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CASE REPORT

Ventricular Tachycardia Recognized as Ventricular Fibrillation by an ICD Due to Double Counting of the QRS Complex

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KEY WORDS: *ICD; inappropriate shock; oversensing; double QRS counting*

ABSTRACT

A case of ventricular tachycardia misdiagnosed as ventricular fibrillation due to double counting of the tachycardia's wide QRS complex in an implantable cardioverter defibrillator (ICD) recipient is presented. As a result, an inappropriate shock was delivered by the device instead of anti-tachycardia pacing. Reprogramming of the detection criteria in a less sensitive manner resolved the problem.

INTRODUCTION

Appropriate and reliable detection of ventricular tachyarrhythmias is crucial for determining effective and safe interventions of implantable cardioverter defibrillators (ICD). Inappropriate shocks delivered by ICDs are an increasingly recognized complication, many cases have been reported[1-3] and availability of stored electrograms allows correct interpretation of ICD failures.

We report a case in which a sustained ventricular tachycardia (VT) was falsely characterized as ventricular fibrillation (VF), due to double counting of the VT's QRS complex, resulting in inappropriate shock delivered by the device, instead of anti-tachycardia pacing (ATP) therapy.

ABBREVIATIONS
ATP = antitachycardia pacing
ICD = implantable cardioverter defibrillator
VF = ventricular fibrillation
VT = ventricular tachycardia

CASE REPORT

A 67-year-old male presented with ischemic cardiomyopathy, hypokinesia and dilated left ventricle (end diastolic diameter of 68 mm), reduced left ventricular ejection fraction of 20% and a narrow QRS complex during sinus rhythm. The clinical tachycardia was characterized by a wide right bundle branch block (RBBB)-like QRS complex of 220 ms duration, at a heart rate of 150 bpm (Fig. 1). A dual chamber ICD (Atlas II+ V-268 DR model, St Jude Medical) was implanted for sudden cardiac death secondary prevention.

Therapies were programmed in two zones: VF zone for rate greater than 220 bpm delivering shocks and VT zone for rate between 140 and 220 bpm applying sequences

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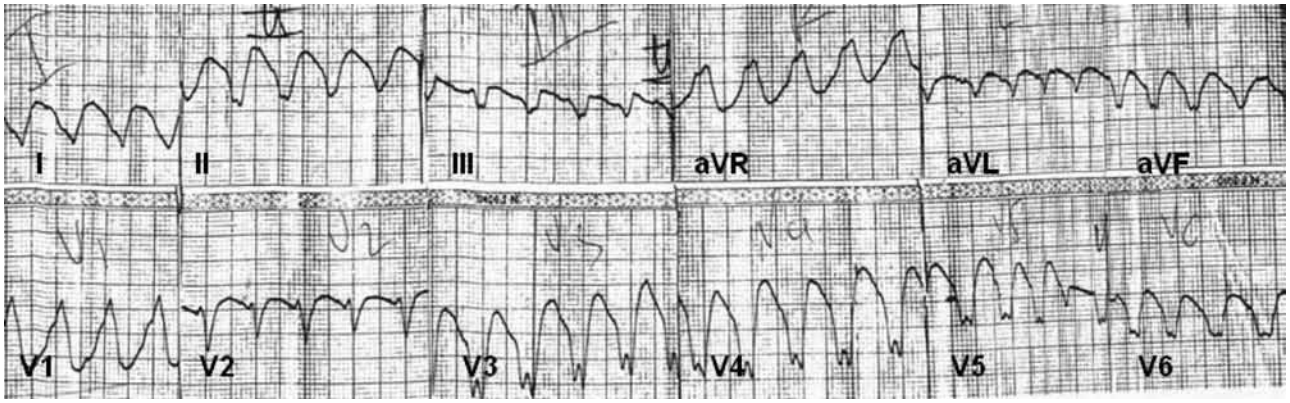

FIGURE 1. Clinical ventricular tachycardia with RBBB-like pattern, a QRS width complex of 220 ms with notches and a rate of 153 bpm. RBBB = right bundle branch block.

