Original Article

Association of ST segment depression >5 min after exercise testing with severity of coronary artery disease

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Abstract

Objective: To determine the association of prolonged ST segment depression after an exercise test with severity of coronary artery disease.

Methods: A cross sectional study of 100 consecutive patients referred to the cardiology laboratory for stress myocardial perfusion imaging (MPI) conducted between April-August 2008. All selected patients were monitored until their ST segment depression was recovered to baseline. ST segment recovery time was categorized into less and more than 5 minutes. Subsequent gated SPECT-MPI was performed and stratified according to severity of perfusion defect. Association was determined between post exercise ST segment depression recovery time (<5 minutes and >5 minutes) and severity of perfusion defect on MPI.

Results: The mean age of the patients was 57.12 ± 9.0 years. The results showed statistically insignificant association (p>0.05) between ST segment recovery time of <5 minutes and >5 minutes with low, intermediate or high risk MPI.

Conclusion: Our findings suggest that the commonly used cut-off levels used in literature for prolonged, post exercise ST segment depression (>5 minutes into recovery phase) does not correlate with severity of ischaemia based on MPI results (JPMA 60:288; 2010).

Introduction

Exercise testing is a well established tool for diagnosis of coronary artery disease (CAD). Functional testing is usually required for diagnosis and prognostication of CAD.[1] Exercise tolerance test (ETT) is relatively inexpensive, easy to perform, interpret, and safe.

Gianrossi et al in a meta-analysis of 147 published reports, involving 24,074 patients who underwent both coronary angiography and ETT, reported the sensitivity and specificity of ETT 68% and 77% respectively.[2]

The interpretation and subsequent decisions regarding patient management is based on EKG evidence of ischaemia during stress or in recovery phase. Scoring system like Duke treadmill score (DTS) can also be utilized in analysis of ETT data.[3] Other prognostic ST segment variables include, number of leads that show significant ST-segment depression, configuration of the exercise induced ST depression (downsloping, horizontal or upsloping) and prolonged (>5minutes) ST depression in the recovery phase of the test.[4]

It is generally perceived that persistence of ST segment depression for >5 minutes after ETT signifies a strongly positive test and predicts more severe ischaemia and CAD.[5] However it is also reported that prolonged ST recovery time may be a result of exaggerated atrial repolarization waves during exercise which can cause ST depression in the absence of ischaemia.[6]

Desai and colleagues looked for correlation of post stress prolonged ST depression with severity of CAD, determined by MPI. The results showed that commonly used cutoff for prolonged post exercise ST segment depression (>5 minutes), does not correlate with severity of ischaemia or coronary artery disease (p=0.13).[5]

There is sparse data on post stress ST segment recovery time (>5 minutes) and severity of CAD that makes a strong rationale to conduct such study in our population. The present study is to determine the association of prolonged ST segment depression with severity of coronary artery disease.

Patient and Methods

A cross sectional study was conducted between April to August 2008 at Tabba Heart Institute, a tertiary care cardiac centre located in a densely populated area of Karachi, Pakistan. The ethical approval of study was provided by Tabba Heart Institute ethical review board.

We consecutively enrolled 100 patients of any age and of either sex referred to nuclear cardiology laboratory for evaluation of chest pain. Those who had a positive ETT defined as "more than 1mm horizontal/downsloping ST-segment depression or ≥ 2mm upsloping ST segment depression measured at 860 miliseconds after J point"[4,7] and were given informed consent were included. All patients with uninterruptible ECG; left bundle branch block, left ventricular hypertrophy, baseline ST segment depression ≥

1mm, pre-excitation, pre excitation or patients taking digoxin were excluded. Subsequently all patients underwent gated SPECT MPI, using TC 99 MIBI (sestamibi) single day stress-rest protocol.

The main outcome variables of the study were age, gender, history of diabetes (defined as a fasting glucose ≥ 126 mg/dl or on treatment), hyperlipidaemia (fasting cholesterol ≥ 200 mg/dl or on treatment), hypertension (systolic blood pressure ≥ 140/90 mmHg or on treatment), smoking, positive family history of CAD in first degree relatives (<55 years in male and <65 years in female).

Treadmill data included total exercise time in minutes and age predicted heart rate was recorded. All patients were observed until their post exercise ST depression recovered to baseline. Their post exercise ST segment recovery time was then categorized and recorded in performa into less than 5 minutes and more than 5 minutes. Subsequently, gated MPI were performed, analyzed and stratified according to severity of perfusion defect by a nuclear cardiologist. 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).[8,9] MPI data was also recorded in a proforma.

