STRESS ECHOCARDIOGRAPHY
ITS PRINCIPLES AND PRACTICAL ASPECTS

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STRESS ECHOCARDIOGRAPHY HAS EMERGED as an important imaging modality for the evaluation of patients with coronary artery disease (CAD).

The rationale for using stress echocardiography stems from the fact that CAD cannot always be confirmed or ruled out on the basis of symptoms and/or ECG findings alone. Moreover, stress echocardiography provides additional information on the cardiac mechanical pump function which is an important parameter that helps the clinician to determine prognosis in patients with ischemic heart disease. Irrespective of the cause, myocardial ischemia in a single coronary territory is associated with three clinical manifestations: abnormal regional left ventricular function, ECG changes, and angina.

Experimental and clinical experience suggests that regional wall motion abnormalities may precede both angina and the ECG changes. The loss of normal contractile activity in a vascular bed results early and rapidly in asynergy, which is detectable by echocardiography.

Advantages of Stress Echocardiography

Stress echocardiography has several advantages for its utility in the evaluation of CAD. The technique is one of the least expensive cardiac imaging modality with regard to equipment, physical setup and the necessary personnel needed to operate the equipment. Moreover, since ultrasound machines are portable, they can subsequently be used at various hospital sites besides the exercise laboratory, such as the patient's bedside, the intensive care unit and the operating room. Furthermore, and additional to the information about CAD and myocardial ischemia, stress echocardiography can diagnose other cardiac diseases that are responsible for causing chest pain, such as hypertrophic cardiomyopathy, aortic stenosis, pericardial disease, and mitral valve prolapse. Finally, this noninvasive modality is safe to both patients, technicians and physicians.

Methods for Inducing Stress

Various stress-inducing methods are used in combination with echocardiography (Table 1). These are either techniques that involve increase in oxygen demand such as exercise, pacing and dobutamine stress, or reduction in oxygen supply such as vasoactive stress.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Pharmacological Beta-agonists</th>
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<tr>
<td>Post-treadmill</td>
<td>(Dobutamine) Vasodilators</td>
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<tr>
<td>Bicycle (Supine/Upright)</td>
<td>(Dipyridamole/Adenosine)</td>
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<td>Isometric (Hand-grip)</td>
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<table>
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<tr>
<th>Pacing</th>
<th>Others Cold</th>
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<tr>
<td>Transesophageal</td>
<td>pressor</td>
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<tr>
<td>Direct atrial Post ventricular</td>
<td>Mental stress</td>
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Exercise-induced Ischemia

Walking on a treadmill is the most common form of exercise used in conjunction with echocardiography. However, because of the difficulty of obtaining echocardiographic images during exercise on the treadmill, studies are, therefore, done at the completion of the exercise protocol.

Supine or upright bicycle exercise can be combined with echocardiography and the ultrasound studies can be obtained at any time during the exercise, including peak stress.
The physiological basis for exercise-induced ischemia is the increase in oxygen demand. With exercise, there is increase in the three major determinants of oxygen consumption, heart rate, blood pressure, and inotropic cardiac state. Unless coronary perfusion increases to satisfy the enhanced oxygen demand, the myocardium will become ischemic. This relationship is modulated by other factors such as body position and coronary tone. A change from supine to upright posture results in marked blood pooling in the legs and abdominal viscera, resulting in a decrease in venous return, left ventricular end-diastolic volume and pressure, stroke volume and cardiac index, thus resulting in reduced cardiac work and delay in the ischemic threshold. Also dynamic changes in the coronary artery tone at the site of the atherosclerotic lesion can be induced by exercise, thus contributing to myocardial ischemia via the mechanism of vasospasm.

