Implantable cardioverter defibrillator: Charge saver, not syncope saver!

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In patients with an implantable cardioverter defibrillator, empirical anti-tachycardia pacing/burst pacing (ATP) is associated with a significantly decreased rate of appropriate shocks. The use of ATP as first-line therapy in ventricular tachycardia promotes less pain and better quality of life because the number of shocks is reduced. Additionally, battery longevity is substantially increased with this strategy. Based on this, device manufacturers have developed new algorithms to optimize the use of ATP and shocks in patients with an implantable cardioverter defibrillator. The present report describes a case in which the use of one of these new algorithms was associated with a significant delay in tachycardia termination and, consequently, led to syncope.

Key Words: *Antitachycardia burst pacing; Appropriate shock; Implantable cardioverter defibrillator; Syncope*

An implantable cardioverter defibrillator (ICD) with or without A resynchronization therapy (CRT-D) reduces the risk of death among patients with left ventricular dysfunction (1,2). However, the use of ICD has been limited by problems including infection, device malfunction and inappropriate shocks, which contribute to a significant increase in morbidity and mortality rates (3). Additionally, inappropriate shocks cause psychological stress and early battery depletion (4). Programming ICDs to deliver antitachycardia pacing/burst pacing (ATP) as a first-line therapy reduces the risk of shocks and may be preferred for most patients. However, this approach can be associated with problems, including a significant delay in therapies, which can lead to syncope as illustrated in the present case.

CASE PRESENTATION

A 78-year-old man with ischemic cardiomyopathy and paroxysmal atrial fibrillation was admitted to the hospital after receiving multiple shocks from his CRT-D device (Concerto, Medtronic Inc, USA), with the last shock being preceded by syncope. The device had been programmed to VVIR 70 beats/min, ventricular tachycardia (VT) detection 150 beats/min to 182 beats/min and ventricular fibrillation (VF) detection of more than 182 beats/min. Therapies were programmed as follows:

- VT zone: ATP (three attempts) followed by shock (one 25 J shock and three 35 J shocks);
- VF zone: shock (35 J six times) with ATP DuringCharging (Medtronic Inc, USA).

Device inspection demonstrated normal function. Two nonsustained VT and four VF episodes were logged. All the episodes logged into the VF zone were actually fast VT and they fell into the VF zone because of the rate criteria (in ICD programming, VF is usually defined as tachycardia with rates of more than 182 beats/min). Figure 1 shows the dot plot and electrograms during one of the VT episodes successfully terminated

Le défibrillateur interne : Un économiseur de charge, mais pas de syncopes !

Chez les patients munis d'un défibrillateur interne, la stimulation antitachycardique empirique ou la stimulation de l'activité électrique (SAT) s'associe à une diminution considérable du rythme de chocs administrés. Le recours à la SAT comme thérapie de premier recours en cas de tachycardie ventriculaire favorise une diminution de la douleur et l'amélioration de la qualité de vie puisque le nombre de chocs est moins élevé. De plus, la longévité de la pile augmente de manière significative grâce à cette stratégie. Compte tenu de ces observations, les fabricants d'appareils ont mis au point de nouveaux algorithmes afin d'optimiser le recours à la SAT et aux chocs chez les patients munis d'un défibrillateur interne. Le présent rapport décrit un cas où le recours à l'un de ces nouveaux algorithmes a entraîné un report important de l'arrêt de la tachycardie et, par conséquent, une syncope.

by ATP. The baseline rhythm was atrial fibrillation with biventricular pacing. There was a sudden increase in the ventricular rate to a cycle length of 290 ms (207 beats/min), which fell into the VF detection zone, and was successfully treated with ATP. Careful analysis of the electrogram during the episode showed fast monomorphic VT. Figure 2 shows the subsequent episode, which was associated with syncope. This episode was again a fast monomorphic VT that was detected in the VF zone. Despite one unsuccessful ATP attempt, the device delivered a second attempt, which was again unsuccessful. Finally, a 35 J shock from the device was effective in terminating VT and also in restoring sinus rhythm. In this second episode, it was questioned why the device delivered two successive ATPs before a shock, which potentially delayed therapy and triggered syncope.

