

## Electrocardiographic Repolarisation Changes as Markers for Asymptomatic Coronary Artery Disease

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*30 asymptomatic service personnel presenting with ECG abnormality in the form of ST segment or T wave changes were worked up for confirming the presence of coronary artery disease, by treadmill testing and coronary arteriography. The specificity of treadmill test was found to be 85.7%. The predictive values of exercise electrocardiography and resting ST-T abnormalities were found to be 75% and 30% respectively.*

**Keywords:** ECG-abnormalities, repolarisation abnormalities test, coronary arteriography, coronary artery disease, silent coronary artery disease

Clinically overt coronary artery disease (CAD) is what is proverbially called "the tip of iceberg". Subjects with CAD remain asymptomatic for years before they manifest with angina, arrhythmias, cardiac decompensation or non-fatal myocardial infarction<sup>1,2,3</sup>

Electrocardiogram has been used to screen apparently healthy individuals since World War II<sup>4,5,6</sup>. Studies have demonstrated that resting ECG can be a pointer to identify persons at high risk of CAD<sup>7,8,9,10,11,12</sup>. The present study was designed to evaluate asymptomatic abnormalities on resting ECG. Definite evidence of CAD was demonstrated by coronary arteriography in selected cases.

### Material and Methods

30 asymptomatic men presenting with repolarisation abnormalities on routine ECG were selected for the purpose of this study. In selecting subjects certain categories were excluded. Those diagnosed to have ischemic heart disease in the past and are presently asymptomatic were excluded. Subjects having angina or angina equivalents were also not included. Known diabetics or hypertensives were also not included and so were subjects having rhythm disturbances or any evidence of congestive heart failure, myocarditis or pericarditis. Subjects detected to have valvular heart disease of any etiology and obviously ill patients due to some unrelated disease were excluded. Likewise those showing

abnormalities in ECG patterns other than repolarisation abnormalities, specially significant Q waves, left ventricular hypertrophy and bundle branch blocks were excluded.

A detailed history was taken and a thorough clinical examination was carried out. A 12-lead ECG was recorded at rest and the ST-T changes noted were recorded. ST-segment changes were recorded as ST depression upto 0.5 mm, 0.5 - 0.9mm and more than 0.9 mm as ST elevation. T wave abnormalities were recorded as T wave amplitude of -5 mm, -1 to -5 mm and T wave flat or small/diphasic. The ECG recording was repeated in the standing posture and after hyperventilation. Changes if any, for the resting ECG were noted.

With informed consent each individual was subjected to a staged exercise electrocardiography using a treadmill and telemetric device attached to a Marquette 3-channel oscillographic monitor. Bruce Protocol was followed in each case. Diagnostic criteria for a positive treadmill test are shown in Table I. All subjects with a strongly positive test were subjected to coronary arteriography, with necessary consent.

**Table-I Diagnostic Criteria - Treadmill Test<sup>13</sup>**

1. A horizontal ST segment depression of 1 mm persisting 6 min after exercise, when the total treadmill exercise time was less than 10 min.
  2. ST segment depression of 2 mm or more which appears early in the test and continues for at least 2 min post exercise.
  3. Additional criteria to increase reliability:
    - a. R wave amplitude, which increase, when total treadmill exercise time was less than 10 min.
    - b. Reduction in maximal exercise heart rate.
    - c. Progressive decrease in systolic BP greater than 10 mm Hg during the treadmill exercise.
- Predictive value of the test increases to 84% when one conventional risk factor is combined with two or more of the following:
- a. 3 mm ST depression within first 6 min.
  - b. Duration of the exercise is less than 10 min.
  - c. ST depression persisting into 6 min after exercise.

## Results

Of 30 subjects with repolarisation abnormalities subjected to treadmill test, 12 (40%) were found to have a positive treadmill test. 20 (66%) of these 30 were above 35 years age. Out of the 12 with an abnormal TMT responses, 11 (91%) were more than 35 years age ( $p < 0.05$ , Table - II).

**Table-II Age Distribution and Treadmill Response**

Age (Yrs)	Number of cases		Total
	Positive	Negative	
16-30	1	4	5
31-40	3	9	12
41-55	8	5	13
Total	12	18	30

The 12 subjects with positive TMT were subjected to coronary arteriography. 9 of these (75%) confirmed to have coronary artery disease. 3 (25%) subjects were detected to have triple vessel disease (TVD), all 3 developed significant ST depression at low levels of exercise (Table-III). Left main coronary artery involvement was not detected in our study.

