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Original Article

Relationship Between a Positive T Wave in the Precordial V1 Lead and Advanced Coronary Artery Disease and 1-Year Mortality in Patients Undergoing Elective Coronary Angiography: An Observational Study

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ABSTRACT

Background: Data are scarce regarding the association between a positive T wave in the precordial lead V1 (TV1) and the severity of coronary artery disease (CAD) and long-term mortality in patients with suspected CAD and otherwise normal electrocardiograms (ECGs). The present study aimed to assess the association between a positive TV1 and the severity of coronary artery stenosis and 1-year mortality in patients with normal ECGs undergoing elective coronary angiography.

Methods: The present retrospective study enrolled 500 patients referred for elective coronary angiography and normal ECGs. We excluded patients with a history of myocardial infarction and acute coronary syndromes, bundle branch blocks, left ventricular hypertrophy, intraventricular conduction delays, significant valvular heart diseases, and permanent pacemakers. The patients were divided into 2 groups based on their ECG: patients with a positive TV1 and those with a negative or flat TV1.

Results: Out of 500 patients, 139 (27.8%) had a positive TV1. Multivessel CAD was more frequent in the patients with a positive TV1 than in those with a negative or flat TV1 (40.3% vs 28.5%; *P*=0.012). The 1-year mortality rate was significantly higher in the patients with a positive TV1 (9.4% vs 2.8%; *P*=0.003). A positive TV1 was an independent predictor of 1-year mortality (OR, 4.07; 95% CI, 2.16 to 7.62; *P*<0.001).

Conclusions: The findings of the present study suggest that a positive TV1 in patients with normal ECGs and suspected CAD is associated with advanced CAD and is an independent predictor of 1-year mortality. ***(Iranian Heart Journal 2023; 24(1): 6-14)***

KEYWORDS: T wave, Lead V1, Coronary artery disease, Mortality

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The electrocardiogram (ECG) has been widely used for the diagnosis of possible and known cardiovascular diseases, including coronary artery disease (CAD). The T wave in resting ECG denotes ventricular repolarization. [1] Repolarization abnormalities have been described as predictors of cardiac mortality. [2-4] Such abnormalities may be an early sign of heterogeneities associated with electrical instability and arrhythmic cardiac deaths. [5-7] Multiple studies have also found an association between various descriptors of repolarization, such as T-wave morphology, [8] and long-term mortality in the general population and patients with cardiovascular diseases.

Myocardial ischemia may change the sequence of repolarization and affect T-wave polarity and duration. [9]

The T wave in the precordial lead V1 (TV1) mirrors the sum of the repolarization waves of the anterior and posterior myocardial walls and can be positive, negative, or biphasic. [10]

A positive TV1 may be considered a normal variant or could be detected in patients with acute coronary occlusion, including those with posterior myocardial wall infarction, ventricular hypertrophy, left bundle branch blocks, and lead displacement

There is a paucity of data concerning the possible association between a positive T wave in TV1 and the severity of CAD and long-term mortality in patients with suspected CAD and otherwise normal ECGs. [11, 12] In the present study, we sought to assess the association between a positive TV1 and the severity of coronary artery stenosis and 1-year mortality in patients with otherwise normal ECGs undergoing elective coronary angiography.

METHODS

Design and Study Population

The present retrospective study enrolled all patients with suspected CAD and normal ECGs undergoing elective coronary angiography between June 2018 and December 2018 in Madani Heart Center in Tabriz in the northwest of Iran. The study complies with the Declaration of Helsinki, and the Ethics Committee of Tabriz University of Medical Sciences reviewed and approved the study protocol (ID: IR.TBZMED.REC.1397, 1065). Informed consent was obtained from all the patients.

Measurements

The standard 12-lead ECG was recorded with a paper speed of 25 mm/s and standardization of 10 mm/1 mV. Lead V1 was placed in the fourth intercostal space just to the right of the sternum.

The TP segment was used as the isoelectric line. Based on previous reports [11,12] and because of the difficulty in interpreting minor changes (within 10 mm in the T wave), we defined a positive T wave in lead V1 as a positive deflection ≥15 mm. Patients without such criteria were considered a group without a positive TV1.

All the ECGs were evaluated by a cardiologist blinded to the patients' clinical and angiographic data.

