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Original article

Shock Reduction With Antitachycardia Pacing Before and During Charging for Fast Ventricular Tachycardias in Patients With Implantable Defibrillators

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A B S T R A C T

Introduction and objectives: Fast ventricular tachycardias in the ventricular fibrillation zone in patients with an implantable cardioverter-defibrillator are susceptible to antitachycardia pacing (ATP) termination. Some manufacturers allow programming 2 ATP bursts: before charging (BC) and during (DC) charging. The aim of this study was to describe the safety and effectiveness of ATP BC and DC for fast ventricular tachycardias in the ventricular fibrillation zone in patients with an implantable cardioverter-defibrillator in daily clinical practice.

Methods: Data proceeded from the multicenter UMBRELLA trial, including implantable cardioverter-defibrillator patients followed up by the CareLink monitoring system. Fast ventricular tachycardias in the ventricular fibrillation zone until a cycle length of 200 ms with ATP BC and/or ATP DC were included.

Results: We reviewed 542 episodes in 240 patients. Two ATP bursts (BC/DC) were programmed in 291 episodes (53.7%, 87 patients), while 251 episodes (46.3%, 153 patients) had 1 ATP burst only DC. The number of episodes terminated by 1 ATP DC was 139, representing 55.4% effectiveness (generalized estimating equation-adjusted 60.4%). There were 256 episodes terminated by 1 or 2 ATP (BC/DC), representing 88% effectiveness (generalized estimating equation-adjusted 79.3%); the OR for ATP effectiveness BC/DC vs DC was 2.5, 95%CI, 1.5-4.1; $P < .001$. Shocked episodes were 112 (45%) for ATP DC vs 35 (12%) for ATP BC/DC, representing an absolute reduction of 73%. The mean shocked episode duration was 16 seconds for ATP DC vs 19 seconds for ATP BC/DC ($P = .07$).

Conclusions: The ATP DC in the ventricular fibrillation zone for fast ventricular tachycardia is moderately effective. Adding an ATP burst BC increases the overall effectiveness, reduces the need for shocks, and does not prolong episode duration.

Taquicardias ventriculares rápidas en pacientes con desfibrilador implantable: reducción de choques mediante terapia antitaquicárdica antes y durante la carga

Palabras clave:
Taquicardia ventricular rápida
Desfibrilador automático implantable
Estimulación antitaquicárdica antes de la carga
Reducción de descargas de alta energía

R E S U M E N

Introducción y objetivos: Las taquicardias ventriculares rápidas en zona de fibrilación ventricular en pacientes con desfibriladores implantables son susceptibles de terminación mediante estimulación antitaquicárdica (EA). Algunos fabricantes permiten la programación de 2 ráfagas de EA: antes de la carga (AC) y durante la carga (DC). Nuestro objetivo es describir la efectividad y la seguridad de la EA AC y DC en las taquicardias ventriculares rápidas en zona de fibrilación ventricular en pacientes con desfibriladores implantables en la práctica clínica diaria.

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Métodos: Los datos proceden del ensayo multicéntrico UMBRELLA, y se incluyó a los pacientes portadores de desfibriladores implantables seguidos por el sistema de monitorización a distancia CareLink. Se incluyeron las taquicardias ventriculares rápidas en la zona de fibrilación ventricular hasta una longitud de ciclo de 200 ms y tratadas con EA AC y/o DC.
Resultados: Se revisaron 542 episodios en 240 pacientes. Dos ráfagas de EA (AC/DC) se programaron en 291 episodios (el 53,7%, 87 pacientes) mientras que 251 (el 46,3%, 153 pacientes) tuvieron 1 sola EA DC. Los episodios terminados por 1 EA DC fueron 139: el 55,4% de eficacia (ajustado por las ecuaciones de estimación generalizada, el 60,4%). Los episodios terminados por 1 o 2 EA (AC/DC) fueron 256, el 88% de efectividad (ajustado por las ecuaciones de estimación generalizada, el 79,3%). La OR para la eficacia de la EA AC/DC frente a DC fue 2,5 (IC95%, 1,5-4,1; $p < 0,001$). Los episodios con descarga de alta energía fueron 112 (45%) con EA DC frente a 35 (12%) con EA AC/DC (reducción absoluta del 73%). La media de duración de los episodios con descarga fue de 16 s con EA DC frente a 19 s con EA AC/DC ($p = 0,07$).
Conclusiones: La EA DC en la zona de fibrilación ventricular en taquicardias ventriculares rápidas es moderadamente eficaz. La adición de una ráfaga de EA AC aumenta la efectividad general, reduce la necesidad de descargas y no prolonga el episodio.

