ORIGINAL ARTICLE

Cardiac mortality predictability of T-wave alternans in young ST-elevated myocardial infarction patients with preserved cardiac function

Korunmuş kardiyak fonksiyonlu genç yaş ST-yükselmeli miyokart enfarktüsü hastalarında T dalgası alternansının kardiyak mortalite öngörülebilirliği

Mustafa Umut Somuncu, M.D.,[1] Hüseyin Karakurt, M.D.[2]

[1]Department of Cardiology, Bülent Ecevit University Faculty of Medicine, Zounguldak, Turkey

[2]Department of Cardiology, Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery, Training and Research Hospital, İstanbul, Turkey

ABSTRACT

Objective: Primary prevention of sudden cardiac death in ST-elevation myocardial infarction (STEMI) is a complicated issue due to the highly heterogeneous population. The effect of T-wave alternans (TWA) on cardiac mortality has been examined in various populations, most often in patients with a high risk of fatal arrhythmia, such as patients with a low left ventricular ejection fraction (LVEF). The aim of the present study was to investigate the prevalence of TWA and its relationship to cardiac mortality in young STEMI patients with preserved LVEF.

Methods: A total of 108 STEMI patients with preserved cardiac function who were under the age of 45 and underwent single-vessel primary percutaneous coronary intervention were enrolled in this prospective study. Preserved cardiac function was defined as an LVEF of ≥50% as detected with echocardiography 24 to 72 hours after the procedure. The TWA test was performed approximately 1 year after the STEMI occurrence. TWA positivity was defined with a maximal voltage of >64 μV and a heart rate of 125 beats per minute, as in previous studies. The patients were followed up for 5 years and overall cardiac mortality was measured.

Results: There was a positive TWA finding in 24 patients (22.2%). There was no significant difference in the use of medications, traditional risk factors, or LVEF in those with TWA positivity. During a follow-up period of 5 years, 7 patients (6.5%) reached the endpoint. Patients with TWA positivity had 10.7 times greater odds for 5-year cardiac mortality, independent of other risk factors.

Conclusion: Clinicians should consider using the TWA test in young STEMI patients, as TWA positivity may be associated with increased cardiac mortality in this population.

ÖZET

Amaç: ST-yükselmeli miyokart enfarktüs (STYME) hastaları homojenlik göstermediğinden dolayı ani kardiyak ölümlerin primer korunması ihtilaflı bir konudur. T-dalga alternansının (TDA) kardiyak mortalite ile ilişkisi, çoğunluğu ölümcül aritmi riski yüksek olan düşük sol ventrikül ejeksiyon fraksiyonlu (SVEF) hastalar olmak üzere, birçok farklı kalp hastalıklarında incelenmiştir. Çalışmamızda, genç yaş STYME geçirmiş ve korunmuş SVEF'ye sahip spesifik bir popülasyonda TDA'nın prevalansını ve kardiyak mortalite ile ilişkisini araştırmayı amaçladık.

Yöntemler: Bu ileriye yönelik çalışmaya, 45 yaş altı tek damar primer perkütan koroner işlem uygulanmış, korunmuş kardiyak fonksiyonlu 108 STYME hastası dahil edildi. Korunmuş kardiyak fonksiyon, işlem sonrası 24–72 saatte yapılan ekokardiyografide SVEF ≥50 saptanması olarak kabul edildi. TDA analizi STYME'den yaklaşık bir yıl sonra yapıldı. TDA pozitifliği, daha önceki çalışmalarda tanımlandığı gibi, dakikada 125 kalp atımında maksimum voltajın 64 μV üzeri olması şeklinde tanımlandı. Hastaların beş yıllık takibi sonucu primer sonlanım noktası olarak total kardiyak nedenli ölümler kabul edildi.

Bulgular: T-dalga alternansı, 24 hastada (%22.2) pozitifti. TDA pozitifliğine göre oluşturulan iki grup arasında; geleneksel risk faktörleri, ilaç kullanımı ve SVEF açısından fark yoktu. Beş yıllık takip sonucunda yedi hasta (%6.5) primer sonlanım noktasına ulaştı. Diğer risk faktörlerinden bağımsız olarak, TDA pozitifliği olan hastalarda beş yıllık kardiyak mortalite, TDA pozitifliği olmayanlara göre 10.7 kat oranında artmıştı.