of ATP followed by cardioversion. The patient was referred to our arrhythmia outpatient clinic due to a shock received from the device. The interrogation of the ICD showed an episode of VT at a rate of 153 bpm terminated by shock, despite the fact that according to the QRS rate of the tachycardia an ATP scheme should have been initiated. A careful analysis of the ventricular electrograms, markers and counters of the ongoing tachycardia revealed double counting of the QRS complex and as a consequence the arrhythmia was recognized as having a faster rate belonging in the VF zone (Fig. 2). The device counted the VT as VF at a rate of 307 bpm and an inappropriate shock was delivered instead of an ATP. No electrolyte disturbances were detected in the routine biochemical blood examination.

This problem was finally resolved by reprogramming the detection parameters in a less sensitive manner in order to avoid double counting of the VT wide QRS complex. More specifically, the post-ventricular sensor threshold was programmed to start at 75% instead of 62.5% and the post ventricular sensor decay was raised from 60 ms to 125 ms. However, lowering the sensitivity of the device could put the patient at risk as a true VF might not be recognized and in that case a shock might not be delivered. For this purpose, the ICD was tested in the electrophysiology laboratory by inducing true VF, which was properly recognized and terminated by a shock. At a 12-month follow-up visit, appropriate functioning of ICD was confirmed by correct detection of VT based on recorded QRS electrograms (Fig. 3).

DISCUSSION

Despite the remarkable progress in ICD technology, oversensing of electrical events remains a major problem concerning the proper device function. This phenomenon is related to misinterpretation by the ICD of various signals (non cardiac or cardiac), such as electromagnetic interference, T waves and double counting of the QRS complex in sinus rhythm or during ventricular tachyarrhythmia.

In this case, the etiology of inadvertent shock was double counting of an extremely prolonged and fragmented ventricular electrogram during VT and therefore, the ICD device recognized one QRS complex twice, interpreting VT as VF. The fragmented ventricular electrogram probably represents intramyocardial conduction abnormalities due to extensive myocardial necrosis or scar.[4]

In such a case, the physician's alternatives consist of de novo programming the pacing/sensing parameters or replacing the pace/sense lead. Reducing the minimum sensitivity level may affect the proper detection of a true VF and therefore a test should be performed by inducing VF and confirming proper detection and ICD function.

In the present case, as a first step in order to avoid the oversensing problem, it was decided to reprogram some of the detection criteria in a less sensitive manner. However, in case the aforementioned reprogramming is not successful concerning the double counting phenomenon, the detection software of the implanted device offers 2 additional alternative options such as reprogramming the ventricular refractory period and the sensitivity of the QRS complex.

The newest generation ICDs permit the managing physician to program the device to deliver "pain-free" anti-tachycardia pacing (ATP) therapy instead of a painful shock as the first attempt when the organized ventricular tachyarrhythmia is detected in the VF zone. Several studies demonstrate that most VTs, even those faster than 200 bpm, may be terminated by this method. In some of them,[5] the effectiveness of ATP was demonstrated in decreasing shock therapy and thus improving patient quality of life. In the PainFREE Rx II (Pacing Fast VT Reduces Shock Therapies II) study,[6] in patients with VT rates from 188 to 250 bpm, empirical ATP for fast VT was shown to be highly effective and equally safe, and to improve quality of life.

