Microvolt T-wave Alternans (MTWA) Warns of Impending Cardiac Arrest

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Introduction

T-wave alternans (TWA) refers to an alternating pattern in the T-wave of the electrocardiogram (ECG) and is recognized as a marker of electrical instability. Visible or macroscopic alternans was first reported in the context of proarrhythmic conditions including Prinzmetal's angina and long QT syndrome, and was often found to immediately precede the onset of ventricular tachycardia or fibrillation [1-3]. More recently, techniques have been developed to measure microvolt-level T-wave alternans (MTWA) not visible to the human eye [4]. The presence of MTWA has been linked with increased risk of sudden cardiac arrest (SCA) in several patient populations [5-8]. presents the case of a patient who experienced VF during the recovery phase of an MTWA stress test. While there was no visible abnormality on the ECG which would alert to the impending arrhythmia, significant microvolt-level alternans was detected immediately prior to the cardiac arrest.

Case History

A 72-year-old male with coronary artery disease, chest discomfort and bilateral arm discomfort underwent dobutamine stress testing with myocardial perfusion imaging (MPI). The MPI study was abnormal with large fixed defects in the anterior, septal and lateral walls and a left ventricular ejection fraction (LVEF) of 39%. Due to the patient's ischemic cardiomyopathy and moderately reduced LVEF, an MTWA test was ordered to further assess the patient's risk for ventricular tachyarrhythmias and sudden cardiac arrest.

MTWA Test and VF Arrest

MTWA testing was performed with treadmill exercise using the HearTwave II system from Cambridge Heart. At the time of the test, the patient was in normal sinus rhythm. The heart rate was elevated to the target range of 100-120 bpm by gradually adjusting the workload to a maximum of 3.7 METS. At peak exercise, the patient developed downsloping ST segment depression in the antero-lateral and inferior leads

and reported shortness of breath but denied chest pain. Approximately two and half minutes into the recovery phase, the patient developed polymorphic ventricular tachycardia which quickly deteriorated into ventricular fibrillation (VF) (Figure 1). An AED was applied within three minutes and the patient was successfully defibrillated on the second attempt.

Upon review of the test, ST segment changes suggestive of ischemia were evident, but there were no urgent symptoms or overt indications on the ECG that signaled the impending arrhythmia (e.g., ventricular ectopy or visible repolarization alternans). From the MTWA report, however, it is clear that non-visible microvolt-level T-wave alternans was present during the exercise portion of the test and immediately preceded the onset of VF (Figure 2).

MTWA detected during stress testing may indicate the presence of active ischemia that is especially arrhythmogenic and may identify patients in whom coronary angiography should not be delayed. As such, MTWA may be used to enhance the diagnostic yield of traditional stress testing.

Follow-Up

Following the cardiac arrest, the patient underwent coronary bypass surgery (x2) for significant disease in the LAD and left circumflex coronary arteries which he tolerated well. One month after the bypass surgery, his LVEF was 42% by MUGA. During a stress echocardiography assessment 18 months later, the patient showed no symptoms or exercise-induced dysrhythmias and an LVEF of 45%.

Discussion

While macroscopic TWA on the surface ECG has been observed as an immediate precursor to ventricular tachyarrhythmias, few cases have reported microvolt-level (but visually inapparent) alternans as a harbinger of imminent VT or VF [9]. In this case, there were no overt signs to herald the onset of ventricular fibrillation; however, upon retrospective review of the report, it is clear that

MTWA was present in the minutes preceding the event

In this case, MTWA was concomitant with ST changes indicative of active ischemia, a common underlying cause of ventricular tachyarrhythmias and sudden cardiac arrest [10]. Ischemia has also been mechanistically linked to repolarization alternans via altered calcium cycling that occurs in cardiac myocytes when perfusion is reduced [11, MTWA detected during stress testing, 121. particularly in the context of ST changes or symptoms, may indicate the presence of active ischemia that is especially arrhythmogenic and may identify patients in whom coronary angiography should not be delayed. As such, MTWA may be used to enhance the diagnostic yield of traditional stress testing.



Figure 1. Electrocardiogram (leads II and V5) recorded during the recovery period of the MTWA test. While not visible to the human eye, the Cambridge Heart system was able to detect microvolt-level T-wave alternans prior to the onset of VT/VF.

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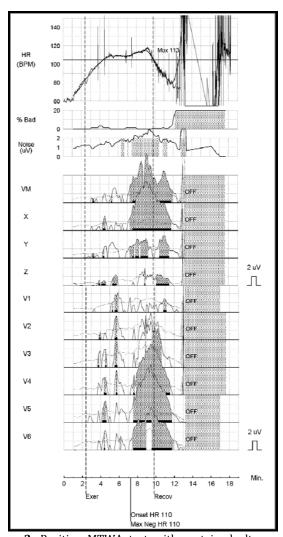


Figure 2. Positive MTWA test with sustained alternans in leads VM, X and V4-V6. The abrupt increase in heart rate during recovery corresponds to the onset of ventricular fibrillation which caused several leads to become disconnected when the patient fell (denoted by the OFF symbol on the report). Significant alternans (denoted by gray shading) begins at a heart rate of 110 bpm and is present throughout the recovery phase until VF onset.

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