Sonuç: T-dalga alternansı pozitifliği genç yaş STYME hastalarında artmış kardiyak mortalite ile ilişkili olabileceğinden dolayı, klinisyenler bu popülasyonda TDA testini dikkate almalıdır.

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Correspondence: Dr. Mustafa Umut Somuncu. Bülent Ecevit Üniversitesi Tıp Fakültesi, Kardiyoloji Anabilim Dalı, Zonguldak, Turkey.
Tel: +90 372 - 261 20 02 e-mail: usomuncu@gmail.com

Myocardial infarction (MI) patients frequently experience repeated cardiovascular events throughout their lives, which can lead to morbidity and mortality.[1] Studies have shown that a low left ventricular ejection fraction (LVEF) is an important risk factor for cardiovascular mortality in post-MI patients.[2] Young MI patients often have preserved LVEF because they have mostly single-vessel disease.[3] This makes it difficult to classify the risk and can prevent patients and physicians from ensuring that the appropriate attention is given to the post-MI follow-up. Therefore, it is also necessary to stratify the risk of cardiac mortality in post-MI patients with a preserved LVEF.

Microvolt T-wave alternans (TWA) has been proposed as a predictor of sudden cardiac death (SCD) in patients with coronary artery disease, with or without congestive heart failure.[4,5] Several experimental studies have established that variations in TWA were related to increased vulnerability to fatal arrhythmias,[6] and particularly in post-MI patients with a low LVEF.[7] Although several studies have investigated the prognostic value of TWA in different populations,[8] to the best of our knowledge, there are no studies that have reviewed the predictive value of TWA in young MI patients. Consequently, the aim of the current study was to investigate the prediction value of TWA positivity in young MI patients. The inclusion criteria limited the study to patients with a single-vessel lesion and with preserved EF to ensure population homogeneity.

METHODS

Study population

In this prospective, observational study, 108 consecutive patients (<45 years old) with preserved cardiac function who were admitted to a large-volume center with a diagnosis of STEMI and underwent successful single-vessel primary percutaneous coronary intervention (PCI) were included. The patient population was enrolled between January 2009 and June 2012 from a cardiology center with an annual MI volume of approximately 3500 patients. The exclusion criteria were missing or unavailable patient data; malignant, infectious, or other systemic inflammatory diseases; unsuccessful PCI procedure; and no indication for PCI. STEMI patients were defined as patients with typical chest pain at rest lasting more than 30 minutes, and ST-segment elevation of ≥0.2 mV in 2 or more contiguous, precordial leads or adjacent limb leads on a standard 12-lead electrocardiogram (ECG). All primary PCI procedures were performed by surgeons at a single center who perform more than 100 PCIs/year (>3000 PCIs/year).

Abbreviations:

CI	*Confidence interval*
ECG	*Electrocardiogram*
HR	*Hazard ratio*
IRA	*Infarct-related artery*
LV	*Left ventricle*
LVEF	*Left ventricular ejection fraction*
MI	*Myocardial infarction*
MMA	*Modified moving average*
OR	*Odds ratio*
PCI	*Percutaneous coronary intervention*
SCD	*Sudden cardiac death*
STEMI	*ST-elevation myocardial infarction*
TIMI	*Thrombolysis in Myocardial Infarction*
TWA	*Microvolt T-wave alternans*

The TWA test was performed approximately 1 year (8–14 months) after the PCI. The patients were followed up for 5 years and the primary outcome was defined as overall cardiac mortality. An independent committee, unaware of the test results, reviewed all of the events. Patient follow-up data were obtained from the hospital or autopsy records or by interviewing (in person or by telephone) the patients, their family, or their physician. Cardiac mortality was defined as death from MI, fatal arrhythmia, heart failure, or SCD. The study was conducted in accordance with the Declaration of Helsinki. Written, informed consent was obtained from all of the patients who participated and the study protocol was approved by the ethics committee of our university.

