Pak Heart J

COMPARISON BETWEEN DOBUTAMINE STRESS ECHOCARDIOGRAPHY AND MYOCARDIAL PERFUSIONM IMAGING IN DETECTION OF CORONARY ARTERY DISEASE

Sher Bahadar Khan[1], Sultan Zaib[2], Muhammad Adil[3], Syed Tahir Shah[4], Muhammad Asif Iqbal[5] ,Shahzeb[6], Mohammad Hafizullah[7]

[1-7]Department of Cardiology, Lady Reading Hospital & Khyber Medical University, Peshawar - Pakistan

Address for Correspondence:
Dr.Sher Bahadar Khan,
Department of Cardiology, Lady Reading Hospital, Peshawar - Paksitan

E-mail: docyousafzai@yahoo.com

Date Received: August 11, 2012
Date Revised: August 27, 2012
Date Accepted: September 12, 2012

Contribution
All the authors contributed significantly to the research that resulted in the submitted manuscript.

All authors declare no conflict of interest.

ABSTRACT

Objective: To compare the validity of both myocardial perfusion imaging (MPI) and 2-dimensional echocardiography for identification of patients with coronary artery.

Methodology: This was hospital based observational study, conducted in Cardiology department, Lady Reading Hospital, Peshawar, from May 2008 to Jun 2009. Total number of patients were 50 in number (Non probability purposive sampling.)

Results: Total of 50 patients, whose mean age was 53.8±9.7, were studied. Men were 35 (70%) and women were 15 (30%). Myocardial perfusion imaging was reported as normal in 5(10%) patients while 45 (90%) had abnormal results. Dobutamine stress echo was interpreted as normal in 8 patients (14%), wall motion abnormality was noted in 42 patients (86%). Coronary angiography showed 44 patients (88%) had > 50% stenosis in at least one coronary artery. Compared with coronary angiography, the sensitivity, specificity, positive predictive value and negative predictive values of myocardial perfusion imaging for detection of CAD were 98%, 67%, 95%, and 80% respectively. The sensitivity for LAD, RCA, and CIRC were 89.7%, 94.7% and 72.2% respectively. The overall sensitivity, specificity, positive predictive value and negative predictive values of dobutamine stress echo were 93%, 83%, 98%, and 63% respectively while for LAD, RCA, CIRC the sensitivities were 84.6%, 73.3%, 72.2% respectively.

Conclusion: Both myocardial perfusion imaging (MPI) and Dobutamine Stress Echocardiography has a high sensitivity for identifying patients with coronary artery disease. Myocardial perfusion imaging is more sensitive than stress echo while the specificity of stress echocardiography is high in detection of CAD.

Key Words: Myocardial perfusion imaging, Dobutamine Stress Echocardiography, Coronary artery disease, Coronary angiography

INTRODUCTION

Exercise testing has a sensitivity and specificity for obstructive CAD of 68% and 77%, respectively, while sensitivity for left main/three-vessel CAD is 86%.[1] Therefore, exercise testing does not detect all patients with (severe) obstructive CAD and the finding of a negative test does not rule out the presence of CAD.[2] The addition of myocardial perfusion imaging (MPI) in conjunction with exercise stress improves the diagnostic accuracy and provides prognostic information incremental to that obtained by clinical and exercise stress test parameters.[3] Overall sensitivity in the subset of patients undergoing angiography was 91% and overall specificity was 87%, with no significant difference between the tracers.[4] Stress echocardiography and myocardial perfusion imaging are commonly used noninvasive imaging modalities for the evaluation of ischemic heart disease. Both modalities have proved clinically useful in the entire spectrum of coronary artery disease. Both techniques can detect coronary artery disease and provide prognostic information. Both techniques can identify low-risk and high-risk subsets.[5-6] Scintigraphy is also useful in evaluating myocardial viability, in establishing the "culprit" lesion prior to revascularization, in assessing the completeness of revascularization, and in the risk stratification of patients with stable CAD, postmyocardial infarction, post-unstable angina, and prior to vascular surgery.[7]

Apart from diagnosis of CAD, stress echocardiography is used for assessing the results of various revascularization procedures[8-9] and for risk stratification[10-11] Coronary angiography remains the gold standard for identifying the presence or absence of arterial narrowing due to atherosclerosis. It is the only helpful modality in determining the choice of intervention either percutaneous or coronary artery bypass grafting.[12] Coronary angiography may be warranted in young patients with acute infarction to define the anatomy of the disease.[13] But it cannot be applied as a screening test because it is invasive, costly and needs definite cardiac catheterization laboratory. Myocardial perfusion imaging and stress echocardiography are highly sensitive and specific non-invasive diagnostic modalities. The rationale of this study was to compare these two modalities in our local setup and this will help in selection of non-invasive test required and will aid in selection of patients for coronary angiography and intervention.

