

Significance of Abnormal T Waves in Acute Coronary Syndrome without ST Changes in ECG

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ABSTRACT

Background: T-wave abnormalities are common electrocardiographic occurrences in patients with acute coronary syndromes. The clinical and electrocardiographic course and angiographic findings in patients with evolving inverted or biphasic T waves have not been fully elucidated. Patients with abnormal T waves associated with unstable angina represent a subgroup with a high probability of near total obstruction of coronary artery and myocardial dysfunction. In the present study we describe a subgroup of patients with myocardial ischemia who during the acute Ischemic phase did not develop elevation but only biphasic or inverted T waves in the ECG and had >90% stenosis of 1 or more coronary arteries. **Methods:** The study comprised 125 patients presented with unstable angina pectoris. Patients' characteristics, Electrocardiographic Data, Cardiac enzymes and Coronary angiography findings were obtained. Collected data was analyzed and sensitivity, specificity, positive predictive value, significance of test (p value) were calculated using appropriate statistical method. **Results:** Of the 125 patients deep symmetrical and sustained T-wave inversions were present in 72 patients & biphasic T-waves in 28 patients. 125 patients underwent coronary angiography, 92(74%) patients had >90% stenosis of 1 or more coronary arteries; sensitivity of abnormal T waves for significant stenosis was 90%, specificity 92%, positive predictive value 97.83 % and p value <0.001. **Conclusion:** We have identified a subgroup of patients with critical obstruction of coronary artery in patients with unstable angina and non diagnostic ECG T-wave abnormalities are significant electrocardiographic occurrences in patients with acute coronary syndromes and frequently associated with coronary artery obstruction.

Keywords: Acute coronary Syndrome, Biphasic T waves, T wave inversion.

INTRODUCTION

The electrocardiogram (ECG) has long been recognized as an important aid in the diagnosis and localization of myocardial ischemia and infarction. Characteristic changes in the QRS complexes, S-T segments and T waves recorded from standard leads have been described for various stages of acute and chronic myocardial infarction. S-T segment and T wave changes during exercise testing are significant indicators of ischemia resulting from coronary insufficiency.^[1]

In the electrocardiogram, ST segment displacement is one of the useful signs of acute myocardial ischemia; ST segment elevation has been considered to reflect Transmural ischemia and ST segment

depression and T wave inversion reflects subendocardial or non Transmural ischemia (2).

T-wave abnormalities are common electrocardiographic occurrences in patients with acute coronary syndromes. T wave abnormalities as the sole manifestation of ischemia are possible. Study has shown Patients with abnormal T waves have a significantly higher risk of death, acute myocardial infarction, and/or refractory angina. Thus, T-wave abnormalities in patients presenting with acute coronary syndromes should not automatically be regarded as benign phenomena (3). The clinical and electrocardiographic course and angiographic findings in patients with evolving inverted or biphasic T waves have not been fully elucidated.

Patients with abnormal T waves associated with unstable angina represent a subgroup with a high probability of near total obstruction of coronary artery and myocardial dysfunction. We assume that during the period of total obstruction there was preexisting adequate collateral circulation in order to prevent Trans mural ischemia, which explains the absence of ST segment elevation.

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In the present study we describe a subgroup of patients with myocardial ischemia who during the acute Ischemic phase did not develop elevation but only biphasic or inverted T waves in the ECG and had >90% stenosis of 1 or more coronary arteries.

The Study Objective

To signify new abnormal T-waves in ECG by finding the pathoanatomic correlation between new abnormal T-waves in ECG and critical obstruction of coronary artery in patients with unstable angina.

MATERIALS AND METHODS

Population: The study approved by ethical committee comprised 125 patients admitted in September and October 2018 presented with unstable angina pectoris.

Table 1: Patient characteristics

Age (years) Mean	55.48
Sex	
Male	100
Female	25
Arterial hypertension	22%
Diabetes mellitus	20%
Previous infarction	10%
Previous angina	32%
Duration (years) Mean	3.6

Inclusion criteria: Patients with unstable angina (New onset of ischemic chest pain or rapid deterioration of a previously stable effort angina) without ST-segment deviation in ECG, with following electrocardiographic findings of T wave abnormality and who have given written informed consent were included:

- (1) A new abnormality of T wave in comparison to previous electrocardiograms (patients without previous electrocardiograms for comparison were not entered in the study, unless they presented with new symptoms of unstable angina).
- (2) A sustained T wave abnormality (>24 hours), that is, not a transient phenomenon associated with pain only.
- (3) T wave inversion >5 mm in amplitude from the isoelectric line.
- (4) T-wave inversion present in 2 or more than 2 of the anterior leads (I, aVL, V1 to V6) and/or in 2 or more than 2 of the inferior lead (II, III, and aVF), without evidence of previous MI in the leads analyzed.
- (5) Biphasic T waves.