Study Sample

Out of 836 patients undergoing elective coronary angiography during the study period, 500 consecutive patients were enrolled in this study (Fig. 1). We excluded patients with a history of myocardial infarction or revascularization (n=209), patients with bundle branch blocks (n=21), left ventricular hypertrophy (n=14), intraventricular conduction delays (n=27), severe valvular heart diseases (n=12), cardiomyopathy (n=3), permanent pacemakers (n=11), uninterpretable ECGs (n=32) and electrolyte abnormalities (n=7). Out of 500 patients referred for coronary angiography, 63 patients had positive findings in noninvasive tests before catheterization, including positive exercise

tests in 40 patients, positive myocardial perfusion imaging in 21 patients, and positive coronary CT angiography in 2 patients. The majority of the patients were referred without any noninvasive tests before coronary angiography.

The patients were divided into 2 groups based on their ECG: patients with a positive T wave in TV1 and patients without a positive TV1. Demographic characteristics, clinical data, and angiographic findings were recorded and compared between the groups. Coronary angiography was performed via the radial or femoral approach. Significant coronary artery stenosis was defined as stenosis diameters exceeding 70%. Multivessel involvement was defined as 2 or more significant coronary artery stenoses. All the catheterization data were evaluated by an interventional cardiologist blinded to the patients' clinical and ECG data. Surgical or percutaneous revascularization was based on the operator's decision and was done in the same hospitalization or within 30 days.

Statistical Analysis

Continuous variables were expressed as the mean ± the standard deviation (SD). Categorical variables were presented as frequencies and percentages. The normal distribution of continuous data was evaluated using the Kolmogorov–Smirnov test, which showed that all these data had unbalanced distributions (P<0.001). Accordingly, the Mann–Whitney U test was applied to analyze the continuous data. The categorical variables were compared using the χ^2 test. Univariate and multivariate logistic regressions were applied to identify the independent predictors of 1-year mortality. Variables with a P value ≤0.05 in univariate analysis were used for multivariate analysis. Differences in long-term event-free survival between the 2 groups were examined with the Kaplan–Meier method and compared using the log-rank test.

In all the comparisons, a P value <0.05 was considered statistically significant. The data were analyzed using the IBM SPSS Statistics V22.0 software.

RESULTS

Out of 500 patients, 139 (27.8%) had positive T waves in TV1. The study population's demographic characteristics, clinical findings, and angiographic data are summarized in Table 1.

Patients with a positive TV1 had a significantly higher degree of left anterior descending artery stenosis (P=0.001) than those without a positive TV1. Multivessel CAD was more frequently found in the patients with a positive TV1 than in those without TV1 (40.3% vs 28.5%; P=0.012). On the other hand, normal epicardial coronary arteries or nonobstructive CAD were seen more frequently in the patients without a positive TV1 (54.8% vs 33.8%; P=0.001).

Additionally, the number of patients treated via percutaneous coronary intervention or coronary artery bypass grafting was significantly higher in the group with a positive TV1 than in the group without a positive TV1 (P=0.001 and P=0.021, respectively). In-hospital deaths occurred in 2 patients: both were in the positive TV1 group. One patient died during a complex coronary angioplasty and the other following multi-organ failure after emergent coronary artery bypass surgery.

The 1-year mortality rate was higher in the positive TV1 group than in the patients without a positive TV1 (9.4% vs 2.8%; P=0.003). Cardiac deaths during this period occurred in 5.7% of the patients with a positive TV1, far more common than in the patients without a positive TV1 (1.1%; P=0.005).

The cumulative survival rate at 1 year was significantly lower in the patients with a positive TV1 than in those without a positive TV1 (the log-rank test; P<0.001) (Fig. 2).

Logistic regression analysis was used to determine the variables affecting the 1-year mortality rate. The results analysis showed that only multivessel disease, a positive TV1, and left anterior descending coronary artery (LAD) stenosis were predictors of mortality in the model. These variables were entered into a multivariate logistic regression, which showed that multivessel disease (adjusted OR, 2.61; 95% CI, 0.99 to 6.82; *P*=0.05) and a positive TV1 (adjusted OR, 4.07; 95% CI, 2.16 to 7.62; *P*<0.001) were the independent predictors of 1-year mortality (Table 2).