METHODOLOGY

This hospital based observational study was conducted from May 2008 to Jun 2009, in Cardiology department, Postgraduate Medical Institute, Lady Reading Hospital, Peshawar, KP. Total number of patients were 50.It was non probability purposive sampling. Using WHO sample size estimating software , 5 0stable angina patients at 9 5 % confidence level with 5 %margin of error was needed to find out to compare the sensitivity and specificity of dobutamine stress echocardiography and myocardial perfusion imaging keeping the angiographic findings as gold standard .The expected prevalence of patients with stable angina was 3 . 5 % .

All patients irrespective of sex and age with stable angina and undergoing coronary angiography with or without past history of myocardial infarction were included.All 50 patients underwent MPI, Stress echo and coronary angiography. Patients with (acute coronary syndrome.(acute ST elevation MI,NSTEMI,and USA), valvular heart diseases, congestive heart failure,acute pulmonary embolism or pulmonary infarction, uncontrolled hypertension (systolic BP> 190mmHg, Diastolic BP>120),acute myocarditis or pericarditis,acute aortic dissection and Uncontrolled arrhythmia) were excluded from the study.

Myocardial perfusion imaging procedure: A symptom-limited traedmill exercise stress test was performed on all 50 pateints. Technetium-99m Sestamibi was injected at peak stress, and exercise was continued for an additional 60 seconds. Patients who were unable to perform a physical stress test or patients with a left bundle branch block underwent a pharmacological stress test. Vasodilatation was induced using intravenous administration of dipyridamol infusion in a dose of 142μg/kg/min over 4 minutes. Technetium-99m Sestamibi was injected 3 minutes after start of infusion of the pharmacological agent. Horizontal or downsloping ST-segment depression of 1 mm or greater or upsloping of 1.5 mm or greater at 80 milliseconds after J point was considered positive for ischemia. A dose of 20 mCi was given intravenously, stress study. Dosages of 20 and 30 mCi, respectively, were given for the rest study. All acquisitions took place 30 to 45 minutes (stress) or 45 to 60 minutes (rest) post-injection. Gated SPECT acquisition protocol was performed post-stress. Acquisitions were performed with a 1-detector gamma camera (Ecam, Siemens). Quantitative SPECT analysis was performed on an ICON workstation computer (Siemens). Semi-quantitative visual interpretation of SPECT perfusion images used short-axis and vertical long-axis tomograms divided into 17 segments for each patient. Myocardial perfusion status was scored as follows: 0=normal radiotracer uptake; 1=mildly reduced uptake; 2=moderately reduced tracer uptake; 3=severely reduced tracer uptake; and 4=absent radiotracer uptake. Perfusion defect was considered fixed when there were no differences between rest and stress score, while reversible defect was defined as a segment with higher score on stress images. Ischemia was defined as a change of one or more grades between rest and stress images. Interpretation of tomographic images was done by consensus of two

experienced observers unaware of other patient data.

Dobutamine Stress Echocardiographic Procedure: Dobutamine stress echocardiography was performed by ACO-Son Siemens CV-70 . Patient was started dobutamine infusion at 10μg/Kg/min for 03 minutes, and dose was increased by 20, 30, and 40μg/Kg/min in 03 minutes as per incremental dosing protocol. Images were recorded on video tape at baseline, at minimum dose, at peak dose and at recovery period. For semi quantitative assessment, the LV was divided into 16 segments model recommended by the American Society of Echocardiography. The location of segmental wall motion abnormality was bcorrelated with the location of diseased coronary arteries. Left ventricular wall motion was assessed qualitatively and graded as normal, hypokinetic, akinetic or dyskinetic according to 4 point scale. A score of 1(normal) to 4(dyskinetic) was assigned to each segment under resting conditions and during the test. A wall motion score index was derived by summation of individual segment score divided by the total number of segments.

A test was considered positive if new wall motion or worsening of previous wall motion abnormality developed in $\geq$1 segment and score increased by $\geq$1 grade. The resting wall motion abnormality was also considered positive in this study.

Coronary Angiography: Coronary angiography was performed in all 50 patients. A coronary stenosis was considered significant if the vessel diameter was narrowed by 50% in a major epicardial coronary artery or a major branch vessel. Visual estimation of percent diameter stenosis was performed in all the patients. The view demonstrating the maximum stenosis was considered for analysis.

