Original Article

Correlation of Duke's treadmill score with gated myocardial perfusion imaging in patients referred for chest pain evaluation

Ayaz Hussain Shaikh, Bashir Hanif, Khursheed Hassan
Tabba Heart Institute, Karachi.

Abstract

Objective: To determine the correlation of Duke treadmill score (DTS) with gated single photon emission computed tomography-myocardial perfusion imaging (SPECT-MPI) in patients evaluated for chest pain.

Methods: A retrospective study was conducted at Tabba Heart Institute. Two hundred consecutive patients, referred to the nuclear cardiology laboratory for evaluation of chest pain by using stress myocardial perfusion imaging (MPI) from January 2008 to August 2008 were included. Duke Treadmill Score (DTS) was calculated after exercise testing and categorized as low, moderate and high DTS groups. Subsequent gated SPECT-MPI was performed and stratified according to severity of perfusion defect. Spearmans rho (non parametric test) was applied to determine the correlation between DTS and SPECT-MPI

Results: The overall result showed positive linear correlation between DTS and MPI (p= <0.001). Out of 200 patients, 136 (68%) had low DTS, 51 (25.5%) had moderate and 13 (6.5%) had high DTS respectively. In low DTS group 129 (95%) patients had low risk MPI and 7 (5%) had intermediate risk MPI. In moderate risk DTS group 25 (49%) had low risk MPI whereas 15 (29.5%) and 11 (21.5%) had intermediate and high risk MPI respectively. In high DTS group all 13 patients had high risk MPI.

Conclusions: On the basis of our findings it can be hypothesized that patients with high DTS can be referred for coronary angiography without imaging and patients with low DTS can be followed on medical management. However for definite conclusion diagnostic accuracy needs to be determine in further studies.

Keywords: Myocardial perfusion imaging, Exercise tolerance test, Coronary angiography (JPMA 61: 723; 2011).

Introduction

The diagnosis of coronary artery disease (CAD) based on presenting history can not be made solely, functional testing is usually required. Exercise tolerance test (ETT) is relatively inexpensive, easy to perform, interpret, and safe.[1] A meta-analysis by Detrano and colleagues, reported a sensitivity of 68% and specificity of 70% for the detection of CAD with ETT.[2] Gianrossi et al in a meta-analysis including 147 published reports, involving 24,074 patients who underwent both coronary angiography and ETT, reported the sensitivity of 68% and specificity of 77%.[3] Scoring system like Duke treadmill score (DTS) are commonly used in analysis of ETT data. DTS improves the prognostic ability of the technique.[4] It also provides valuable information about the presence and severity of CAD.[5]

If ETT interpretation and subsequent patient management is based solely on electrocardiogram (ECG) signs of ischaemia, then the detection of at-risk patients will be less than that achieved with the utilization of DTS.[4]

The limited sensitivity and specificity of ETT for detection of coronary artery disease lead to development of perfusion imaging.[6] Accuracy of MPI for detecting CAD in patients with undiagnosed chest pain has been well established in a number of large studies. The sensitivity was 87% in a meta-analysis of 33 studies with the specificity of 73%.[7] This added diagnostic accuracy of myocardial perfusion imaging (MPI) is associated with substantially higher cost.[8]

Application of DTS to the data derived from ETT can be a low cost alternative to MPI.

Banerjee and colleagues looked at the role of ETT and gated SPRCT-MPI in predicting severity of ischaemia in patients with chest pain. They found that in high DTS group 91.66% patients had perfusion defect.[9] Vacanti and colleagues also showed that ETT and MPI presented similar results for myocardial ischaemia (21% vs 15%, respectively).[10]

There are very few studies found after an extensive literature search which correlate DTS and MPI. Especially no study was found from our part of world. This provided a very strong rationale to conduct such a study in our population to increase analytic efficiency of ETT using DTS and to hypothesize that DTS can be an alternative to MPI in patients being evaluated for chest pain.

Patients and Methods

The medical records of 200 consecutive patients referred to nuclear cardiology laboratory of Tabba Heart

Institute Karachi from January through August 2008 were reviewed respectively for evaluating chest pain. All patients included in the study had no prior history of Coronary Artery Disease (CAD), surgical or percutaneous revascularization. They were not taking any negative chronotropic medications and had interpretable ECG (absence of left bundle branch block, left ventricular hypertrophy, baseline Q waves, baseline ST segment depression ≥ 1mm, pre-excitation).