Analysis of patient data

Demographic data and details of past medical history and previous medical therapies were collected. A 12-lead ECG exam was recorded for each patient immediately after hospital admission and the MI type was defined based on the ECG results. At 24 to 72 hours after revascularization, transthoracic echocardiography (Vivid S5 probe 3 S-RS; GE Healthcare, Inc., Chicago, IL, USA) was performed to calculate the LVEF using the biplane Simpson method.[9] Patients with an LVEF <50% were excluded from the study. Echocardiography was performed again 3 months after discharge and an LVEF of <50% was not detected in any of the patients.

Coronary intervention procedure

All of the participants received a chewable 300 mg or 100 mg aspirin (according to previous usage) and

clopidogrel (600 mg loading dose) before coronary angiography was performed. Heparin (100 IU/kg) was administered after the decision to perform coronary intervention. After angioplasty, all of the patients were admitted to the coronary care unit, where routine antithrombotic therapy of a daily dose 100 mg of aspirin, 75 mg of clopidogrel, and subcutaneous enoxaparin was administered. Emergency coronary angiography and angioplasty were performed by femoral access. The artery that was assumed to be the non-infarct-related artery (IRA) was injected first. Blood flow in the IRA was evaluated using the Thrombolysis in Myocardial Infarction (TIMI) classification.[10] There was no instance of MI related to nonobstructive coronary arteries in any of the study participants. IRA stenosis was severe (>70%) and blood flow in the IRA was <TIMI grade 3 in all patients. Only patients who underwent successful primary PCI were included in the study. PCI success was defined as a minimum stenosis diameter reduction to <20% narrowing in a stented artery with relief of signs and/or symptoms of myocardial ischemia and without a major, in-hospital clinical complication. All of the culprit lesions had a TIMI grade 3 flow after the PCI, and there was no significant stenosis in the other vessels.

Measurement of T-wave alternans

A treadmill (CardioSoft v4.14 Diagnostic System; GE Healthcare Inc., Chicago, IL, USA) exercise stress test was conducted according to a standard symptom/sign-limited Bruce protocol. The TWA analysis was performed noninvasively during submaximal exercise. An expert cardiologist who was blinded to patient details evaluated the test. Continuous ECG monitoring was digitally registered with the CardioSoft exercise ECG system and analyzed automatically using the modified moving average (MMA) method. Blood pressure was measured 3 times (baseline, during peak exercise, and during the last minute of exercise). TWA was assessed with the time-domain MMA method: the MMA algorithm divides consecutive ECG waveforms into odd and even groups and simultaneously creates mean templates for these groups. The average morphologies of both were evaluated separately and adjusted for every new beat with a weighting factor of 1 of 8. This minimizes the influence of noise and artifacts, such as those caused by respiration and walking. The TWA value was the maximal difference between the averages of the odd and even beats along one of the J-T segment sample points in any lead during the stress test. Periods when the level was greater than 10 microvolts, no T-wave could be clearly seen, the TWA value was >125 heart rate, and instances when the templates of the QRS wave complexes could not be superimposed completely were excluded from the analysis. These processes were repeated until the accepted TWA values were obtained. The TWA values were recorded on all standard leads during all exercise stages. If the value was greater than the cut-off value of 65, which was based on a previously published report,[11] the TWA was considered positive. Patients were divided into 2 groups according to TWA positivity. The TWA was negative for 84 patients (39.4±4.8 years) and positive for 24 patients (37.8±4.0 years).

Statistical analysis

Statistical analysis was performed using PASW Statistics for Windows, Version 18.0 software (SPSS Inc., Chicago, IL, USA). Visual (histograms, probability plots) and analytical methods (Kolmogorov-Smirnov test, Shapiro-Wilk test) were used to assess the normal distribution of the variables. Descriptive analyses are presented as the mean and SD, and categorical variables are expressed as numbers and percentages. Comparisons between groups were performed using an unpaired Student's t-test for continuous variables with normal distribution, and the Mann-Whitney U test for continuous variables without normal distribution. Groups were formed according to TWA positivity, and the presence of a primary outcome, clinical features, and laboratory values were compared. Multivariate Cox regression with backward, stepwise selection that included variables with a p value <0.01 in univariate analysis was carried out to identify independent predictors of 5-year cardiac mortality. The cumulative survival curve for 5-year cardiac mortality was executed using the Kaplan–Meier method, with differences assessed using log-rank tests. A p value <0.05 was considered statistically significant.