Table 1: Baseline clinical characteristic of patients with and without positive T waves in lead V1 (TV1)

	Patients With a Positive TV1 (n=139)	Patients Without a Positive TV1 (n=361)	*P* value
Age, y	60.00±9.85	60.98±32.87	0.50
Sex, Female, N (%)	51(36.7%)	166(46%)	**0.03**
Family history, N (%)	10 (7.2%)	23 (6.4%)	0.11
Diabetes, N (%)	30 (21.6%)	83 (23%)	0.41
Hypertension, N (%)	70 (50.4%)	184 (51%)	0.49
Smoking, N (%)	33 (23.7%)	60 (16.6%)	0.07
Heart rate, bpm	74.55±7.99	76.29±8.33	0.17
Systolic blood pressure, mm Hg	123.17±17.44	124.00±17.39	0.41
Diastolic blood pressure, mmHg	75.41±11.16	76.25±9.45	0.54
Sinus rhythm	133 (95.7%)	349 (96.7%)	0.28
Angiographic Data Culprit Lesion Location			
LAD, N (%)	77 (55.4%)	109 (30.2%)	**0.001**
RCA, N (%)	31 (22.3%)	79 (21.8%)	0.90
LCX, N (%)	24 (17.2%)	52 (14.4%)	0.48
LMCA, N (%)	4 (2.9%)	14 (3.9%)	0.59
Number of Coronary arteries With >70% Stenosis			
Single-vessel disease, N (%)	29 (20.9%)	55 (15.2%)	0.132
Multivessel disease, N (%)	56 (40.3%)	103 (28.5%)	**0.012**
Need for Coronary Revascularization			
PCI	48 (34.5%)	59 (16.3%)	**0.001**
CABG	29 (2.9%)	69 (0.3%)	**0.021**
In-hospital mortality	2 (1.5%)	0 (0.0%)	0.07
One-year mortality	13 (9.4%)	10 (2.8%)	**0.003**
One-year cardiac death	8(5.7%)	4(1.1%)	**0.005**

CABG, Coronary artery bypass grafts surgery; LAD, Left anterior descending artery; LCX, Left circumflex artery; LMCA, Left main coronary artery; PCI, Percutaneous coronary intervention RCA, Right coronary artery; TV1, T wave in lead V1

Table 2: Univariate and multivariate logistic regression analyses for 1-year mortality

Variables	Univariate		Multivariate	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age	1(0.99-1.01)	0.770		
Sex	0.928(0.54-1.75)	0.928		
DM	1.23(0.62-2.4)	0.545		
HTN	0.81(0.44-1.45)	0.475		
Smoking	0.82(0.37-1.81)	0.619		
LAD stenosis	1.79(0.99-3.23)	0.05	1.043(0.45-2.37)	0.92
LM stenosis	2.71(0.85-8.57)	0.09		
Multivessel disease	2.34(1.19-4.59)	0.013	2.61(0.99-6.82)	0.05
Positive TV1	3.88(2.13-7.06)	<0.001	4.07(2.16-7.62)	<0.001

DM, Diabetes mellitus; HTN, Hypertension; LAD, Left anterior descending artery; LM, Left main coronary Artery; TV1, T wave in lead V1