**Pacing-induced Ischemia**

Pacing, either via the transesophageal19 or direct atrial routes,20,21 or post-ventricular pacing in which segmental wall motion is analyzed during sinus rhythm that follows a run of rapid ventricular pacing, is used as an alternative technique for induction of myocardial ischemia, for patients who cannot exercise and also have contraindications to pharmacologic myocardial stress agents. The primary mechanism for induction of ischemia during pacing is through the development of tachycardia22 that can be made equivalent to exercise. Augmentation of blood pressure and inotropic state are minor and of secondary importance. An element of vasospasm may also be operating.23

With the development of technology, the introduction of transesophageal echocardiography (TEE) has led to its utilization in combination with trans esophageal atrial pacing.24-26 This latest technique of attaching the pacing electrodes to the TEE probe has enhanced their esophageal contact and resulted in reduction of the stimulation energy and thus contributed to better patient tolerance and lesser discomfort.

**Dobutamine-induced Ischemia**

The inotropic effect of dobutamine is a combination of alpha-1 and beta-1 stimulation.27 Dobutamine also has an alpha-2 vasoconstrictor effect in the vasculature, but this is usually offset by its beta-1 vasoconstrictor activity that limit the net changes in blood pressure following its infusion. Despite the enhanced inotropic effect of dobutamine, this agent through its chronotropic effect also augments the heart rate and the heart rate blood pressure products which are the more important determinants of myocardial oxygen consumption, but usually to a lesser extent than what occurs during sub maximal exercise. Nonetheless, in the presence of coronary stenosis, the ischemic response to dobutamine is analogous to that achieved with exercise.28

**Vasodilator-induced Ischemia**

Coronary vasodilators induce myocardial ischemia by impairment of oxygen supply through the reduction of collateral flow due to lowering of perfusion pressure in the supplying vessels. This phenomenon is known as "steal process," and may be vertical and, therefore, redirected from the endocardium to the epicardium, or horizontal with redirection from areas supplied by a stenosed artery to areas with normal perfusion. Other mechanisms can also be involved such as collapse at the site of coronary stenoses or simple reduction in coronary blood flow due to a reduction in the coronary perfusion pressure.29 Finally, a state of increased demand may be created during vasodilator infusion as a result of increased cardiac workload from sympathetic overdrive initiated by both angina and vasodilatation. This could additionally contribute to the generation of ischemia. Dipyridamole and adenosine are the major coronary vasodilators that are used for stress echocardiography. Dipyridamole inhibits the cellular uptake of adenosine, thus resulting in an increased level of adenosine in the myocardium and the arterial wall. 30 Xanthines that are present in coffee, tea and cola drinks, antagonize the effects of dipyridamole on adenosine metabolism and should be avoided for 12 hours before the examination. Aminophylline is available antidote that counteracts the effects of dipyridamole.

Adenosine, on the other hand is a very potent endogenous vasodilator. It is a direct-acting drug, which rapidly achieves steady state and with rapid onset biological effects.32 The effects of adenosine resolve within one minute of discontinuation of the infusion and, therefore, aminophylline as antidote is not required. Both dipyridamole and adenosine are contraindicated in patients with untreated atrioventricular block and bronchospastic diseases.
Practical Aspects of Performing Stress Echocardiography

Myocardial ischemia impairs regional left ventricular systolic function. The magnitude, spatial distribution and timing of these abnormalities are determined by the extent and severity of ischemia.

Stress echocardiography compares images of the heart acquired at rest with those obtained during or following stress with the realization that regional function deterioration corresponds to the presence of myocardial ischemia. With exercise-induced ischemia, regional dysfunction is usually transient and hence, reliable data are generally acquired at either peak exercise or within the shortest time following exercise which is 60 to 90 seconds. Moreover, higher quality images should be acquired to demonstrate subtle abnormalities in such situations where the coronary stenosis is moderate, peripherally situated or when the stress is submaximal.