RESULTS

There were no significant differences between the groups in the baseline characteristics or use of medications (antiplatelet, renin-angiotensin system blocker, beta blocker, statin) except platelet count (Table 1). When analyzed according to cardiac mortality, there were no significant differences between the groups

Table 1. Baseline characteristics of the study population

Variable	TWA (+) (n=24)			TWA (-) (n=84)			*p*
	n	%	Mean±SD	n	%	Mean±SD	
Age (years)			38.7±4.0			39.4±4.8	0.172
Male	22	91.7		75	89.3		0.737
Body mass index (kg/m^2)			30.0±3.9			29.0±4.7	0.303
Smoking	19	79.2		64	76.2		0.760
Diabetes mellitus	4	16.7		16	16.7		1.000
Hypertension	11	45.8		39	46.4		0.959
Family history	11	45.8		41	48.8		0.797
Anterior myocardial infarction	17	70.8		38	45.2		0.037
Use of medications							
Antiplatelet	23	95.8		80	95.2		0.903
Beta blocker	21	87.5		66	78.6		0.330
Renin angiotensin system blocker	16	66.7		51	60.7		0.596
Statin	18	75.0		61	72.6		0.816
Infarct-related artery							0.140
Left anterior descending artery	16	66.7		27	32.1		
Circumflex	4	16.7		37	44.0		
Right coronary artery	4	16.7		20	23.8		
Proximal lesion	5	20.8		14	16.7		0.636
Creatinine (mg/dL)			0.85±0.12			0.84±0.12	0.852
Low-density lipoprotein-C (mg/dL)			130.4±32.6			142.4±39.8	0.178
High-density lipoprotein-C (mg/dL)			36.1±8.7			36.2±8.7	0.967
White blood cell count (10^3/L)			13.3±3.2			12.6±8.4	0.671
Hemaglobin (g/dL)			14.8±1.49			14.5±1.6	0.411
Platelet count (10^3/L)			296.6±61.7			256.6±64.3	0.008
Left ventricular ejection fraction (%)			55.1±4.7			55.8±4.6	0.509

TWA: T-wave alternans; C: Cholesterol; SD: Standard deviation.

in demographic characteristics, medical history, use of medications, or other factors that could affect the prognosis except TWA positivity (Table 2).

TWA test positivity was detected in 24 patients (22.2%). A total of 7 cardiac deaths had occurred at the end of the 5-year follow-up period. Four of the 7 deaths occurred in our hospital, 2 took place at another medical center, and 1 occurred at the patient's home. Two of the deaths in our hospital were admitted to the emergency department with MI accompanied by cardiogenic shock and though the PCI was successful, the patients died during in-hospital follow-up. The remaining 2 of the 4 deaths at our hospital both presented with ventricular fibrillation and did not respond to cardiopulmonary resuscitation. Similarly, the 2 patients who died at another medical facility presented at the emergency department with symptoms of chest pain and palpitations. Cardiopulmonary arrest ensued after admission and the patients did not respond to resuscitation. In the final case, relatives indicated that the patient had reported chest pain and shortness of breath at night and he was found dead in his apartment in the morning. Since these patients did not have any additional disease, these deaths were evaluated as cardiac mortality.