All patients underwent ETT using Bruce protocol and then gated SPECT-MPI scan using Tc-99m-tetrofosmin in same day stress and rest protocol. During ETT serial recordings of heart rate, blood pressure and 12-lead ECG were made. DTS was calculated {DTS= Exercise time- (5 x ST segment deviation)-(4 X treadmill angina index)}, where treadmill angina index was (0: no angina, 1: non-limiting angina, 2: limiting angina). ST-segment deviation were measured at 60 to 80 ms after the J point. If the exercise-induced ST-segment deviation was <1 mm, the value entered into the score for ST deviation was zero. Subsequently gated MPI were performed, analyzed and stratified according to severity of perfusion defect.

Performa was designed to collect information including, age, gender, history of diabetes (defined as a fasting glucose ≥ 126 mg/dl or on treatment), hyperlipidemia (fasting cholesterol ≥ 200 mg/dl or on treatment), hypertension (systolic blood pressure ≥ 140/90 mmHg or on treatment), smoking, positive family history of coronary artery disease (CAD in first degree relatives, <55 years male and <65 years in female).

Treadmil data including total exercise time in minutes, age predicted maximal heart rate (APMHR) response, blood pressure response, arrythmias during exercise, treadmil angina index, ST segment shift from baseline was recorded. DTS was calculated and categorized in low, moderate and high DTS groups.

Gated SPECT-MPI data was recorded and analyzed for presence, extent and reversibility of myocardial perfusion defect. Stress induced left ventricular dilatation and increased lung uptake was also recorded. Perfusion imaging data was stratified into low, intermediate and high risk groups according to severity of perfusion defect.

Patients were divided into three groups as per results of DTS: low DTS group (score ≥ 5), moderate DTS group (score -10 to +4) and high DTS group (score ≥-11). MPI was stratified into: low risk scan (normal or small perfusion defect), intermediate risk scan (stress induced moderate perfusion defect without left ventricular dilatation or increased lung uptake) and high risk scan (stress induced large perfusion defect, stress induced multiple perfusion defects of moderate size, stress induced moderate perfusion defect without left ventricular dilatation or increased lung uptake, large fix perfusion defect with left ventricular dilatation or increased lung uptake). Finally DTS and gated SPECT-MPI data were correlated.

All the variables were entered into the Statistical Package for Social Sciences software, version 14 (SPSS Inc) for data analysis. Descriptive statistics were computed and presented as means ± standard deviations for continuous variables like age, exercise time (minutes), age predicted maximum heart rate, ST segment shift and DTS. Frequency and percentages were computed for gender, risk factors (hypertension, diabetes, smoking, dyslipidaemia and family history of premature CAD), angina index, DTS and MPI categories. Spearmen rank correlation was applied to determine the correlation between DTS and MPI results. P value <0.05 was considered as significant.

Results

Total of 200 patients were included in this study. Table-1 shows the baseline demographic and clinical characteristics of studied patients. The mean age was 52.4 ± 8.2 years. There were 122 (61%) males and 78 (39%) females. In all 103 (51.5%) patients were diabetic, 157

Table-1: Baseline Demographic and Clinical characteristics.

Patients characteristics:	**n= 200 (%)**
Age (mean ± SD) (years)	52.44 ± 8.22
Male	122 (61%)
Female	78 (39%)
Medical history:	
Hypertension	157 (78.5)
Diabetes Mellitus	103 (51.5)
Smoker	60 (30)
Dyslipidaemia	99 (49.5)
Family history of premature coronary Artery disease	65 (32.5)

Table-2: Exercise and Imaging Data.

ETT:	**n=200(%)**
Exercise time(mean ± SD) minutes	7.7± 2.2
%Max HR achieved (mean ± SD) beats per minute	94± 9
ST shift (mean ± SD) millimeter	1.63 ± 0.79
Angina index:	
0	176 (88%)
1	22 (11%)
2	2 (1%)
Duke's treadmill score (DTS) (mean ± SD)	4.30 ± 6.35
Duke score categories:	
Low DTS	136 (68%)
Moderate DTS	51 (25.5%)
High DTS	13 (6.5%)
Myocardial perfusion imaging (MPI) categories:	
Low risk	154 (77%)
Intermediate risk	22 (11%)
High risk	24 (12%)

Table-3: Correlation of Duke Treadmill Score with myocardial perfusion imaging.