Chi-square test was used to compare the significant relationship between Coronary Angio and stress echocardiography, Coronary Angio and Myocardial Perfusion Imaging in detection of coronary artery disease. Sensitivity, specificity, positive predictive values, negative predictive values were calculated according to standard definitions. P-value of less than 0.05 was considered significant. Data was analyzed in SPSS version 11.

RESULTS

A total number of patients were 50, males were 35 (70%). The age was from 26 to 75 years, mean age was 53.8 $\pm$ 9.7years .

Coronary angiography results: On coronary angiography , Significant CAD was detected in 44 patients (88%). Twenty one patients (42%) had single vessel disease, 14 (28%) had double vessel disease, 9 (18%) had triple vessel disease and 4 patients (8%) had left main stem disease . Significant disease in Left anterior descending artery was detected in coronary angiography in 39 (78%) patients, left circumflex coronary artery in 18 (36%) patients and right coronary artery in 19 (38%) patients (Table.1 & 2).

Myocardial perfusion imaging results: The overall sensitivity, specificity, positive predictive value, negative predictive values of myocardial perfusion imaging were 98%, 67%, 95%, and 80% respectively (Table 1).

The calculated sensitivity, specificity, positive predictive value and negative predictive value for LAD were 89.7%, 81.8%, 94.6%, 69.2%respectively (Graph 1 & 2).

For right coronary artery, the sensitivity, specificity, PPV and NPV were 94.7%, 61.3%, 60.0% and 95.0% respectively(Graph No. 1& 2).

For left circumflex artery, the sensitivity, specificity, PPV and negative predictive values were 72.2%, 81.3%, 68.4% and 83.9% respectively (Graph 1& 2).

Dobutamine stress Echo results : The overall sensitivity, specificity, positive predictive value, negative predictive values and accuracy of dobutamine stress (DSE) were 93%,

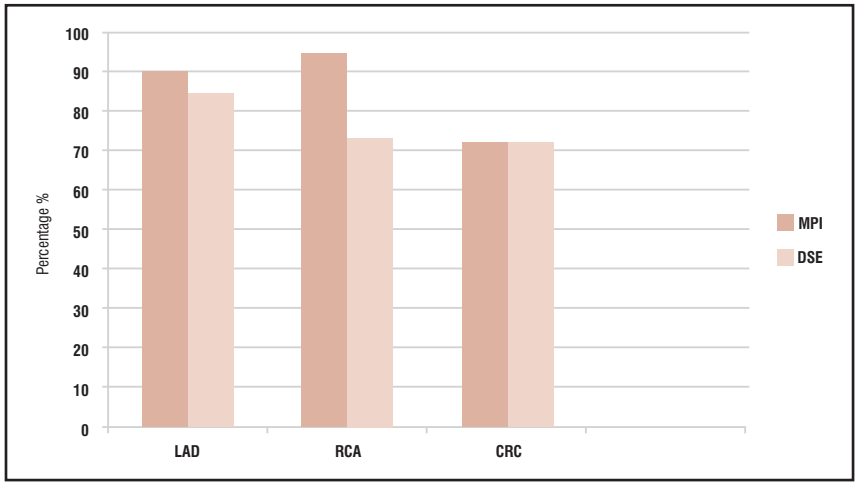
Table 1: Validity of Myocardial Perfusion Imaging (MPI)

Disease on MPI	Disease on Coronary Angiography		Total no. of Cases
	Present	Absent	
Present	43	2	45
Absent	1	4	5
Total	44	6	50
Sensitivity of MPI			98%
Specificity of MPI			67%
Positive predictive value of MPI			95%
Negative predictive value of MPI			80%

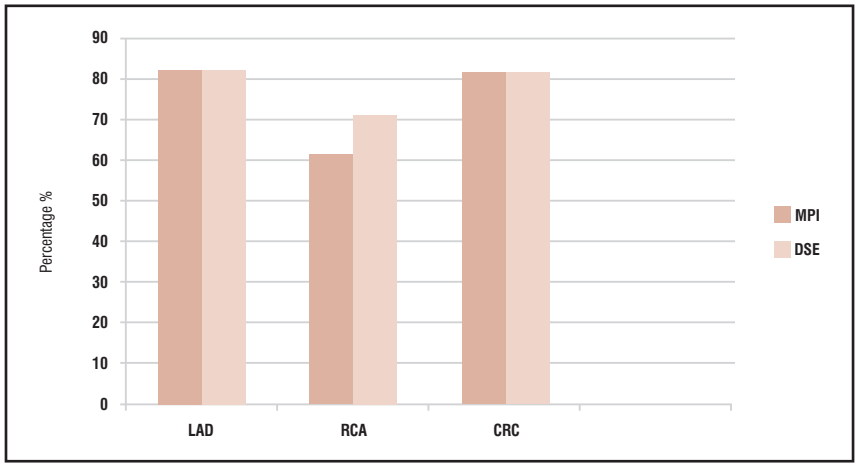
Table 2: Validity of Dobutamine Stress Echo (DSE)