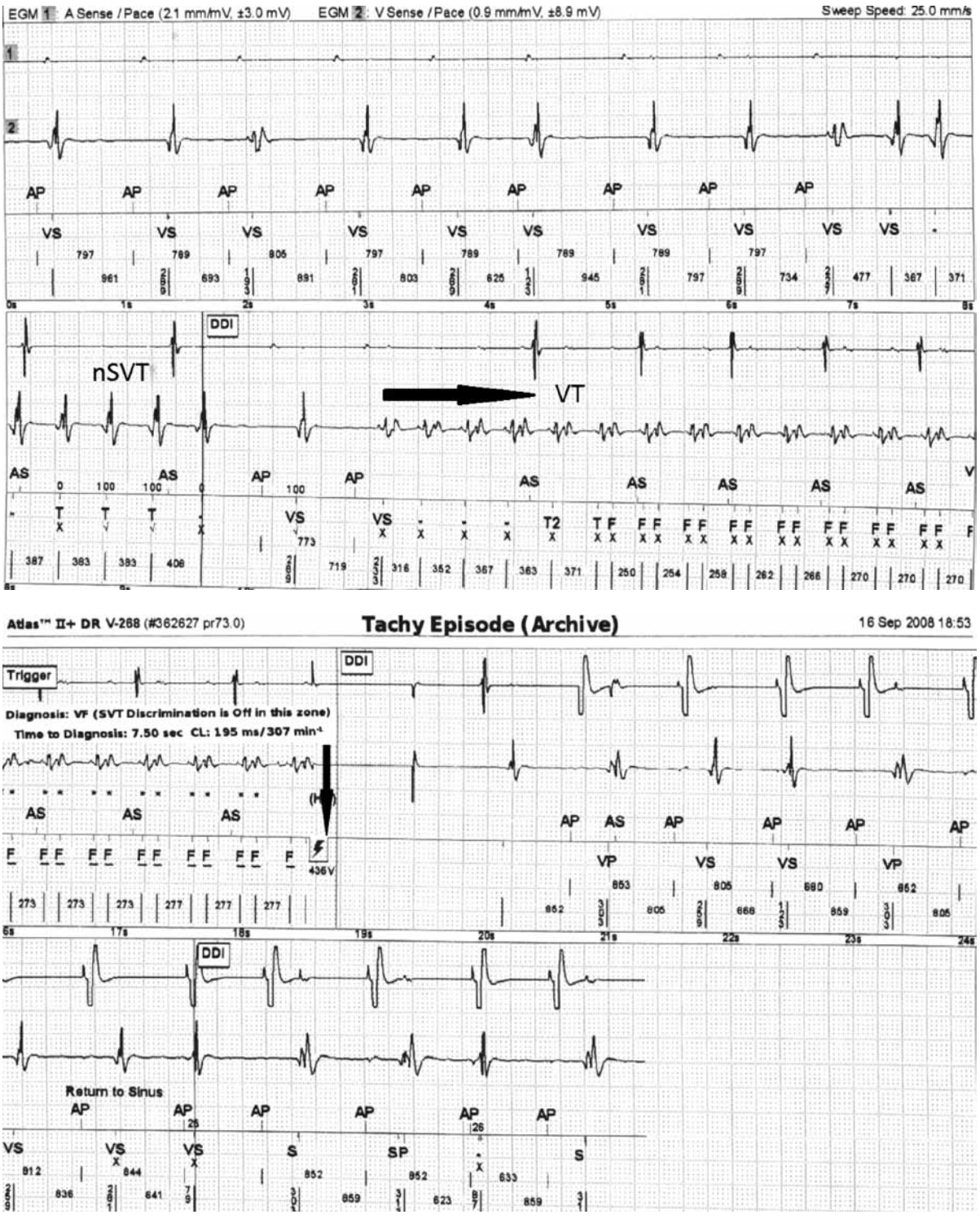

FIGURE 2. Intracardiac electrogram recorded from the ICD. Top to bottom: atrial channel, ventricular channel, markers and counters. The rate of the VT was 153 bpm, but the device recognized it as VF at a rate of 307 bpm (cycle length of 195 ms), because of double-counting of the VT's electrogram (marked with asterisks) and a shock was delivered (marked with a black arrow). It is noticeable that, before the previous described VT, a non-sustained VT (nSVT) of 7 complexes with different electrogram morphology without oversensing of the tachycardia QRS was recorded. ICD = implantable cardioverter defibrillator; VF = ventricular fibrillation; VT = ventricular tachycardia.