The technical demands of stress echocardiography dictate the use of the best available echocardiographic equipment. Conventional video recordings on video-tapes have several disadvantages in stress echocardiography, namely, degradation of image quality during recording and playing back from tapes and impairment of freeze-frame images by artifacts. Recent advances in computers have introduced digital recording as an alternative. Digitization of the images may be performed off-line after the stress or directly (on-line) from the echocardiogram, the latter being less tedious and avoids image degradation. Marwick et al. have confirmed this superiority of digital processing compared to interpretation from video tapes in 86 patients who have undergone both dobutamine and exercise stress echocardiography.

Protocol for Stress Echocardiography

Analogous to scintigraphy, stress echocardiography may be performed with exercise or exercise-stimulating techniques, such as pharmacological agents or pacing. If exercise stress is chosen, the examination bed should be in close proximity to the treadmill or bicycle to facilitate rapid acquisition of post-stress images. Repositioning of the electrocardiographic electrodes may be needed to optimize the echocardiographic windows. Intravenous line is required only for pharmacologic stress. The first step in performing stress echocardiography is to obtain high quality baseline resting studies. Non-ischemic causes of chest discomfort such as pericardial disease, pulmonary emboli, aortic and mitral valve diseases and cardiac masses are usually excluded during the resting studies. Parasternal images are acquired and digitized in both the long and short-axis views, the latter being at the mid-ventricular (papillary muscle) level. Two more views are also acquired and digitized from the apical window, which are the apical-2 and apical-4 chamber views.

These four echocardiographic images are repeated during and after stress. Subsequently, the digitized resting and stress data from these four different views are analyzed and compared. With the development of the technology and the introduction of the cine-loop and quad-screen display, both the resting and stress images can be played side by side in cine-loop format for accurate comparison (Figures I and 2).

Definition of Abnormal Stress Study

Regional wall motion at rest is classified as dyskinetic, akinetic, hypo kinetic or normal. Dyskinetic and akinetic segments are considered by most observers as fully infarcted territories, while hypokinetic segments are identified as non-fully infarcted zones, as the residual contractility implies.
the presence of residual viable tissue. With cardiovascular stress, the ventricular wall motion becomes hyperdynamic, and failure to develop such a hyperdynamic response to exercise correlates well with CAD. However, with vasodilator stressors or submaximal exercise, failure to develop hyperdynamic function is not necessarily abnormal.

In segments with normal resting function, myocardial ischemia which is induced by stress, manifests as deterioration of regional endocardial excursion, delayed excursion (tardokinesis) and a reduction of myocardial thickening. Identification of segmental post-stress akinesia or dyskinesia is easy and reproducible. However, hypokinesia is more difficult to identify and requires a reference screen marker to assist in its detection.

The diagnosis of ischemia in segments with abnormal resting function is more difficult to establish and may, to some extent, depend on the stress agent. Improvement of resting hypokinesia with stress is considered normal, while further deterioration is consistent with ischemia. With dobutamine stress echocardiography, further deterioration in resting dyskinesia or akinesia should not be regarded as indicative of ischemia as change in loading condition may be responsible for such a response while with vasodilator stress echocardiography, worsening of these abnormalities are considered to be diagnostic of ischemia.

The summary of the interpretation of the stress echocardiography is shown in Table 2.

Although the above interpretation is purely qualitative, a semi-quantitative regional approach is also widely used for reporting the stress echocardiogram. This is based upon scoring regional function. The popular scoring system which is used is a modification of the American Society of Echocardiography score that was described by Broderick et al., where a score of I is given to normal regions, with scores of 2, 3, 4, 5, 6, and 7, for hypokinesia, akinesia, dyskinesia, aneurysm, akinesia with a scar and dyskinesia with a scar, respectively. A "score index" is obtained by averaging the scores of individual segments which gives a quantitative index of global systolic function similar to the ejection fraction with similar prognostic significance.