		Risk grading based on MPI			Total	p value
		Low risk	Intermediate risk	High risk		
Risk grading based on DTS	Low risk	129 (94.9%)	7 (5.1%)	-	136 (100%)	
	Moderate risk	25 (49%)	15 (29.4%)	11 (21.6%)	51 (100%)	<0.001
	High risk			13 (100%)	13 (100%)	
Total		154 (77%)	22 (11%)	24 (12%)	200 (100%)	

(78.5%) were hypertensive, 60 (30%) were smokers and 99 (49.5%) had dyslipidaemia.

Table-2 shows exercise data. The mean treadmill exercise time as per Bruce protocol was 7.7 ± 2.2 minutes. Maximum ST segment deviation was 3mm during exercise. All patients achieved 85% age predicted maximal target heart rate. Majority of patients, 176 (88%) had no treadmill angina and 22 (11%) had non limiting angina. Exercise was stopped in 2 (1%) patients due to limiting treadmill angina. The mean DTS was 4.30 ± 6.35, with 136 (68%) in low DTS group and 51 (25.5%) and 13 (6.5%) in moderate and high DTS subgroups respectively.

Gated SPECT-MPI data was analyzed and stratified. Majority of patients, 154 (77%)were stratified as low MPI group whereas 22 (11%) and 24 (12%) were stratified as moderate and high risk MPI subgroups respectively depending on extent of myocardial ischaemia and presence or absence of abnormal lung uptake or stress induced left ventricular cavity dilatation (Table-2).

DTS data was correlated with gated SPECT-MPI data. Out of 136 low DTS patients, 129 (95%) patients had low risk MPI and 7 (5%) had intermediate risk MPI. In moderate risk DTS group, 25 (49%) had low risk scan whereas 15 (29.5%) and 11 (21.5%) had intermediate and high risk scan respectively. In high risk DTS group, all 13 patients had high risk MPI (100%). Our study showed over all correlation between DTS and MPI results (p<0.001) (Table-3).

Discussion

Risk stratification of patients with suspected or known coronary artery disease into low, intermediate and high-risk subgroups by means of noninvasive testing is highly relevant in the selection of patients who require further diagnostic or therapeutic workup.

Current American College of Cardiology/American Heart Association (ACC/AHA) guidelines recommend use of ETT without imaging as the initial test in the noninvasive evaluation of patients with suspected CAD, who have an interpretable ECG and are able to exercise. It may not be cost-effective to perform MPI on all of these patients to identify a small number of high-risk individuals.[11] Unfortunately these recommendations are not followed judiciously in day to day clinical practice and most of the patients presenting with chest pain and suspected CAD, despite having a normal ECG and good functional class end up with MPI as an initial evaluation strategy. This point is highlighted in our study where a good number of patients with interpretable ECG underwent perfusion imaging for initial evaluation of chest pain. This approach not only increases the financial burden on patients but also exposes patients and nuclear laboratory staff to radiation hazards.

The ACC/AHA guideline also emphasizes the utility of DTS in out patients with suspected CAD. The score works equally well with men and women.[12] Studies also showed that DTS can be effectively utilized in elderly patients.[10] Using DTS patients can be stratified as high-risk group; score $\geq$-11 with an average annual cardiovascular mortality $\geq$ 5%. Low-risk group, score $\geq$ 5, had an average annual cardiovascular mortality rate of 0.5%.[13] Thus DTS is useful for risk-stratifying diagnostic and prognostic patient subsets.[14] Majority of low-risk patients had no coronary disease or single-vessel coronary disease, whereas high-risk treadmill score patients were likely to have more extensive or multivessel coronary disease.[4]

Vacanti and colleagues studied comparison of ETT with MPI with respect to its efficacy, cost effectiveness and prediction of cardiovascular event. They showed correlation between the tests was 88% (Kappa 0.63, p<0.01).[10] Few studies utilized DTS in addition to ETT data and found a good correlation between DTS and MPI results. This correlation is best seen in patients categorized as low risk and high risk subgroups.

Galassi et al studied the accuracy of exercise testing in the assessment of the severity of myocardial ischaemia as determined by SPECT-MPI and concluded that the results of DTS satisfactorily correlates with imaging in patients with low risk scan and in those with severely abnormal scan.[15] Banerjee and colleagues also showed that DTS was correlated with SPECT-MPI scanning in high DTS subsets (91.6%) whereas in intermediate and low risk group correlation was 60% and 40.9% respectively.[9]

Our study shows that subset of patients categorized as high DTS all had high risk scan. Patients with moderate DTS (49%) had low risk scans and 51% showed abnormal scan, whereas in low DTS category 95% had low risk scan.

Our findings suggests that exercise testing should to be used more often in evaluation of patients with suspected CAD who have interpretable ECG and good functional class. It also shows good overall correlation between DTS and MPI findings.

