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CAN WE PREDICT THE SITE OF MYOCARDIAL ISCHEMIA BY EXERCISE INDUCED ST DEPRESSION?

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

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ABSTRACT

Objective: The aim of this study was to determine a relationship between exercise induced ST-depression and site of myocardial ischemia by SPECT Imaging.

Methodology: This study was conducted at Atomic Energy Medical Center, Jinnah Postgraduate Medical Center, Karachi, Pakistan. A total of 82 consecutive patients who underwent exercise myocardial perfusion scan and developed significant ECG depressions were included in the study. Data was analyzed using SPSS version 10. All continuous variables were expressed as means ± SD. Chi square test was used to study the relationship between the site of ischemia on MPS and ST depression in different ECG groups. A p-value < 0.05 was considered statistically significant in analysis.

Results: Out of 82 patients, 64 (78%) had abnormal scans; 62 patients revealed reversible perfusion defects and 18 patients' scans were declared normal. Patients had ST depressions in anterior leads were 25 but cardiac scans of only 4 patients (16%) showed anterior or antero-septal walls' perfusion defects, while 3 patients (12%) had lateral wall (infero-lateral / antero-lateral) defects and 4 patients showed inferior or infero-septal wall defects (16%).

Conclusion: Our study revealed that ST depression on 12 lead Exercise ECG does not predict the site of myocardial ischemia by SPECT.

Key Words: Exercise Tolerance Test, Coronary Artery Disease, Myocardial Perfusion Scan, ST-Depression

INTRODUCTION

Exercise tolerance test (ETT) is widely used to detect coronary artery disease (CAD).

ST elevation during acute phase of myocardial infarction (MI) as well as during exercise provides valuable information about the location of ischemic area.[1,2] However, the validity of prediction of site of ischemia by ST depression during exercise is skeptical.[3] In contrast, Myocardial Perfusion Scan (MPS) can localize the site of ischemia more accurately.

Since exercise ECG stress testing is considerably less expensive than exercise perfusion imaging and it is widely used as an effective non invasive tool to detect CAD, we tried to examine the relationship between exercise ECG ST-segment depression and location of myocardial ischemia by ^{99m}Tc-Sestamibi Single photon emission tomography (SPECT) imaging.[4]

It may be contended that the superiority of stress perfusion imaging over ECG response may be artificially enhanced by induction of patients with baseline ECG abnormalities.[5]

We conducted this study to determine a relationship between exercise induced ST-depression and site of myocardial ischemia by SPECT Imaging.

METHODOLOGY

This study was conducted at Atomic Energy Medical Center, Jinnah Postgraduate Medical Center, Karachi, Pakistan. About 82 patients who underwent exercise MIBI myocardial perfusion scan (MPS) were included in our study according to the following criteria: 1) Normal baseline ECG; 2) Patients who had developed $\geq$1-mm down sloping or horizontal or $\geq$1.5 mm up sloping ST segment depression measured at 80 ms during or after exercise.

We excluded those patients who had any evidence of previous MI, conduction defects, ST-T wave changes, coronary revascularization, digitalis intake or pacemaker rhythm. We also did not include those patients who had any primary cardiomyopathy, congenital or any valvular heart disease.

All patients underwent symptom limited treadmill exercise testing in the fasting state according to the Bruce protocol. Nitrates, Beta and Calcium channel blocking agents were withheld at least for 48 hours prior to the test. ECG and blood pressure measurements were obtained at baseline and at 2-min intervals during exercise and for 5 min afterwards. Exercise end points were severe fatigue, dyspnea, dizziness, moderate to severe angina, hypotension, 2-mm ST segment depression or significant arrhythmia.

Site of ST segment depression were noted as conventionally described. ST-depression occurring in leads V1 through V4 was classified as anterior and those occurring in I, aVL and V5, V6 as lateral while depression in leads II, III, aVF were considered as inferior.

At peak exercise, 10 mCi of ^{99m}Tc-Sestamibi was injected intravenously and patients were encouraged to exercise for an additional minute before termination of the test. 45 minutes and four hours (with reinjection of 30 mCi of ^{99m}Tc-Sestamibi) post exercise images were acquired using circular orbit over 180 arc starting at the 45 right anterior oblique projection and ending at the 45 left posterior oblique projection. Each of 32 projections was acquired using a 64 * 64 matrix for 25s/image. No scatter or attenuation correction was used. From these transaxial images, the long axis of the left ventricle was identified and obliquely angled images were generated in the short-axis and vertical and horizontal long-axis orientations.

The interpretation of images was performed by visual analysis according to 17 segment model.[6] Stress and rest tomographic views were reviewed side by side by two experienced observers who were unaware of patients' clinical and angiographic data. In cases of disagreement a third reader was called in for the interpretation. The raw images were also viewed in a cine film format for patient motion and breast attenuation artifacts.

Data was analyzed using SPSS version 10. All continuous variables were expressed as means ± SD. Chi square test was used to study the relationship between the site of ischemia on MPS and ST depression in different ECG groups. A p-value < 0.05 was considered statistically significant in analysis.

RESULTS

Out of 82 patients, 58 were males and 24 were female patients with mean age of 57±10 yrs. Patients developed anginal symptoms during exercise were 37. Patients had ST depressions only in anterior leads were 11, inferior leads 14 and in lateral leads 23 .