25 patients presented with unstable angina with normal ECG were taken for finding statistical comparison parameters.

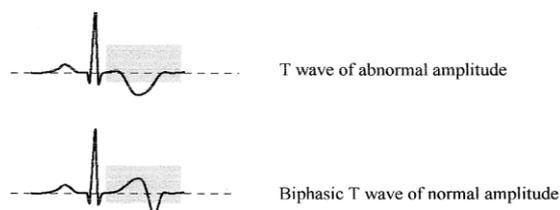


Figure 1: Types of abnormal T waves

Exclusion Criteria:

- (1) Past history or ECG documentation of old myocardial infarction (Evidence of previous anterior MI is defined as presence of Q waves >0.04 second duration in any of leads I, aVL, and V1 to V6, and of previous inferior MI as a presence of Q wave >0.03 second duration in lead II or aVF).
- (2) More than 80 years of age.
- (3) ST segment elevation more than 1mm and/or depression more than 0.5mm during the acute ischemic phase.
- (4) Conditions producing secondary T-wave abnormalities such as bundle branch block, ventricular pacing, ventricular rhythm, ventricular preexcitation, or left ventricular hypertrophy, Cardiomyopathy of any origin.
- (5) Patients treated with thrombolytic therapy.

Electrocardiographic Data:

Continuous electrocardiographic recording was done during the acute stage for the first hour of admission and every 15 to 30 min for the next 4 h. Serial ECGs were taken to confirm that T wave changes were sustained and not temporary.

Cardiac enzymes: Cardiac enzymes were obtained on admission as well as every 12 hours till angiography findings available.

Coronary angiography findings: Coronary angiography was performed in all 125 patients using the Judkins or Sones technique. Multiple projections of selective coronary angiograms were obtained. Arteriograms were analyzed by at least 2 independent experienced observers without knowledge of electrocardiographic findings. Coronary stenosis of greater than 90 percent of the luminal diameter in any view was considered significant.

Collateral vessels were looked for in all patients and were graded as good, poor or absent, based on a modification of the criteria of Levinn

Good collateral vessels caused opacification of portion of the recipient artery distal to the obstructive lesion. Poor collateral vessels caused faint or incomplete visualization of the recipient artery distal to its obstructive lesion. In cases with multiple collaterals only the vessel causing highest grade of opacification was used in the analysis.

Data Analysis:

Collected data was analyzed and sensitivity, specificity, positive predictive value, significance of test (p value) were calculated using appropriate statistical method

RESULTS

We have taken total 125 patients of unstable angina. 25 patients had normal electrocardiograms on admission. In the remaining 100 patients, abnormal T-waves were either a definite new finding

compared with a recent electrocardiogram, or was considered a new finding because the symptoms of unstable angina occurred a new. Of the 125 patients deep symmetrical and sustained T-wave inversions were present in 72 patients. Biphasic T-waves were present in 28 patients.

125 patients underwent coronary angiography, 92(74%) patients had >90% stenosis of 1 or more coronary arteries, out of which 90 patients were having abnormal T waves and 2 patients were having normal ECG. Out of 92 patients 42 had single-vessel, 44 had double-vessel and 6 had triple-vessel disease. Of the remaining 33 patients, 10 patients had 50 to 70% stenosis of a single coronary artery, 12 patients had <50% stenosis of 1 vessel, and 11 patients had no evidence of coronary artery disease.

Table 2: Association of abnormal T waves with coronary artery stenosis

Patients presented with unstable angina		Total number of patients	Patients with associated coronary artery stenosis (>90%)
Patients with T wave abnormality	Inverted symmetrical T waves	72	65
	Biphasic t waves	28	25
	Total t wave abnormality	100	90
Patients without t wave abnormality		25	2

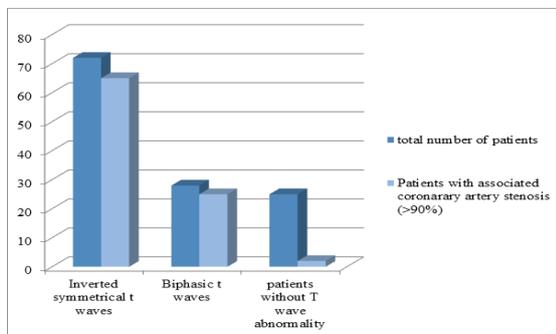


Figure 2: Association of abnormal T waves with coronary artery stenosis

Table 3: Stastical parametres showing abnormal T wave & coronary artery stenosis association

Sensitivity	90%
Specificity	92%
Positive predictive value	97.83%
P value	<0.001

DISCUSSION

In the present study we describe a subgroup of patients who during the acute Ischemic phase did not develop elevation but only T wave inversion or biphasic T waves.