### Table 2: Qualitative Interpretation of the Stress Echocardiography

<table>
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<tr>
<th>Diagnosis</th>
<th>Echo-findings</th>
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<tr>
<td>Normal stress echo</td>
<td>A. normal echo at rest with following scenario at peak/post-stress:</td>
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<tr>
<td></td>
<td>Reduction of function. Reduction compared to other hyperkinetic regions.</td>
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<tr>
<td></td>
<td>Tardokinesis (delayed contraction)</td>
</tr>
<tr>
<td>Ischemic stress echo</td>
<td>B. Hypokinetic segment(s) at rest with further deterioration at peak/post-stress.</td>
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moderate stenosis in a single vessel disease, poor image quality, delayed post-exercise image acquisition, continued antianginal medications and submaximal exercise. If one of these causes is present in a non-positive exercise echo, the test should be labelled as non-diagnostic rather than negative.

Exercise echocardiography has a similar accuracy for detection of coronary artery disease as other nuclide techniques such as Thallium-201 perfusion scanning and exercise nuclear ventriculography (Exercise MUGA).

**Indications of Exercise Echocardiography**

There are many indications for the use of exercise echocardiography apart from its utilization in the diagnosis of CAD. The technique is used after coronary bypass surgery for detection of bypass grafts obstruction or progression of the native CADs and also in assessing PTCA results and in resolving treadmill exercise ECG ambiguity, such as false-positive and false-negative results that may approach 50% in middle-aged women. Prediction of prognosis following myocardial infarctions is also additional important indication of exercise echocardiography.

**Pharmacologic Stress Echocardiography**

The protocols for dobutamine, dipyridamole and adenosine stress echocardiography are shown in Tables 4 and 6 and the contraindications for dobutamine stress echo are shown in Table 5.

Compared to exercise echocardiography, pharmacologic stress echo cardiography has the advantages of high-quality image acquisition, obtainment of images at peak stress which enhances the technique's sensitivity, and also the capability of determination of the time of onset of myocardial ischemia which has important prognostic implication, since the earlier the induction of
ischemia occurs, the more ominous is the prognosis of CAD. These merits of pharmacologic stress echo cardiology are analogous to those of pharmacologic stress thallium scintigraphy.55-58

Indications of Pharmacologic Stress Echocardiography

Diagnosis of coronary artery disease (CAD): Pharmacologic stress echocardiography is primarily used for the diagnosis of CAD in patients who are unable to exercise due to peripherovascular orthopedic and neurologic diseases or those with poor physical fitness, such as the elderly.59-61

Use after coronary bypass surgery (CABG): Stress echocardiography is used after CABG for the detection of graft attrition and the progression of disease in native coronary arteries. Sensitivity and specificity for the technique of 95% and 87%, respectively, have been reported.62,63

Evaluation of patients pre and post coronary angioplasty (PTCA): Selection of patients and evaluation of the immediate results of PTCA 64-66 and diagnosis of late restenosis 65,67 are also other indications of pharmacologic stress echocardiography. The test accuracy in the diagnosis of late restenosis correlates well with isotope-perfusion scintigraphy.41

Prognosis following myocardial infarction (MI): Post-MI, the frequency of cardiac events during the first year ranges between 5% to 10%.6 Detection of an ongoing ischemia that requires revascularization is an important goal. The prognostic stratification of post-MI patients is, therefore, another important indication of pharmacologic stress echocardiography.77-73 Both dobutamine and dipyridamole stress echocardiography have the capability to detect the amount of left ventricular damage on the rest images, the extent of jeopardized myocardium on the stress images and the evaluation of left ventricular function based on a wall motion score index.41

Bosco et al.74 reported a sensitivity and specificity of 76% and 92%, respectively, for dipyridamole stress echocardiography for prediction of cardiac events such as death, re-infarction and angina pectoris within the first year post-MI. The test was performed between 1 to 2 weeks post infarction, which proves its safety. In a group of patients with recent MI, McNeil et al.75 showed that dipyridamole echo was more accurate than MIBI spect in the prediction of subsequent hard cardiac events, largely because of its higher positive-predictive value.