Patients having ST depressions in two or more regions were

Table 1: General Characteristics of the Study Group

Variables	Percentage
Age (yr)	57±10
Male	70.7%
Hypertension	54.9%
Diabetes Mellitus	59.8%
Dyslipidemia	15.8%
Tobacco use	41.5%
Family History	23.2%

Table 2: ETT Parameters of the Study Group

Variables	Values
Exercise duration (min)	6.07±2.50
METs achieved	7.27±2.46
Exercise Heart Rate (beats/min)	141±72
Exercise systolic BP (mm Hg)	164±26
Total reaching 85% HR	68
Angina symptoms	37

34 i.e. 06 had both in anterior and inferior, 20 had in inferior and lateral while 08 had in anterior and lateral leads. Clinical characteristics and exercise tolerance test (ETT) parameters of the study population are shown in Table 1 & 2, respectively.

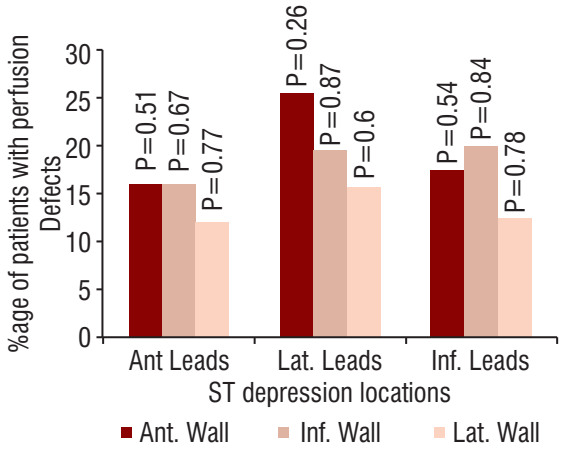
Out of 82 patients, 64 (78%) had abnormal scans; 62 patients revealed reversible perfusion defects and 18 patients' scans were declared normal. Patients having ST depressions in anterior leads were 25 but cardiac scans of only 4 patients (16%) showed anterior or antero-septal walls' perfusion defects, while 3 patients (12%) had lateral wall (infero-lateral / antero-lateral) defects and 4 patients showed inferior or infero-septal wall defects (16%).

In total 51 patients had lateral wall ST depressions out of which only 8 patients had perfusion defects of lateral wall while 23 patients showed anterior and inferior wall regions defects.

Patients had exercise induced inferior segmental ST depressions were 40 but only 8 patients' scans divulged inferior and infero-septal wall defects while 5 had lateral wall defects and 7 had anterior wall perfusion defects.

No significant relation could be found between the site of ST-depression in any ECG group and location of ischemia on myocardial perfusion scan (p value > 0.05) as shown in Figure 1.

Figure 1: Correlation Between Site of ST Depression and Location of Inducible Ischemia on Myocardial Perfusion Scan



DISCUSSION

Exercise ECG testing has been widely performed to detect CAD. Horizontal or down slopping ST segment depression 0.1 mV is accepted as a common manifestation of CAD. [7] Previous studies have demonstrated that correlation of anatomic stenosis or spasms of coronary arteries with the location of exercise induced ST segment depressions remains controversial. Ares kog et al, compared 12 lead electrocardiography and coronoary angiography during exercise and found no correlation between the extent of disease in the coronary arteries in patients with anterior, lateral and posterior ST depressions.[2] However, there are situations in which positive correlation between ST segment depression on exercise and the site of coronary artery obstruction has been found. Dunn et al, found that exercise induced ST depression in inferior leads indicate right coronary artery disease and ST depression in chest leads and leads I, aVL indicated left coronary disease.[3]

Kang et al, observed different findings in their studies. They noted that patients with LAD territory defects most commonly had inferior ST segment depressions and patients with RCA and LCX territory defects had similar frequencies of anterior and inferior ST-segment depression.[8] Several observers exhibited in their studies that exercise induced ST depression is a poor predictor of the location of myocardial ischemia. Dunn et al, and Tavel et al, concluded on the basis of their studies that it is difficult to identify the site of ischemia by exercise tolerance test.[3,9]

The lack of correlation may be related to several factors. Coronary supply varies in each person and is further altered by proximal or distal obstruction. Collaterals can adequately perfuse an area served by an obstructed artery. But most of those studies were done by planar scintigraphy. As SPECT imaging is more sensitive and specific than planar imaging we opted for it. Since myocardial perfusion imaging has been used to accurately evaluate myocardial ischemia, we tried to assess the location of exercise induced ischemia and hoped that it would overcome limitations upto some extent.

Our study also found no correlation between exercise tolerance test and site of ischemia. Rotation of heart during exercise may be the reason for the lack of correlation between leads and ischemic regions as the position of heart can differ in exercise and at rest. Some argue that exercise induced ST depression may not represent localized ischemia, rather it represents global sub endocardial ischemia and it is difficult to clinically demonstrate global sub endocardial ischemia in patients.[10]

LIMITATION

Our study has got few limitations: First the number of patients studied were less and secondly there was no angiographic data in addition to SPECT to support our findings.

CONCLUSION

Our study revealed that ST depression on 12 lead Exercise ECG does not predict the site of myocardial ischemia by SPECT.

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