Disease on DSE	Disease on Coronary Angiography		Total no. of Cases
	Present	Absent	
Present	41	1	42
Absent	3	5	8
Total	44	6	50
Sensitivity of DSE			93%
Specificity of DSE			83%
Positive predictive value of DSE			98%
Negative predictive value of DSE			63%

Graph 1: Sensitivity comparison of myocardial perfusion imaging and Dobutamine Stress Echo for Different Vessels



Graph 2: Specificity Comparison of Myocardial Perfusion Imaging and Dobutamine Stress Echo for Different Vessels



83%, 98%, and 63% respectively (Table 2).

The calculated sensitivity, specificity, positive predictive value and negative predictive value for LAD were 84.6%, 81.8%, 94.3%, 60.0%respectively.

The sensitivity, specificity, PPV and NPV for RCA were 73.3%, 71.0%, 60.9% and 81.5% respectively(Graph 1 & 2).

The sensitivity, specificity, PPV and negative predictive values for CIRC were 72.2%, 81.3%, 68.4% and 83.9% respectively (Graph 1 & 2).

DISCUSSION

In our study we observed that both myocardial perfusion imaging (MPI) and Dobutamine Stress Echocardiography has a high sensitivity for identifying patients with coronary artery disease. Myocardial perfusion imaging is more sensitive than stress echo while the specificity of stress echocardiography is high in detection of CAD.

In comparison to our study, O'keefe, concluded that exercise MPI was more sensitive than exercise echocardiography for the detection of significant coronary artery disease, and that pharmacologic MPI was more accurate than dobutamine stress echocardiography.[14] And contrast to it, Geleijnse and Elhendy directly comparing the results of seven studies, of exercise echocardiography and exercise MPI(revealed comparable sensitivities (78% *v* 83%, respectively) and specificities (91% *v* 83%, respectively).[15] But in the same review, the authors also compared dobutamine echocardiography with dobutamine MPI; in eight studies, they found a similar results like our study that, dobutamine echocardiography had a lower sensitivity than MPI (80% *v* 86%, $p<0.05$), but a higher specificity (86% *v* 73%, respectively, $p<0.005$).Similarly meta-analysis by Schinkel and colleagues revealed , a slightly higher overall sensitivity for myocardial perfusion imaging as compared to stress echocardiography (84 vs 80%, $P<0.05$) and like our study, stress echocardiography was more specific compared to perfusion imaging (86 vs 77%, $P<0.001$).[16] Kontos and colleagues results are also similar to our study, who compared 2-dimensional echo and myocardial perfusion imaging for diagnosing myocardial infarction in emergency department on 141 patients, found similar sensitivities and specificities for echocardiography (91%; 95% CI, 86%-95%) and MPI (89%; 95% CI, 83%-94%).[17]Our results are also in accordance to a study by Fragasso who, found high specificity for DSE (Sensitivity 98%, specificity 36% for perfusion Scintigraphy and 88%, and 80% respectively for dobutamine stress echocardiography).[18]

Our results are also similar to a meta-analysis of peer reviewed articles of 13 studies comprising of 860 patients by Imran MB et al who found that the diagnostic accuracy of the two tests was almost similar, 0.77 for stress echo vs 0.8 for MPI ($p=$ not significant). MPI gave higher sensitivity, 0.88 vs 0.70 ($p<0.0001$) while stress echo gave higher specificity, 0.90 vs 0.67 ($p<0.0001$).[19]

LIMITATIONS

The limitation of this study is that, the non quantitative interpretation of echocardiographic images. And the last is, quantitative coronary angiography for exact measurement of luminal diameter was not used. Only visual assessment was done.

In our study the possible bias could be the patients with old myocardial infarction. Secondly majority of patients in our study were men (70%) in whom the prevalence of CAD is high, this could also have raised the sensitivity. Thirdly majority of our population (88%) had significant stenosis. This high prevalence of severe disease could also potentially raise sensitivity. Another reason for high sensitivity may be referral bias. Most of these patients were being referred for angiography because of high pretest probability of CAD.

CONCLUSION

Both myocardial perfusion imaging (MPI) and Dobutamine Stress Echocardiography have a high sensitivity for identifying patients with coronary artery disease. Myocardial perfusion imaging is more sensitive than stress echo while the specificity of stress echocardiography is high in detection of CAD.