Five of the 7 cases of cardiac mortality had TWA positivity (71.8%). Cox regression analysis to identify independent predictors of 5-year cardiac mortality and

Table 2. Comparison of baseline characteristics according to cardiovascular mortality presence

Variable	Cardiovascular mortality (+) (n=7)			Cardiovascular mortality (-) (n=101)			*p*
	n	%	Mean±SD	n	%	Mean±SD	
Age (years)			40.0±5.1			39.4±4.2	0.738
Male	6	85.7		91	90.1		0.737
Body mass index (kg/m^2)			27.8±4.1			29.4±4.1	0.324
Smoking	6	85.7		77	76.2		0.565
Diabetes mellitus	1	14.3		17	16.8		0.861
Hypertension	4	57.1		46	45.5		0.552
Family history	3	42.9		49	48.5		0.772
Anterior myocardial infarction	4	57.1		51	50.5		0.734
Use of medications							
Antiplatelet	7	100		96	95.0		0.547
Beta blocker	5	71.4		82	81.2		0.528
RAS blocker	4	57.1		63	62.4		0.783
Statin	4	57.1		76	75.2		0.290
Infarct-related artery							0.856
Left anterior descending	4	57.1		49	48.5		
Circumflex	2	28.6		23	22.8		
Right coronary artery	1	14.3		29	28.7		
Proximal lesion	3	42.9		16	15.8		0.102
Creatinine (mg/dL)			0.81±0.16			0.84±0.15	0.667
High-density lipoprotein-C (mg/dL)			39.1±6.0			35.9±8.6	0.344
Low-density lipoprotein-C (mg/dL)			138.1±32.7			139.9±39.0	0.875
Hemoglobin (g/dL)			14.4±2.1			14.6±1.5	0.789
White blood cell count (10^3/L)			13.9±1.9			12.6±7.8	0.669
Left ventricular ejection fraction			52.8±5.4			55.8±4.8	0.125
T-wave alternans positivity	5	71.4		19	18.8		0.001

C: Cholesterol; SD: Standard deviation.

a Kaplan-Meier survival plot to illustrate the relationship between cardiac mortality and TWA positivity were performed (Table 3, Fig. 1). The TWA-positive group had 10.7 times greater odds of 5-year cardiac mortality than the TWA-negative group, independent of LVEF and use of medications.

DISCUSSION

The primary findings of our study of STEMI patients with preserved cardiac function under the age of 45 years who underwent single-vessel primary PCI are that (a) 22.2% had TWA positivity, (b) the patients with TWA positivity had a significantly higher incidence of cardiac mortality at 5 years post procedure compared with the TWA-negative patients (20.8% vs. 2.4%; p=0.001), and (c) after adjustment for potential confounders, it was determined that TWA positivity was the only independent predictor of cardiac mortality (odds ratio [OR]: 10.789, 95% confidence interval [CI]: 1.944–59.896; p=0.007). Moreover, the Kaplan-Meier survival plot for 5-year cardiac mortality demonstrated a poor prognosis for patients with TWA positivity (log rank <0.001).

SCD is more devastating in younger patients compared with other age groups, both emotionally and socioeconomically. Yet the importance given to this

Table 3. Multivariate Cox regression analysis for potential predictors of 5-year cardiovascular mortality

Variable	Univariate analysis HR (CI 95%)	*p*	Multivariate analysis HR (CI 95%)	*p*
Age, years	1.033 (0.855–1.248)	0.735		
Male, yes	1.517 (0.165–13.901)	0.713		
Diabetes mellitus, yes	0.824 (0.093–7.287)	0.861		
Hypertension, yes	1.635 (0.344–7.767)	0.536		
Beta blocker use, yes	0.589 (0.104–3.726)	0.954		
Statin use, yes	0.247 (0.052–1.107)	0.079	0.256 (0.042–1.542)	0.137
Anterior myocardial infarction, yes	1.307 (0.278–6.140)	0.737		
left ventricular ejection fraction	0.859 (0.721–1.023)	0.088	0.875 (0.734–1.044)	0.138
T–wave alternans positivity, yes	10.789 (1.944–59.896)	0.007	10.789 (1.944–59.896)	0.007

HR: Hazard ratio; CI: Confidence interval.

group of patients and the frequency of follow-up is not sufficient, due to both patient demands and clinician approach. Therefore, noninvasive methods are needed to perform risk classification in young patients, as well as more frequent follow-up of those at risk. TWA, one noninvasive method, is a multifactorial technique that has been studied with different methods in many populations. Therefore, varied results in the literature make it difficult to compare our results with those of other studies. However, the lack of previous studies in young STEMI patients and the long-term results of those with TWA positivity in this group make this study unique and valuable.