It is only through judicious use of the information gained from exercise testing that is linked with improved outcomes. Thus, the post-exercise test prognosis or risk points to a particular management strategy. Therefore it can be hypothesized that patients with high DTS can be referred for coronary angiography without imaging and patients with low DTS can be followed on medical management. Moderate DTS patients need further evaluation. However for definite conclusion, diagnostic accuracy has to be determined in further studies.

Acknowledgement

We are thankful to all staff members of Tabba Heart Institute especially Miss Tadeeb Anwar (Librarian) and Miss Aisha Haider (clinical admin assistant).

References

1. Ashley E A, Myers J, Froelicher V. Exercise testing in clinical medicine. Lancet 2000; 356: 1592-7.
2. Detrano R, Gianrossi R, Froelicher V. The diagnostic accuracy of the exercise electrocardiogram: a meta-analysis of 22 years of research. Prog Cardiovasc Dis 1989; 32: 173-206.
3. 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.
4. Shaw LJ, Peterson ED, Shaw LK, Kesler KL, Delong ER, Harrell FEJ, et al. Use of a prognostic treadmill score in identifying diagnostic coronary disease subgroups. Circulation 1998; 16: 1622-30.
5. Gabaldo K, Hadzibegovi? I, Prvulovi? D, Vujeva B, Samardzi? P, Dani? D. Duke Treadmill Score in prioritizing patients for coronary angiography: retrospective study of a Croatian regional hospital. Coll Antropol 2008; 32: 375-80.
6. Hesse B, Lindhardt TB, Acampa W, Anagnostopoulos C, Ballinger J, Bax JJ, et al. EANM/ESC guidelines for radionuclide imaging of cardiac function. Eur J Nucl Med Mol Imaging 2008; 35: 851-85.
7. Klocke FJ, Baird MG, Lorell BH, Bateman TM, Messer JV, Berman DS et al.; American College of Cardiology; American Heart Association Task Force on Practice Guidelines; American Society for Nuclear Cardiology. ACC/AHA/ASNC guidelines for the clinical use of cardiac radionuclide imaging. executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASNC Committee to Revise the 1995 Guidelines for the Clinical Use of Cardiac Radionuclide Imaging). Circulation 2003; 108: 1404-18.
8. Beller GA, Zaret BL. Contributions of nuclear cardiology to diagnosis and prognosis of patients with coronary artery disease. Circulation 2000; 101: 1465-78.
9. Banerjee SK, Haque KM, Sharma AK, Ahmed CM, Iqbal AT, Nisa L. Role of exercise tolerance test (ETT) and gated single photon emission computed tomography-myocardial perfusion imaging (SPECT-MPI) in predicting severity of ischemia in patients with chest pain. Bangladesh Med Res Counc Bull 2005; 31: 27-35.
10. Vacanti LJ, Sposito AC, Séspedes L, Sarpi M, Ramires JA, Bortnick AE. In comparison to the myocardial perfusion scintigraphy, a treadmill stress test is a viable, efficient and cost effective option to predict cardiovascular events in elderly patients. Arq Bras Cardiol 2007; 88: 531-6.
11. Gibbons RJ, Balady GJ, Bricker JT, Chaitman BR, Fletcher GF, Froelicher VF, et al. ACC/AHA 2002 guideline update for exercise testing: summary article. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Update the 1997 Exercise Testing Guidelines).J Am Coll Cardiol 2002; 40: 1531-40.
12. Daugherty SL, Peterson PN, Magid DJ, Ho PM, Bondy J, Hokanson, et al. The relationship between gender and clinical management after exercise stress testing. Am Heart J 2008; 156: 301-7.
13. Mark DB, Hlatky MA, Harrell FE Jr, Lee KL, Califf RM, Pryor DB. Exercise treadmill score for predicting prognosis in coronary artery disease. Ann Intern Med 1987; 106: 793-800.
14. Gasperin CA, Bueno CP, Yamada AS, da Rocha GA, Heinze RC, Nunes DC, et al. [Prognosis of Duke treadmil score versus scintilography in patients at risk for coronary artery disease. One year follow-up]. Arq Bras Cardiol 2006; 87: 146-52.
15. Galassi AR, Azzarelli S, Lupo L, Mammana C, Foti R, Tamburino C, et al. Accuracy of exercise testing in the assessment of the severity of myocardial ischemia as determined by means of technetium-99m tetrofosmin SPECT scintigraphy. J Nucl Cardiol 2000; 7: 575-83.