REFERENCES

1. Gianrossi R, Detrano R, Mulvihill D, Lehmann K, Dubach P, Colombo A, et al. Exercise-induced ST depression in the diagnosis of coronary artery disease. A meta analysis. Circulation 1989;80:87-98.
2. DeFilippi CR, Rosanio S, Tocchi M, Parmar RJ, Potter MA, Uretsky BF, et al. Randomized comparison of a strategy of predischarge coronary angiography versus exercise testing in low-risk patients in a chest pain unit: in-hospital and long-term outcomes. J Am Coll Cardiol 2001;37:2042-9.
3. Elhendy A, Bax JJ, Poldermans D. Dobutamine stress myocardial perfusion imaging in coronary artery disease. J Nucl Med 2002;43:1634-46.
4. Kapur A, Latus KA, Davies G, Dhawan RT, Eastick S, Jarritt PH, et al. A comparison of three radionuclide myocardial perfusion tracers in clinical practice: the ROBUST study. Eur J Nucl Med Mol Imaging 2002;29:1608-16.
5. Olmos LI, Dakik H, Gordon R Dunn JK, Verani MS, Quiñones MA, et al. Long-term prognostic value of exercise echocardiography compared with exercise

201Tl, ECG, and clinical variables in patients evaluated for coronary artery disease. Circulation 1998;98:2679-86.

6. ElhendyA, Trocino G, Salustri A, Cornel JH, Roelandt JR, Boersma E, et al. Low-dose dobutamine echocardiography and rest-redistribution thallium-201 tomography in the assessment of spontaneous recovery of left ventricular function after recent myocardial infarction. Am Heart J 1996;131:1088-96.
7. Prasad SK, Asomull RG, Penell DJ. Recent development in non-invasive cardiology. BMJ 2004;329:1386-893.
8. Kontos MC, Kurdziel K, McQueen R, Arrowood JA, Jesse RL, Ornato JP, et al. Comparison of 2-dimensional echocardiography and myocardial perfusion imaging for diagnosing myocardial infarction in emergency department patients. Am Heart J 2002;143:659-67.
9. Mieres JH, Shaw LJ. Stress myocardial perfusion imaging in the diagnosis of women with suspected coronary artery disease. Cardiology Rev 2003;11:330-6.
10. Bedetti S, Pasanis EM, Titori G, Fonseca L, Tresoldi S, Minneci C, et al. Stress echo in chest pain unit: the speed trial. Int J Cardiol 2005;102:461-67.
11. Rehman A, Shah SA, Khan RA. Comparison of myocardial perfusion imaging studies with technetium 99 tetrofosmin and coronary angiography findings in non diabetic and diabetic patients of ischemic heart disease. Pak J Cardiol 2003;14:15-21.
12. Fox K, Garcia MA, Ardissino D, Buszman P, Camici PG, Crea F, et al. Guidelines on the management of stable angina pectoris: executive summary: The Task Force on the Management of Stable Angina Pectoris of the European Society of Cardiology. Eur Heart J 2006;27:1341-81.
13. Beller GA. Noninvasive assessment of myocardial viability. N Engl J Med 2000;343:1488-90.
14. Bax JJ, Poldermans D, Elhendy A, Boersma E, Rahimtoola SH. Sensitivity, specificity, and predictive accuracies of various non-invasive techniques for detecting hibernating myocardium. Curr Probl Cardiol 2001;26:141-86.
15. Kertai MD, Boersma E, Bax JJ. A meta-analysis comparing the prognostic accuracy of six diagnostic tests for predicting perioperative cardiac risk in patients undergoing major vascular surgery. Heart 2003; 89:1327-34.
16. Sicari R, Picano E, Landi P, Pasanisi E, Venneri E. Pharmacological stress echocardiography predicts total mortality early after acute myocardial infarction. J Am Soc Echocardiogr 2004;17:114-20.
17. McCully RB, Roger VL, Mahoney DW, Karon BL, Oh JK, Miller FA Jr, et al. Outcome after normal exercise echocardiography and predictors of subsequent cardiac events: follow-up of 1,325 patients. J Am Coll Cardiol 1998;31:144-9.
18. Lallier PL, Lesprance J. Role of angiography for the assessment of coronary artery disease in patients with diabetes mellitus. Can J Cardiol 2006;22:34-7.
19. Sawada SG, Segar DS, Ryan T, Brown SE, Dohan AM, Williams R, et al. Echocardiographic detection of coronary artery disease during dobutamine infusion. Circulation 1991; 83:1605-14.