Prediction of cardiac events in patients undergoing major non-cardiac surgery: Pharmacologic stress echocardiography is further utilized for preoperative risk assessment of patients scheduled for major vascular or intraabdominal surgery76-83 with a sensitivity, specificity, negative predictive value and accuracy for both dobutamine and dipyridamole of 88% to 100%, 83% to 98%, 99% to 100% and 85% to 97%, respectively, for prediction of perioperative cardiac events of death, MI, angina pectoris or CABG.

Detection of coronary artery disease in special groups: Stress echocardiography is of great value and high accuracy in women, hypertensive patients with left ventricular hypertrophy and patients with left bundle branch block.84-86 In these special groups of patients, both the exercise ECG and Thallium-201 scintigraphy are plagued with unacceptable percentages of false-positive and false-negative results.

Diagnosis of viable myocardium: The presence of viable myocardium influences the clinical decision making of revascularization. The definition of myocardial viability is the improvement in regional and global left ventricular systolic function following myocardial revascularization. Conventional techniques of detecting myocardial viability that rely on the ECG Q-waves and fixed scintigraphic perfusion defects lack accuracy. ECG Q-waves may harbor a large zone of underlying viable ischemic myocardium, and regional left ventricular dysfunction may reflect myocardial stunning or hibernation. Thallium perfusion defects which fail to reverse on the 4-hour redistribution images do not predict functional recovery or non-recovery following revascularization.

Experimental models of myocardial stunning have shown that regional myocardial dysfunction may be temporarily ameliorated by sympathomimetic agents such as isoprenaline,
Table 7: Interpretation of myocardial viability using dobutamine stress echocardiography.

**Viable area:**
Visible area: will be abnormal at the rest echo and will show improvement on low dose dobutamine. On peak dose dobutamine it will either show further improvement (if the infarct-related artery is patent) OR deterioration (if the artery is occluded).

**Infarcted area:**
Infarcted area: will be abnormal at the rest echo and also will show no change at both the low and peak dobutamine dose.

dopamine and dobutamine provided that the myocardium is viable. The protocol of low dose dobutamine for detection of viable myocardium and the stress echo interpretation of myocardial viability are shown in Tables 4 and 7, respectively. Figures 3 and 4 are examples of low dose dobutamine stress echocardiogram.

Dobutamine stress echocardiography has been introduced for the assessment of myocardial viability in chronic coronary artery disease; postmyocardial infarction, following reperfusion with thrombolysis and PTCA and the prediction of the magnitude of improvement in wall motion abnormalities with surgical revascularization. Most clinical studies have used low-dose dobutamine infusion rate of 5 to 10 mcg/kg/min. The response of ventricular segments to increasing doses of dobutamine may indicate the underlying mechanism of dysfunction. Stunned segments that have normal perfusion show dose-dependant augmentation of function. In hibernating myocardium with reduced perfusion due to critical coronary stenosis, a biphasic contractile response usually occurs—function improves at low doses of dobutamine and deteriorates at higher doses. This biphasic response is, therefore, an indicator of significant underlying coronary residual stenosis. However if this biphasic contractile response is not appreciated, the affected segment will be interpreted as non-viable and this will reduce the sensitivity of the test. Many authors have reported the sensitivity, specificity, negative- and positive-predictive values and accuracy of low-dose dobutamine in the assessment of myocardial viability. In 59 patients thrombolysed after acute myocardial infarction Previtali et al., reported a sensitivity, specificity, negative- and positive-predictive values of low-dose dobutamine in predicting spontaneous recovery of function of 79%, 68%, 50% and 89%, respectively. Watada et al. studied 21 patients with reperfused anterior myocardial infarction with a mean of 3 days post-infarction and reported a sensitivity and specificity of 83% and 86%, respectively, for predicting reversible dysfunction. Smart et al. reported a sensitivity and specificity of 85% and 90% to 93%, respectively, for low-dose dobutamine in detecting...
reversible damage in 63 patients within 7 days of thrombolytic therapy.