**Table-III Results of Coronary Arteriography in Treadmill Positive Subjects**

Case No	Criteria for positive TM	Exercise level (METs)	CART Results
3	Sig ST Dep	11	SVD (RCA)
5	"	7	DVD (RCA + LCx)
6	"	9	Normal coronaries
8	* +angina	4	TVD
12	* +fatigue	6	SVD (RCA)
14	* +angina	6	SVD (LCx)
16	Sig ST Dep	7	DVD(RCA + LCx)
19	"	5	TVD
20	* +fall in BP	4	TVD
22	Sig ST Dep	10	SVD (LCx)
23	"	7	Normal coronaries
29	"	10	Normal coronaries

SVD = Single vessel disease

DVD = Double vessel disease

TVD = Triple vessel disease

RCA = Right coronary artery

LCx = Left circumflex artery

Sig ST Dep = Significant ST depression

4 subjects (33%) with angiographically significant CAD who developed significant ST depression during exercise did so early in the exercise period ( less than 5 min) and this lasted nearly the whole of the remaining period of exercise or into the immediate post-exercise

period (less than 3 min). All 3 with no angiographically significant CAD developed ST depression late in exercise and this reverted in early recovery phase (Table-IV).

**Table-IV Occurrence of Abnormal Exercise ECG Response**

	Total No	Occurrence of Abnormal Response		
		During Exercise/ Immediate Recovery	During Recovery only	During both
Angiographically significant CAD	9	4	1	4
No Significant CAD	3	3	0	0
Total	12	7	1	4

Only one subject with significant disease was below 35 years of age. 4 subjects (33%) were found to have single vessel disease (SVD), 2 (17%) had double vessel disease and 3 (25%) had triple vessel disease (Table-V).

**Table-V Coronary Arteriographic Findings in Subjects with a Positive Treadmill**

Age (Yrs)	Normal CART	Angiographic coronary artery disease (50% stenosis or more)		
		Single Vessel	Double Vessel	Triple Vessel
26-30	0	1	0	0
31-35	-	-	-	-
36-40	1	1	0	1
41-45	1	0	1	0
46-50	1	1	1	2
51-55	0	1	0	0
Total	3	4	2	3

CART = Coronary arteriography

## Discussion

Asymptomatic CAD may be partial, where some episodes of ischemia are symptomatic and others are asymptomatic or having suffered an infarction in the past and is at present asymptomatic or it may be total where significant CAD is demonstrated by angiography or necropsy without any history of angina, myocardial infarction, arrhythmia or congestive heart failure<sup>1</sup>.

Recently, it has been demonstrated that almost 70% ischemic episodes in patients with symptomatic CAD are not associated with

angina<sup>14,15,16</sup> and 10-15% of acute myocardial infarctions are silent<sup>17</sup>. Furthermore, some asymptomatic patients successfully resuscitated after cardiac arrest have exercise induced silent ischemia as the only manifestation of underlying CAD<sup>18</sup>.

Possible presentation of silent CAD on ECG may include a positive exercise test without symptoms, ischemic ECG findings on ambulatory monitoring unaccompanied by symptoms or resting ECG abnormalities such as left ventricular hypertrophy, intraventricular conduction defects or non-specific ST-T abnormalities without other symptoms<sup>19</sup>.

Several studies have been conducted to test the efficacy of treadmill test as a pointer to the presence or absence of CAD in both symptomatic and asymptomatic subjects. The specificity and sensitivity of TMT among these classes of subjects have been variously reported<sup>20,21,22</sup>.

The overall prevalence of significant CAD in the present study was 9 out of 30 (30%). The false positive rate was 14.3% and the maximum specificity of the treadmill test is calculated to be 18 out of 21 or 85.7%, if all subjects with a normal treadmill response were proved to have no significant disease on arteriography. As these subjects did not undergo arteriography, the false negative results and the sensitivity can not be calculated. The predictive value is calculated to be 75% for exercise ECG and 30% for resting ST-T ECG abnormalities.

Joy and Trump<sup>22</sup> assessed 103 asymptomatic men with resting ST-T abnormalities by exercise ECG and arteriography. They calculated the sensitivity of the exercise test lies between 71.4% and 89.5% while its specificity is between 86.3% and 98.8%. The predictive value of exercise ECG was calculated to lie between 27.7% and 94.4% while the predictive value of resting ECG is reported between 4.9 and 16.7%.

Few angiographic studies have been performed in asymptomatic subjects. The prevalence of CAD has been reported to be 4.5%

in subjects receiving cardiac catheterisation for reasons other than chest pain<sup>23</sup>. Similar results have been reported by studies based on mass of historical questionnaire<sup>24</sup> and autopsy<sup>25</sup>.

The pretest likelihood of disease, according to any combination of age, sex, symptoms, may be determined by conditional probability analysis<sup>26,27</sup>. The estimate of pretest likelihood in asymptomatic subjects may be improved by consideration of associated contributory factors including resting ECG abnormalities. The pretest likelihood in asymptomatic individuals with a positive TMT response is quoted to be about 30%<sup>22</sup>.

It is concluded that abnormal ST-T changes on routine ECG in asymptomatic subjects have a high incidence of silent CAD. This correlates with an advanced age (more than 35 years). Therefore the resting electrocardiogram, which is a simple, cheap and readily available test can be a pointer to the presence of significant coronary artery disease. All such subjects should be evaluated to establish or exclude the presence of CAD. The treadmill exercise test is an excellent tool to screen these subjects and select them for coronary arteriography.

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