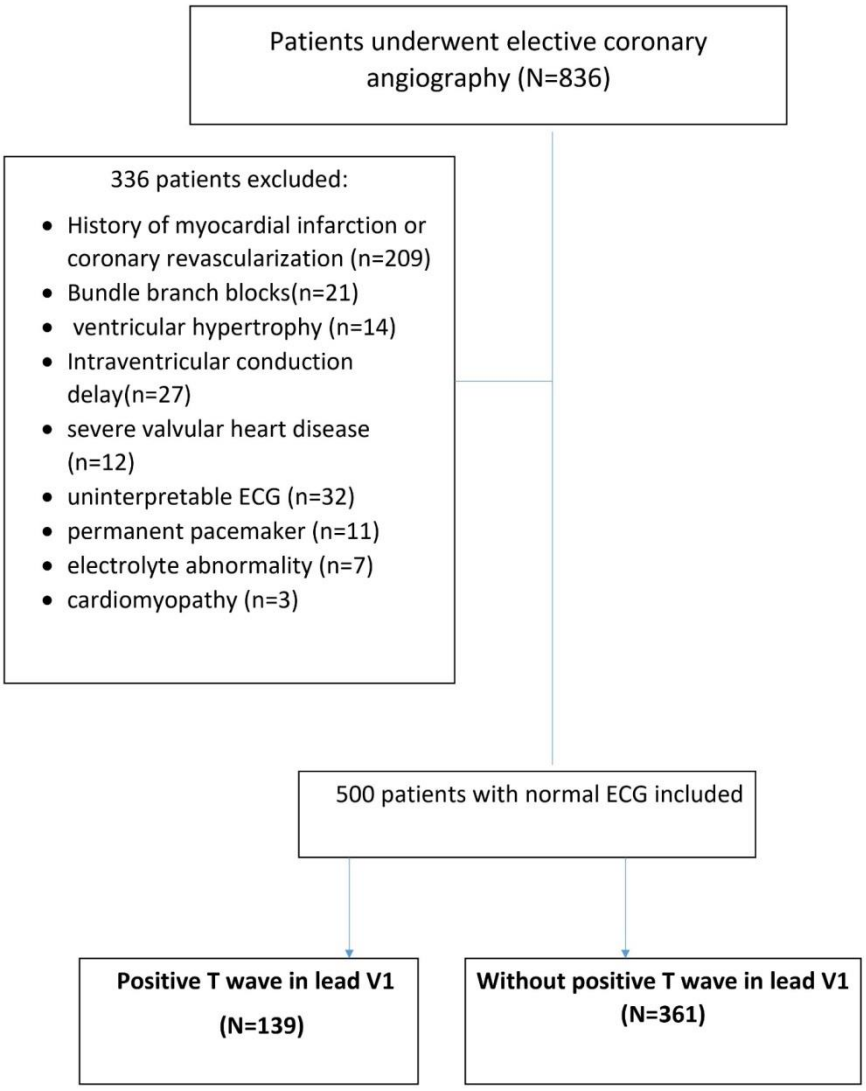
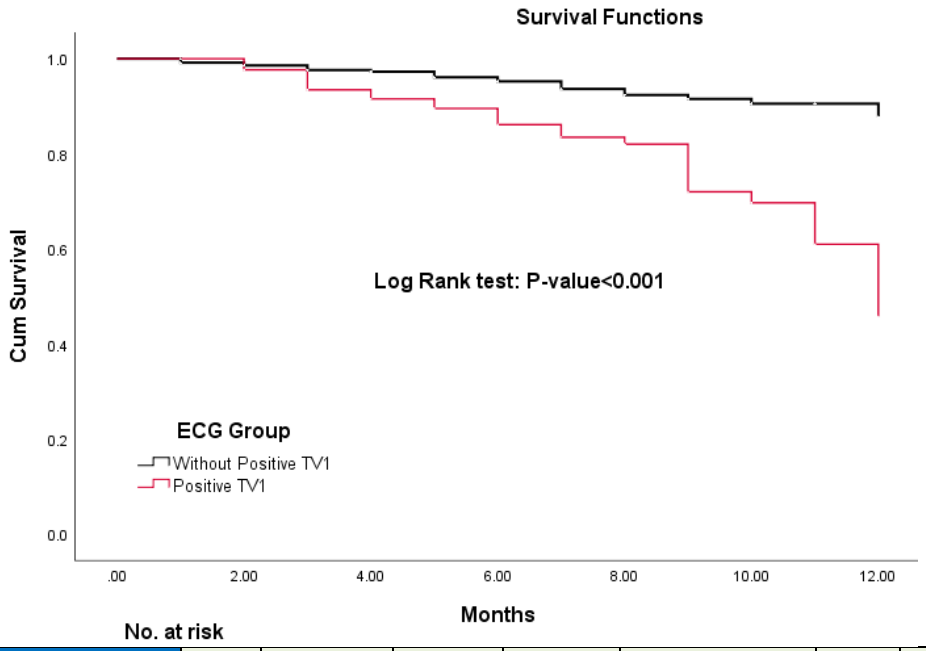


Figure 1: The STROBE (the Strengthening the Reporting of Observational Studies in Epidemiology initiative) flow diagram of the patients is presented herein.