Several authors have compared low-dose dobutamine echocardiography to other modalities of detection of myocardial viability. Amese et al. 113 compared low-dose dobutamine stress echocardiography to Thallium-201 SPECT in 38 patients with severe chronic left ventricular dysfunction, and found a sensitivity and specificity for the prediction of postoperative improvement of segmental wall motion of 14% and 95% by low-dose dobutamine and 89% and 48% by Thallium-201 SPECT, respectively. Positive-predictive value of low-dose dobutamine was higher than that of Thallium-201 SPECT (85% versus 33%). Vanoverschelde et al. 114 compared the diagnostic value of exercise-redistribution-reinjection Thallium SPECT and low-dose dobutamine echocardiography for prediction of contractile recovery after revascularization in 73 consecutive patients with coronary disease and regional left ventricular dysfunction. They found on segmental analysis that dobutamine and SPECT had similar sensitivities of 75% and 77%, respectively, but SPECT had a lower specificity of 56% versus 86% for dobutamine (P < 0.01). They concluded that quantitative exercise-redistribution-reinjection thallium SPECT and dobutamine echocardiography have comparable accuracy for prediction of reversibility of global left ventricular dysfunction after revascularization. However, dobutamine echocardiography has greater specificity than thallium imaging for prediction of functional recovery on a segmental basis.

Low-dose dobutamine echocardiography and rest-redistribution 201Thallium scintigraphy were compared by Elhendy et al. 115 in 30 patients within one week of myocardial infarction for their accuracy in the assessment of spontaneous recovery of left ventricular function. The sensitivities, specificities and accuracy of low-dose dobutamine and rest-redistribution Thallium were 77% versus 77%, 84% versus 57%, 82% versus 63%, respectively. The specificity and the accuracy of low-dose dobutamine were higher than the rest-redistribution thallium (P < 0.005). In a comparison between low-dose dobutamine echocardiography and PET, Pierard et al. reported concordance of 79% between the two techniques in the differentiation of viable from irreversibly damaged myocardium post-thrombolysis for acute myocardial infarction. 116

Bax et al. 117 compared low-dose dobutamine to two other techniques which are Thallium-201 reinjection and fluorine-18 fluorodeoxyglucose (FDG) combined with single-photon emission computed tomography (SPECT) to predict functional recovery after revascularization in 17 patients with left ventricular dysfunction and mean ejection fraction of 36±11%. Regional and global ventricular function were evaluated before and 3 months after revascularization by echocardiography and radionuclide ventriculography, respectively. Myocardial F-18 fluorodeoxyglucose uptake (during hyperinsulinemic glucose clamping) was compared with rest perfusion assessed with early Thallium-201 SPECT. Low-dose dobutamine echocardiography and post-stress Thallium-201 reinjection SPECT were simultaneously performed. The sensitivities for F-18 fluorodeoxyglucose/Thallium-201, Thallium-201 reinjection and low-dose dobutamine echocardiography to assess recovery were 89%, 93% and 85%, respectively. Specificities were 77%, 43% and 63%, respectively. Stepwise logistic regression indicated that F-18 fluorodeoxyglucose/Thallium-201 was the best predictor of recovery of function. However, in hypokinetic segments, the combination of F-18 fluorodeoxyglucose/Thallium-201 and low-dose were the best predictors. The concluded that F-18 fluorodeoxyglucose/Thallium-201 SPECT was superior to the other techniques in assessing functional recovery. Integration of metabolic and functional data is necessary, particularly in hypokinesia for optimal prediction of improvement of regional function.