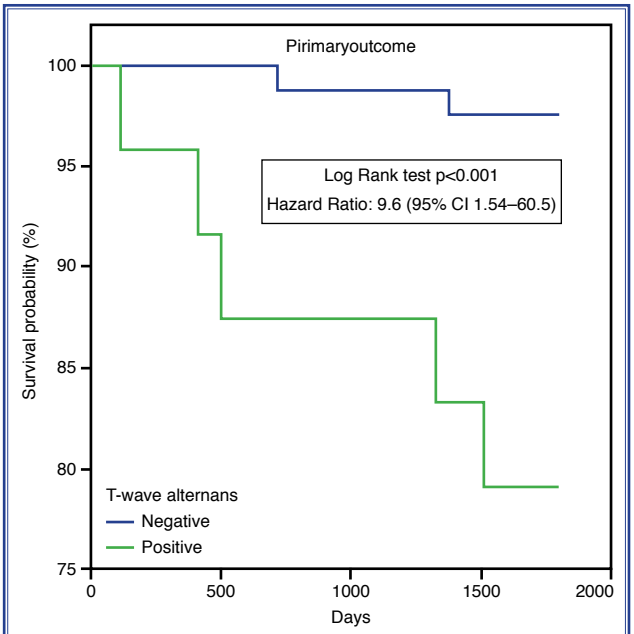

Figure 1. Kaplan-Meier analysis showing the 5-year cardiac mortality rate according to TWA positivity. TWA: T-wave alternans.

Most TWA-related studies have shown that it is powerful predictor of major arrhythmic events, particularly in ischemic heart disease and LV dysfunction.[12–14] Hohnloser et al.[15] demonstrated that a TWA test can help predict SCD in low-risk MI patients. Ozyılmaz et al.[16] observed a relationship between TWA positivity and the risk of SCD in patients with hypertrophic cardiomyopathy. Bloomfield et al.[17] reported that an abnormal TWA test was a strong predictor of all-cause mortality. In a study that analyzed the association between TWA and SCD in post-MI patients, after 25 months of follow-up, TWA positivity predicted SCD with a relative hazard ratio (HR) of 11.4. The negative predictive value of the TWA test was 99.5%.[18] The benefit of the TWA test has been clearly demonstrated in post-MI patients. The objective of the present study was to investigate the TWA test in a more refined group: young STEMI patients with preserved cardiac function who underwent single-vessel primary PCI.

In post-MI patients, low LVEF continues to be the most important risk factor for SCD, and ICD placement is recommended for primary prevention in these patients. However, because SCD does not occur in a significant proportion of these patients, discussion continues regarding noninvasive tests that could be used to determine those at lower risk in this heterogeneous group. In 1 related study, the predictability of the TWA test for cardiovascular events was investigated in post-MI patients with low LVEF. The authors

found that a non-negative TWA was an independent predictor of a cardiovascular event (HR: 7.41, 95% CI: 1.76±31.18; p=0.006).[19] However, SCD has been seen most often in patients with a normal range LVEF.[6] Therefore, risk classification of patients with a preserved LVEF is important. Most studies of the TWA test were conducted on patients with a low LVEF.[12,15] Patients with a preserved LVEF constituted the study population in only 2 studies.[18,20] In the first, among 1003 patients, Ikeda et al.[20] found after an average of 3 years of follow up that TWA positivity was the most important predictor of life-threating arrhythmias, with an HR of 19.7. In the second study, Exner et al.[18] demonstrated that the TWA test performed using both spectral and MMA methods was an important prognostic factor in patients with a preserved LVEF. In our study, the patient population consisted of young patients with preserved LVEF who underwent single-vessel lesion PCI, that is, among post-MI patients, the group at lowest risk for SCD. This study was designed to evaluate whether TWA, a noninvasive tool, can help define risk classification in this very low-risk patient group. There was a follow-up period of 5 years since the frequency of cardiovascular events may be low in such a group. As in other studies, cardiac mortality was about 10 times higher in patients with a positive TWA test. Especially in the very low-risk group, this noninvasive method has been shown to provide important information in terms of risk classification.