Abbreviations

ATP BC: antitachycardia pacing before charging
ATP DC: antitachycardia pacing during charging
CL: cycle length
ICD: implantable cardioverter-defibrillator
VF: ventricular fibrillation
VT: ventricular tachycardia

INTRODUCTION

The benefit of implantable cardioverter-defibrillators (ICD) in reducing cardiac arrest has been demonstrated in many studies.[1–4] Initial ICD therapy is usually antitachycardia pacing (ATP) for slow ventricular tachycardias (VT) while fast VT and ventricular fibrillation (VF) are treated with high-energy shocks. Most (66%-76%) of the ventricular arrhythmias detected in the VF zone are fast monomorphic VT[5–8] that can be terminated by ATP without the need for high-energy shocks.[9–11] Several studies have demonstrated that empirically programming 1 ATP burst in the fast VT zone is highly effective in terminating fast VT with cycle length (CL) between 320 and 240 milliseconds (ms) suggesting that ATP may reduce the need for high-energy shock without increasing morbidity.[6–8,12,13] However, published data suggest that ATP effectiveness is lower if VT CL < 270 ms,[7] while the effectiveness of increasing the number of ATP bursts for very fast VT is still a matter of debate.[8,14] Furthermore, short CL is a predictor of ATP failure and VT acceleration.[11,15] Finally, in the case of ineffective ATP, devices require redetection and capacitor charging before shock delivery, which leads to longer episode duration and may increase the risk of syncope. In addition, several studies have shown that shocks are not harmless and may lead to a 3-fold increase in mortality risk.[16–18]

The possibility of programming ATP bursts before charging (BC) and/or during charging (DC) in the VF zone (EnTrust study[19]) was developed to avoid delay in high-energy shock administration in cases of ATP failure while maintaining the potential for harmless VT termination in the VF zone. The effectiveness of this type of programming has not been evaluated in a broad population of patients in daily clinical practice. The aim of this study was to evaluate the effectiveness and safety profile of ATP BC and/or ATPDC in ICD patients with fast VT detected in the VF zone and to describe predictors of effectiveness in our population.

METHODS

Study Design and Objectives

We analyzed data from the UMBRELLA trial, a multicenter prospective observational study including ICD patients followed up by the CareLink monitoring system. Patients who had episodes of sustained monomorphic VT detected in the VF zone were enrolled. We compared the safety and effectiveness of a single ATP burst DC with a strategy of 2 successive ATP sequences (ATP BC/ATP DC) for termination of VT episodes (CL 200-320 ms). We performed univariate and multivariate analyses to describe predictors of ATP effectiveness.

The UMBRELLA Registry

The present investigation was developed within the framework of the National UMBRELLA Registry (Incidence of Arrhythmias in Spanish Population With a Medtronic Implantable Cardiac Defibrillator Implant, NCT01561144). This registry is a prospective and retrospective study of the population implanted with a Medtronic ICD in Spain. The prospective part of the UMBRELLA study (since 2011) includes all patients implanted with a Medtronic ICD in Spain with prospective collection of all arrhythmic events and ICD interventions via the CareLink monitoring system. All patients implanted with a Medtronic ICD before 2011 and already followed up via the CareLink system were included in the UMBRELLA registry, their clinical and demographic characteristics were collected at the time of ICD implant, and all the arrhythmic events and ICD interventions reported by the monitoring system were included. These patients have been followed up prospectively since 2011. In the present investigation, patients proceeded from both the study and the registry. All the information retrieved from the ICD during CareLink monitoring was analyzed. The episodes recorded were reviewed by a committee of reviewers. Further description of this registry has been reported elsewhere.[20]

Upon completion of this subanalysis, the UMBRELLA study had 1645 patients from 38 centers and 6829 episodes of VT. Among 1645 patients, 288 experienced 1149 episodes of ventricular rhythm detected in the VF zone. Of them, 662 were sustained monomorphic VT that received ATP BC/ATP DC. Of 662 episodes, 120 were eliminated from the analysis to avoid selection bias (see below for details). The remaining 542 episodes in 240 patients were analyzed in the present study (Figure 1). Ventricular events excluded from the study were mostly VF/polymorphic VT (287 [25%]) or slow VT accelerated to the VF zone after ATP

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