De Filippi et al. 118 compared low-dose dobutamine echocardiography and myocardial contrast echocardiography (MCE) in predicting recovery of left ventricular function after coronary revascularization in 35 patients with chronic ischemic heart disease. Thirteen patients had coronary bypass grafting and 10 had undergone percutaneous trans luminal coronary angioplasty. Low-dose dobutamine and MCE were not significantly different in predicting functional recovery of hypokinetic segments. In akinetic segments, low-dose dobutamine and MCE had similar sensitivities of 89% and 94%, respectively, and negative-predictive values of 93% and 97%, respectively, in predicting functional recovery. However low-dose dobutamine had a higher specificity of 92% versus 67% for MCE (P < 0.02), and a higher positive-predictive value of 85% versus 55% for MCE (P < 0.02), in predicting functional
STRESS ECHOCARDIOGRAPHY

recovery. Their conclusions were both low-dose dobutamine and MCE predict functional recovery in hypokinetic segments after coronary revascularization in patients with chronic coronary artery disease. In akinetic segments, myocardial perfusion by MCE may exist in segments that do not recover contractile function after revascularization. Therefore, contractile reserve during low-dose dobutamine infusion is a better predictor of functional recovery after revascularization than perfusion.

Bolognese et al. 119 also compared low-dose dobutamine echocardiography with myocardial contrast echocardiography for predicting 1-month recovery of ventricular function in 30 patients with acute myocardial infarction treated with primary angioplasty. Low-dose dobutamine had a sensitivity and negative-predictive value similar to MCE (89% versus 96%, and 93% versus 89%, respectively), but a higher specificity of 91% versus 18% (P < 0.001), a higher positive-predictive value of 86% versus 41% (P < 0.001) and a higher overall accuracy of 90% versus 47% (P < 0.001). They concluded that contrast enhancement shortly after recanalization does not necessarily imply a late functional improvement. Contractile reserve elicited by low-dose dobutamine is, therefore, a more accurate predictor of regional functional recovery after reperfused acute myocardial infarction than microvascular integrity.

Dobutamine echocardiography is an attractive technique because of its low cost, convenience to both patient and physician, additional ancillary information and determination of the possible need for urgent revascularization. Moreover the technique can be performed at the bedside with great safety as early as couple of days following myocardial infarction. Limitations of dobutamine echocardiography include occasional technical difficulty in obtaining and interpreting predictive value of functional recovery.95

Conclusion I.

Stress echocardiography plays multiple roles in the diagnosis and management of CAD. The 2. technique which comprises various - modalities of myocardial stressors has multiple clinical applications in ischemic heart disease. Apart from 3. its use in the diagnosis of latent CAD, the technique is also valuable in monitoring the success of reperfusion therapies and the various revascularization procedures both interventional, such as angioplasty and surgical, such as coronary bypass surgery. Stress echocardiography also has a role in the prediction of prognosis of patients who are scheduled for major non-cardiac surgery such as abdominal or vascular surgery.

Following myocardial infarction, stress echocardiography assesses the prognosis and helps in the detection of viable myocardium at jeopardy and its need for a revascularization procedure.

Stress echocardiography and radionuclide techniques have similar sensitivities, specificities and diagnostic accuracies, based on the comparative studies which are available in the literature. They share provision of the same information and have similar clinical applications. Stress echo cardiography, however, has several advantages over radionuclide studies, being less costly, and not posing any risk to patients, technicians, or physicians. It can be performed at any site within the hospital or in an office and a versatile technique that provides instantaneous diagnosis to virtually any cardiac abnormality in addition to CAD, and helps in unravelling other causes of chest pain beside CAD. Despite these advantages of stress echocardiography, the likelihood is that this technique and the radionuclide techniques will all continue to be in use in clinical practice in various institutions. An institution's preference of one technique over the other will be dictated mainly by the availability of the expertise of that particular technique in the institution.

Acknowledgement

The author gratefully acknowledges Mrs. Marlene Bartolome-Bernardino for her secretarial assistance in the preparation of this manuscript.

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