All the variables were entered into SPSS software, version 14 (SPSS Inc) for data analysis. Descriptive statistics were used to summarize the data and mean and standard deviations were calculated for continuous variables like age and exercise time in minutes. Frequency and percentages were computed for sex, risk factors (hypertension, diabetes, smoking, dyslipidaemia and family history of premature CAD). Chi-square test was applied to determine the association between post exercise ST segment recovery time ≤ 5 minutes and > 5 minutes with MPI categories i.e. low risk, intermediate risk and high risk. p value <0.05 was considered as statistically significant.

Results

The mean age of the patients was 57.12 ± 9.0 years. Out of the total patients, 69 (69%) were males and 31 (31%) were females. The mean exercise time of the total sample was found to be 7.88 ± 2.0 minutes. Whereas the mean post exercise ST segment recovery time was 6.21 ± 4.85 minutes. The mean age predicted maximum heart rate was 94.12 ± 10%. There were 41% diabetics, 63% were hypertensive, 39% dyslipidaemic, 28% smokers and 45% had a family history of premature CAD. The descriptive statistics of two categories of ST segment recovery time (>5 minutes and <5 minutes) are shown in Table-1.

Table 1: Baseline Demographic and Clinical Characteristics.

Patients characteristics	< 5 minutes n=50	> 5 minutes n=50
Age (years) mean ± SD	54.44 ± 9.5	55.80 ± 8.5
Male (%)	32 (64)	37 (74)
Female (%)	18 (36)	13 (26)
Medical history		
Diabetes (%)	20 (40)	21 (42)
Hypertension (%)	31 (62)	32 (64)
Dyslipidemia (%)	20 (40)	19 (38)
Smoking (%)	12 (24)	16 (32)
Family history of premature Coronary Artery Disease (%)	26 (52)	19 (38)
Exercise time (minutes) mean ± SD	7.96 ± 1.97	7.80 ± 2.18
Age predicted maximum heart rate (%)	93.8 ± 8.9	94.4 ± 13.7

Table-2: Association of ST recovery with Myocardial Perfusion Imaging.

ST recovery time (minutes)	Low risk n (%)	Medium risk n (%)	High risk n (%)	P-value
< 5	33 (66)	9 (18)	8 (16)	0.743
>5	31 (62)	8 (16)	11 (22)	

The over all results showed statistically insignificant association (p>0.05) between post stress ST segment recovery time of <5 minutes and >5 minutes with MPI categories of low, intermediate and high risk. (Table-2).

Discussion

Exercise Tolerance Test (ETT) data is not only helpful for the diagnosis of CAD but can also be utilized for prognostication. Functional capacity, exercise-induced ST-segment depression, ST elevation, duration of ST segment recovery in post exercise period, chronotropic incompetence, heart rate recovery response and number of other variables can be used to determine prognosis.[4] It is important to identify patients with high risk features, who further needs work-up and aggressive treatment.

The importance of ST segment depression limited only to post exercise recovery phase is being supported by a number of studies. Lanza and colleagues had shown that the diagnostic and prognostic value of ST segment depression limited to the recovery phase of an exercise test is largely similar to that of ST segment depression induced during exercise (p=0.72).[10] Delayed post exercise ST segment recovery i.e. > 5minutes is generally taken as a marker of severe CAD. However, data is limited and few studies had highlighted the fact that prolong post exercise ST segment depression may be the result of exaggerated post stress atrial repolarization.[6] Similarly, a study by Gavrielides et al, showed that the duration of post exercise

ST segment recovery time was significantly influenced by body position during recovery ($p < 0.05$).[11]

Desai and colleagues looked for correlation of post stress prolonged ST depression with severity of CAD and had shown that there was no significant difference in the mean summed stress score (9 ± 9 versus 13 ± 10, $p=0.13$), summed difference score (4 ± 3 versus 6 ± 5, $p=0.13$), stress extent percentage (14 ± 16 versus 19 ± 13, $p=0.13$), extent of reversibility percentage (7 ± 9 versus 7 ± 7, $P=0.93$), or lung heart ratio (0.48 ± 0.07 versus 0.46 ± 0.07, $P=0.50$) between the patients with positive ETT and post exercise ST segment recovery time of <5minutes versus >5minutes. However, this study included twenty five patients in each group.[6]

We classified perfusion imaging data as low, intermediate and high risk groups as per ACC/AHA/ASNC guidelines[8] and found statistically insignificant ($p= 0.74$) association between MPI results and patients with post exercise ST segment recovery time < 5 minutes versus those with ST recovery time of >5minutes. Our results are similar to what had been shown by Desai and colleagues.[5] We used MPI as a marker to determine severity and extent of CAD, however, we recommend that for definite assessment of association between post exercise ST segment depression >5 min CAD, coronary angiogram as gold standard should be used.

Conclusion

Our study showed that the commonly used cutoff used in literature for prolonged, post exercise ST segment depression of >5 minutes into recovery phase does not correlates with severity of ischaemia based on MPI results ($p>0.05$).

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