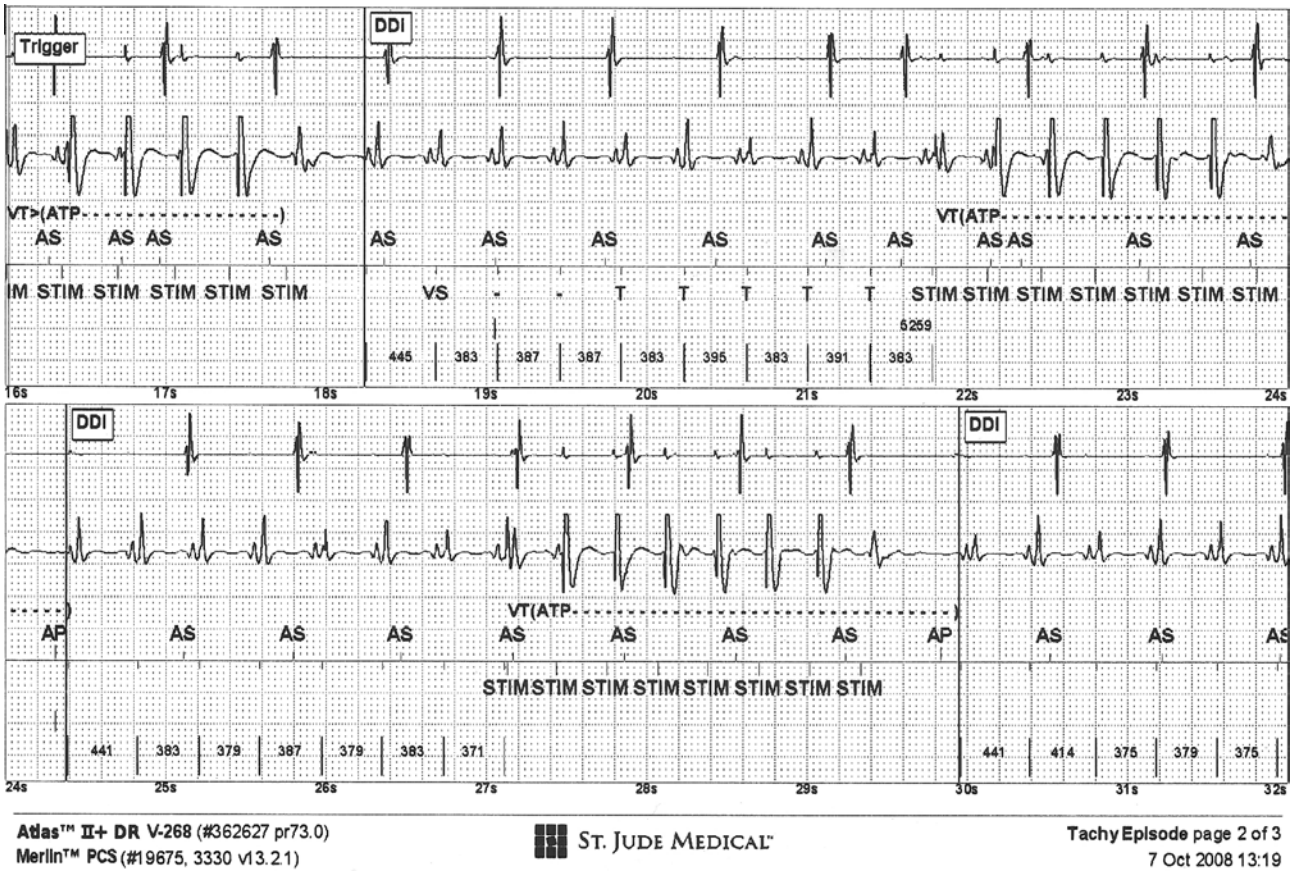

FIGURE 3. By reprogramming the VT detection criteria in a less sensitive manner, we resolved the inappropriate double counting of VT QRS electrogram. The VT episode at a rate of 155 bpm was properly recognized in the VT zone followed by an ATP scheme. ATP = antitachycardia pacing; VT = ventricular tachycardia.

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