA and RCA regions; however, left side circumference disease is relatively underdiagnosed and is consistent with many studies. However, DSE was superior to Ex.E in the diagnosis of left hand circumflex disease (p-value 0.009)15-16. In our series, which was reported as 20% in some studies, no patient developed hypotension from dobutamine stress. This may be due to the relatively low dose of dobutamine administered in our series and the very limited use of atropine (only in 7 patients)17-18. Only 3% of patients developed ventricular arrhythmias in DSE and these are not uncommon, 9% of patients developed premature atrial or ventricular ectopy, and 5% had serial SVT or VT. Data on several studies have revealed MI or ventricular fibrillation in 1 in 2,000 patients19-20. These arrhythmias are usually seen in patients with impaired wall motion at rest or with a history of arrhythmias21-22. One of our patients developed ventricular fibrillation and was able to successfully perform

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CPR. He suffered a myocardial infarction in the anterior wall.

CONCLUSION

Out of the studied cohort of 260 patients, Exercise echocardiography performed by 160 patients and dobutamine stress echocardiography in 100 patients. Patients undergoing DSE were elder and much frequently had a past of bypass surgery and myocardial infarction, more cardiac risk factors (hypertension, hyperlipidaemia, diabetes, family history of early coronary disease, smoking, higher peak WMSI, abnormal ECGs more frequent at rest, poorer LV systolic function, and therefore coronary angiography is not advised in these subjects5-6. With limited resources, a test with high predictive value is very useful in reducing costly invasive procedures such as coronary angiography. The diagnostic accuracy and predictive value of DSE is sophisticated than that of simple exercise ECG. Exercise echocardiography is superior to DSE because it is more physiological, has a better homodynamic profile, restores symptoms, and has fewer side effects7-8. In the current study, 29% of patients experienced some type of side effect with DSE, while none with Ex.E9-10. However, the exercise echo is technically more difficult due to hyperventilation, excessive movement of the chest wall, and tachycardia11-12. DSE is less demanding because the patient is comfortable in a good position for ultrasound imaging without hyperventilation or significant tachycardia, and has ample time for imaging. In contrast, a positive exercise echocardiogram and the extent of regional wall motion disorders are directly related to an increased risk of an event13-14. There was a 100% correlation between the exercise echo and coronary angiograms, and the distribution of the coronary vessels was almost identical to that found in the exercise echo in the ADA and RCA regions; however, left side circumference disease is relatively underdiagnosed and is consistent with many studies. However, DSE was superior to Ex.E in the diagnosis of left hand circumflex disease (p-value 0.009)15-16. In our series, which was reported as 20% in some studies, no patient developed hypotension from dobutamine stress. This may be due to the relatively low dose of dobutamine administered in our series and the very limited use of atropine (only in 7 patients)17-18. Only 3% of patients developed ventricular arrhythmias in DSE and these are not uncommon, 9% of patients developed premature atrial or ventricular ectopy, and 5% had serial SVT or VT. Data on several studies have revealed MI or ventricular fibrillation in 1 in 2,000 patients19-20. These arrhythmias are usually seen in patients with impaired wall motion at rest or with a history of arrhythmias21-22. One of our patients developed ventricular fibrillation and was able to successfully perform CPR. He suffered a myocardial infarction in the anterior wall.history of arrhythmias21-22. One of our patients developed ventricular fibrillation and was able to successfully perform CPR. He suffered a myocardial infarction in the anterior wall.

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