Wita et al.[21] included only patients with an anterior MI in their study and TWA positivity was found to be 32.4%. Consistent with that study, the TWA positivity rate was 22.2% in all patients and 30.9% in patients with an anterior MI in our study population, and TWA positivity was more frequent in patients with an anterior MI (p=0.037). An anterior MI may cause more myocardial damage and fibrotic tissue formation, and consequently, patients with an anterior MI may demonstrate greater TWA positivity. A reduced LVEF may be expected more frequently in patients with an anterior MI because a larger area is affected, and as a result, cardiovascular adverse events may increase. We tried to eliminate this parameter by selecting patients with a preserved LVEF. However, myocardial damage that cannot be detected with a basic systolic function assessment may result in more TWA positivity. Moreover, the presence of an anterior MI was not an independent predictor of cardiac mortality, whereas TWA positivity was a significant predictor in our study (OR: 10.789, 95% CI: 1.944–59.896; p=0.007). This suggests that underlying pathophysiological mechanisms beyond myocardial damage may have an effect.

In the current study, the average TWA value was calculated in a period of approximately 1 year after hospital admission due to MI. In the study by conducted Ikeda et al.,[22] a TWA test evaluated 20 days after MI was highly predictive of survival. Notably, Tapanainen et al.[23] found that TWA assessed 8 days after infarction did not predict survival. The REFINE study (Risk Estimation Following Infarction Non-Invasive Evaluation-ICD Efficacy), which investigated the prognostic value of the TWA test 2 to 4 weeks and 10 to 14 weeks after a cardiovascular event, found that the test was more valuable in the later period.[23] According to the published data, most researchers do not assess the TWA until at least 6 to 8 weeks after an MI to allow for completion of the healing process. Additionally, pharmacological treatment, in particular arrhythmic therapy, can be better titrated in the late period. The present study allowed sufficient time to obtain the best TWA results. Although our study methodology was to perform the TWA test at 12 months, we think that performing this test at any time after the third month of hospital admission can provide prognostic data about young MI patients.

Another significant matter when evaluating the TWA is patient adherence to antiarrhythmic medications. Chan et al.[24] reported that the predictive ability of the TWA test was greatly reduced in patients who interrupted beta blocker use prior to the test, reporting a relative risk for beta blocker users of 5.39 and 1.95 for nonusers. In the current study, no break in medication was assured in order to achieve the most accurate results. Consequently, it can be speculated that the value of the TWA test may improve by conducting the test 3 to 12 months after infarction to allow sufficient time for healing and for medications to do their job.

There are some limitations to our research. First, this was a single-center study, which may result in selection bias. Moreover, we studied the specific population of young STEMI patients; therefore, the number of patients was relatively small. This may have prevented the difference between some groups from reaching statistical significance. For this reason, we consider our study to be a step for future studies, rather than making a definite judgement on this

subject. In addition, this study employed the MMA method, which is used less frequently than spectral analysis. However, studies of the MMA method are highly correlated with spectral analysis. The MMA method has been demonstrated to be as good as spectral analysis at predicting adverse cardiovascular events.[17] We did not include other noninvasive markers of SCD, such as heart rate turbulence. Furthermore, we did not investigate subclinical systolic and diastolic dysfunction with tissue Doppler imaging or spectral analysis, or myocardial fibrosis, which can be associated with TWA positivity. Finally, because of the study design, the value of TWA test assessment cannot be generalized to other age groups with other forms of coronary artery disease.

Conclusion

TWA positivity assessed approximately 1 year after MI in young patients with preserved LVEF and single-vessel coronary artery disease has been shown to be a powerful predictor of 5-year cardiac mortality. This finding, if supported by larger-volume future studies, may change clinical evaluation habits for this specific patient subset.

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