No. at risk

Without a PositiveTV1	361	321	267	200	131	75	16
With a Positive TV1	139	123	95	73	49	24	5

Figure 2: The image depicts the Kaplan–Meier cumulative survival estimates at 12 months in patients with a positive TV1 and without a positive TV1.
TV1, T wave in the precordial lead V1

DISCUSSION

Main Findings

The main findings of the current retrospective observational study were as follows:

A positive TV1 was relatively common in our cohort in that it accounted for about 1 in 4 patients. Moreover, a positive TV1 was associated with advanced CAD. In addition, a positive TV1 was associated with reduced 1-year survival and was an independent predictor of increased 1-year mortality.

T-wave changes, including hyper-acute T waves and negative T waves, have prognostic implications in acute ST-segment elevation and non–ST-segment elevation myocardial infarctions. [13] Nonetheless, there are limited data about the prognostic impact of T-wave polarity in TV1 in healthy patients with suspected CAD. [12]

The direction of the QRS vector usually affects T-wave polarity in various ECG leads. TV1 could be negative, biphasic, or positive in normal adults.

Comparison With Other Studies

In the present study, a positive TV1 was seen in 33.8% of the patients without significant coronary artery stenosis. We found a low prevalence rate of a positive TV1 in our cohort compared with previous studies on the general population, [5] probably due to ethnical differences. Similar to most previous studies, [14] we found more patients with advanced CAD in the positive TV1 group. However, previous studies included patients with acute coronary syndromes and did not exclude patients with a history of prior revascularization and myocardial infarction. These conditions could potentially impact the repolarization phase

and affect T-wave polarity and amplitude in lead V1. [15,16]

Another salient finding of the present study was an increased 1-year mortality rate among patients with a positive TV1 and an otherwise normal ECG. The patients with a positive TV1 were 4 times more likely to die within 1 year after coronary angiography than those without a positive TV1, most probably due to the advanced nature of CAD in this group as evident in increased cardiac deaths in these patients (Table 1).

In the present study, LAD stenosis was seen more frequently in patients with a positive TV1. This result is in line with some previous studies [12] and contradictory to others that showed the left circumflex artery (LCX) as the culprit epicardial artery in patients with a positive TV1. [11] The reason for this difference is unclear, but it could be due to the exclusion of patients with a history of myocardial infarction in the present study, contrary to most prior studies that included such patients. T-wave changes in TV1 may reflect abnormal repolarization in either anterior or posterior left ventricular myocardium corresponding to the LAD or LCX territory of myocardial supply.

Potential Pathophysiological Mechanisms and Clinical Implications

The exact mechanism responsible for the findings of the present study is unclear. Still, the following theoretical hypothesis may be involved:

Recent evidence suggests that T-wave abnormalities may be a sign of myocardial edema, [17] myocardial fibrosis, [18] or local cardiac sympathetic disruption. [19] It is plausible that a positive TV1 as a mirror image has the same role of a negative T wave in the other ECG leads and represents a sign of myocardial edema and sympathetic disruption due to severe myocardial ischemia. Of course, this is only a hypothesis and needs further evaluation with detailed cardiac imaging. It seems reasonable to consider this ECG finding a surrogate of increased long-term risks of adverse events in patients with CAD risk factors and otherwise healthy and proceed to aggressive lifestyle modification and risk factor management.

Study Limitations

Our study has some limitations that should be addressed in future studies. Firstly, our study is a retrospective single-center investigation involving a limited number of patients. Secondly, our study involves patients in a non-random manner. Thus, randomized studies should be conducted to validate our findings. Thirdly, we did not assess the severity of CAD using SYNTAX (Synergy between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery), which is a more accurate measure of CAD severity than the number of stenotic epicardial coronary arteries. Fourthly, other cardiovascular endpoints, such as heart failure, stroke, and myocardial infarction, were not measured in the present study. Fifthly, we did not evaluate other T-wave abnormalities that are potentially associated with CAD. [20]

CONCLUSIONS

The findings of the present study suggest that a positive TV1 in patients with normal ECGs and suspected CAD is associated with advanced CAD and is an independent predictor of 1-year mortality.

Acknowledgments

None

Conflicts of Interest

The authors have no conflicts of interest to declare.

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