In our data, 74% patients had total or near-total obstruction of coronary artery; sensitivity of T-wave inversion for significant stenosis was 90%,

specificity 92%, and positive predictive value 97.83 %.

To explain this uncommon electrocardiographic presentation of MI we searched for an angiographic correlation. Two major angiographic findings were evident

(1) There was high incidence of total or near total (>90percent) obstruction of coronary artery,

(2) Retrograde filling of the coronary artery via collateral vessels was observed in nearly all patients.

David E. Haines et al,^[1] found that among patients with unstable angina, the electrocardiographic development of new T-wave inversion in the anterior leads identified a subgroup of patients with high prevalence of significant LAD stenosis.

Alex Sagie et al,^[2] found a subgroup of patients with anterior AMI who during the acute ischemic phase did not develop ST segment elevation but only positive or peaked T waves in the precordial leads.

Michael D. Jacobsen et al,^[3] found that 6 of 13 (more than 6 abnormal T waves, >5mm of T-wave amplitude abnormality, T wave of abnormal amplitude in any of leads V1 to V3, T wave of abnormal amplitude in any of leads V4 to V6, T-wave amplitude abnormality in Inferior Leads, QRS-T angle >45° with mean T-wave axis <0°) T-wave abnormality categories (represented by 82.1% of the patients) were significantly associated with an adverse outcome.

Some studies in populations have found little prognostic values in abnormal T waves in patients with acute coronary syndromes.^[4] The reason for the discrepancy was in the definition of T-wave abnormality. Three previous negative studies defined T-wave abnormalities as either T-wave inversion >1 mm in 2 contiguous leads, T-wave inversion >1 mm presumably in only 1 ECG lead or simply biphasic/inverted T waves.^[5-7]

The underlying pathophysiologic mechanism of the occurrence of electrocardiographic negative T waves is incompletely understood. Reversible electrocardiographic findings associated with ischemia are often thought of as transient phenomena that resolve immediately as ischemia is diminished. Myocardial ischemia involving the subepicardial area may alter and reverse the pathway of electrical repolarization resulting in inverted T-wave morphology.^[8,15]

It is possible that patients in whom there are no collateral vessels during the acute phase of infarction have less severe atherosclerotic narrowing before complete occlusion by a thrombus than did our patients, in whom there was preexisting severe atherosclerotic narrowing before complete obstruction. Our findings corroborate in a group of patients, with and without new abnormal T-waves, the prognostic information to be gained from the surface electrocardiogram.

The fact that the patients which had anginal history of long duration further supports our assumption that

those patients' coronary obstruction may have occurred more gradually, allowing enough time for the development of collateral circulation. Patients with collateral circulation had a longer history of angina pectoris than patients without collateral filling. Our findings are in agreement with previous clinical studies on the difference in duration of angina pectoris before infarction between patients with and without collateral circulation.

This study supports our assumption that in patients with preexisting adequate collateral circulation sudden complete obstruction of the coronary does not produce ST segment elevation but ST segment depression or no deviation at all during acute occlusion confirmed by inducing percutaneous transluminal coronary angioplasty or spasm.

The management of individual patients with unstable angina may vary considerably in different centers. In some, immediate coronary angiography and grafting of the coronary arteries is recommended, whereas in others a more conservative attitude is taken. As a rule, the electrocardiogram is employed only as additional objective clinical evidence of myocardial ischemia when transient ST-T segment changes occur, particularly during pain. The decision to proceed with coronary angiography and subsequent coronary bypass surgery usually is predominantly based on failure of medical treatment, rather than electrocardiographic findings.

The potential prognostic value of electrocardiograms in patients with unstable angina only recently has been appreciated.^[9-11]

A report of a prospective study by Hultgren et al,^[12] examining medical versus surgical therapy in unstable angina showed a small improvement in survival of those undergoing coronary artery bypass surgery compared with those receiving medical therapy. Early cardiac catheterization and surgery in patients with unstable angina is being advocated by some groups.^[13,14]

CONCLUSION

We have identified a subgroup of patients with AMI and non diagnostic ECG. T-wave abnormalities are significant electrocardiographic occurrences in patients with non-ST-segment elevation acute coronary syndromes and frequently associated with coronary artery obstruction. It is important to recognize this uncommon electrocardiographic presentation of AMI which can easily be misdiagnosed. A critical feature in determining the functional role of collateral vessels is knowledge of their presence before or during the early stages of infarction.

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