DISCUSSION

Clinical trials have revealed several complications arising from the use of ICDs in patients with left ventricular dysfunction. Appropriate shocks occur in a significant proportion (35% to 45%) of patients who have received ICDs. Approximately 35% of recipients will also receive inappropriate shocks in the following years. ICD shocks in this population are associated with higher morbidity and, presumably, lower quality of life. Additionally, battery depletion is significantly faster in patients receiving a great number of shocks. Studies (5) have also demonstrated that empirical ATP is safe and effective compared with shocks for fast VT, which commonly happen for ventricular arrhythmias in the programmed VF zone. Based on this, electrophysiologists usually program ATP as the preferred therapy for fast VT in most ICD patients.

The Medtronic Concerto is a new-generation CRT-D that offers ChargeSaver, Smart Mode and Switchback features. These three algorithms work together in an attempt to optimize pace termination for VT episodes, thereby reducing unnecessary capacitor charge or ICD shocks, and increasing battery longevity. Because ATP can terminate up to 72% of VT episodes, it seems reasonable to consider one attempt

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Figure 1 Dot plot (A) and intracardiac electrogram (EGM) (B) logged by the device showing the episode of ventricular tachycardia (VT) successfully terminated by antitachycardia pacing (ATP). The baseline rhythm was atrial fibrillation. Avg bpm Average beats/min; VF Ventricular fibrillation

Figure 2 Dot plot (A) and intracardiac electrogram (B) logged by the device showing the episode of ventricular tachycardia (VT) that culminated with syncope. Baseline rhythm was atrial fibrillation. Two unsuccessful antitachycardia pacing (ATP) attempts were followed by a 35 J shock, which terminated the VT and converted the patient to sinus rhythm. Avg bpm Average beats/min; Defib Defibrillation; VF Ventricular fibrillation

of ATP before charging the capacitor, with a high chance of arrhythmia termination and minimal delay in therapies.

The ChargeSaver feature automatically switches from ATP during charging to ATP before charging if burst pacing therapy successfully terminates the arrhythmia in a programmable number of consecutive attempts (nominally programmed 'on' at one ATP attempt). On the other hand, the Smart Mode feature automatically disables ATP therapy during or before charging if it fails to terminate the tachyarrhythmia in four consecutive episodes (nominally programmed 'on'). The Switchback feature allows the device to automatically switch from ATP before charging to ATP during charging. This change occurs if ATP before charging fails to terminate the detected arrhythmia on two consecutive attempts.

In the present case, the device was originally programmed in the VF zone with only ATP during charging, followed directly by shock in case of lack of success with burst pacing termination. After the first successful ATP attempt during charging, the ChargeSaver mode activated the ATP before charging in an attempt to avoid unnecessary future device charges. In the subsequent episodes (one of them is shown in Figure 1), VT detection delivered a successful ATP before charging and, consequently, the capacitor was not charged. This is verified by the absence of the "VF Rx 1 Defib" annotation in the ICD electrogram recorded during the episode (Figure 1B). In the episode associated with syncope (Figure 2), ATP before charging failed to terminate the tachycardia. This was then followed by ATP during charging, which was again unsuccessful. Arrhythmia was then reconfirmed and a 35 J direct current shock from the device successfully terminated VT. The delivery of two unsuccessful ATPs in this episode plus the time required to charge the capacitors to a high setting delayed tachycardia termination from 9 s to 15 s, resulting in a syncopal event before VT termination.

CONCLUSION

The present case demonstrates the fine balance between a new specific algorithm that works to prevent ICD shocks, the potential delay in therapies and the patient's ability to tolerate ventricular arrhythmias. The advantage of ATP during charging is that it provides one attempt to pace termination during VT without potential delays of shock, because capacitor charging begins simultaneously with ATP delivery. Because one attempt of ATP during charging succeeds in terminating

VT, one should consider it reasonable to program ATP before charging the capacitor and, therefore, decrease battery depletion. On the other hand, this strategy could cause delay in shocks, leading to hemodynamic instability and syncope, as represented in the present case.

Based on the functioning of the ChargeSaver feature, it is necessary to individualize the mode of program according to each patient's ability to hemodynamically tolerate VT. In patients with established intolerance to VT or with a history of syncope, one should consider turning this feature off to avoid episodes of VT associated with hemodynamic instability. Most importantly, the risk of delaying therapies should be carefully balanced with the risk of excessive shocks. The present case illustrates that ICD programming involves specialized care with new technological features. An 'out-of-the-box' generalized strategy may not be ideal for all patients.

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