Success of Device-Based Methods for Atrial Tachyarrhythmia Induction during Implantation of an Implantable Cardioverter Defibrillator with Atrial Therapy

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Summary

For patients requiring implantable cardioverter defibrillator (ICD) therapy for ventricular tachyarrhythmias, one potential treatment option for concomitant atrial tachyarrhythmias includes an ICD with atrial therapy. Implantation and follow-up testing of such a device should include induction of atrial tachyarrhythmias to evaluate atrial tachyarrhythmia detection and conversion efficacy. Data from a dual-chamber ICD study was analyzed to evaluate the effectiveness of several device-based methods for atrial tachyarrhythmia induction. The programmed extra stimuli were efficient in atrial tachyarrhythmia induction in 24% of patients in whom it was tested, high-frequency bursts in 68%, and atrial induction shock in 55% of patients. Programmed extra stimuli were particulary inefficent in patients at risk for but without documented history of atrial tachyarrhythmia. As high-frequency burst pacing offers comparable success to that of atrial induction shock and is less painful, it should be the first choice when attempting atrial tachyarrhythmia induction during implant testing.

Key Words

Atrial tachyarrhythmia induction, implantable cardioverter defibrillator (ICD) therapy, programmed extra stimuli, high-frequency bursts, atrial induction shock

Introduction

In addition to standard ventricular therapy, cardioversion using an implantable cardioverter defibrillator (ICD) with atrial therapy is one of the many new options available for treating atrial tachyarrhythmias. New data suggest that shock efficacy for AF depends on identifying atrial defibrillation thresholds (DFT) and programming the first atrial shock to at least two times the atrial DFT [1]. Therefore, to ensure the highest degree of atrial therapy effectiveness, atrial induction testing should be conducted during the initial implantation procedure. In order to successfully induce atrial tachyarrhytmias during implantation or follow-up, the ICD should have several methods of atrial tachyarrhythmia induction.

Atrial arrhythmias contribute to patient morbidity and mortality by impairing cardiac function, increasing the risk of thromboembolic events, and inducing ventricular arrhythmia [2-4]. Medications for atrial tachy-

arrhythmia are largely unsatisfactory because of their poorly-tolerated side effects [5,6]. Patients experiencing asymptomatic atrial tachyarrhythmias may benefit from early automatic intervention, because "electrical remodeling" of the cardiac muscle makes arrhythmia conversion at a later time more difficult [7,8]. Based on this information, an ICD with features designed to automatically detect and treat both symptomatic as well as asymptomatic atrial tachyarrhythmias would potentially benefit patients already requiring standard ICD therapy for ventricular tachyarrhythmias.

The primary objective of this study was to evaluate the ability of a new dual-chamber, rate-adaptive ICD (Tachos DR – Atrial Tx, Biotronik, Germany) to detect and convert atrial tachyarrhythmias in patients requiring standard ICD therapy who also have a history of or significant risk for developing atrial tachyarrhythmias. Additionally, the induction success rate for several device-based atrial tachyarrhythmia induction methods was evaluated.

Materials and Methods

Device

The Tachos DR – Atrial Tx is a dual-chamber implantable cardioverter defibrillator capable of delivering antitachycardia pacing (ATP) as well as cardioversion and defibrillation shock therapy to convert ventricular tachyarrhythmias. The ICD provides an advanced SVT/VT discrimination algorithm and rate-adaptive brady pacing. The device is capable of detecting and converting atrial tachyarrhythmias, including atrial fibrillation (AF) and other atrial tachycardias (AT). Atrial tachyarrhythmia therapies include atrial ATP therapy for AT, atrial burst therapy for AT/AF, and shock therapy for AT/AF (Table 1). The device allows programming of one AF and two AT zones.

The Tachos DR – Atrial Tx induces atrial tachyarrhythmias using three different methods: programmed extra stimulation (PES), high-frequency burst (HF burst), or coupled atrial induction shocks similar to the method for inducing ventricular arrhythmias or ventricular T-wave shocks (Table 2).

Study Design

The Tachos Atrial Conversion Therapy (TACT) study included 174 patients enrolled at 18 U.S. sites [9]. All patients had a clinical indication for the implantation of a ventricular ICD and a history or significant risk of developing atrial tachyarrhythmias. The average patient was a 68-year-old male with NYHA class II, an LVEF of 31%, and a monomorphic ventricular tachycardia as the primary ventricular tachycardia. Patients with atrial tachyarrhythmia refractory to cardioversion shock therapy were excluded from enrollment. Prior to enrollment, *Institutional Review Board* approval and written informed consent was obtained. The study required the implantation of a dual-coil ICD lead. Atrial leads were bipolar and included both passive and active fixation mechanisms. A step-up atrial defibrillation threshold protocol was recommended but not required.

The study included the evaluation of AT/AF detection sensitivity, which is the ability of the atrial detection algorithm to appropriately detect AT/AF. Additionally, the overall ability of the device to appropriately convert AT and AF using different therapies was evaluated. The analysis was based on the investigator's review of stored diagnostics from the implanted device. Patients received routine device interrogations at 1, 3, and 6 months after implantation, with additional visits

Therapy Type	Function
ATP	Atrial burst or ramp delivered at programmable percentage of the AT cycle length. Back-up VOO pacing is available during ATP therapy.
HF burst	Atrial pulse train at ~40 Hz with programmable duration of 1 to 29 s. Back-up VOO pacing is available during HF burst therapy.
Shock	Atrial shock at programmable energies between 1 and 30 J. Atrial shocks are delivered within physician specified times only, using a 24-hour clock. The ICD reconfirms the AT/AF prior to shock delivery. A maximum of two atrial shocks are programmable for each episode.

Table 1. Atrial therapies available in the Tachos DR – Atrial Tx (Biotronik, Germany). AT = atrial tachycardia; AF = atrial fibrillation.

Therapy Type	Function
PES	Atrial pulse train followed by a programmable number of timed extrastimuli.
HF burst	Train of atrial pacing pulses at ~40 Hz with programmable durations.
Shock	Atrial pacing train followed by a programmable shock that is coupled to the last pacing stimuli.

Table 2. Atrial tachyarrhythmia induction methods available in the Tachos DR – Atrial Tx (Biotronik, Germany).

	All patients	Group I (history)	Group II (risk)	Group A (episodes)	Group B (no episodes)
Programmed extra stimuli (PES)					
Patients tested	25	17	8	9	16
Patients successfully induced	6 (24.0%)	6 (35.3%)	0 (0.0%)	2 (22.2%)	4 (25.0%)
High frequency burst					
Patients tested	147	96	51	59	88
Patients successfully induced	100 (68.0%)	63 (65.6 %)	37 (72.5 %)	42 (71.2 %)	58 (65.9%)
Atrial induction shock					
Patients tested	103	69	34	43	60
Patients successfully induced	57 (55.3%)	38 (55.1%)	19 (55.9%)	26 (60.5%)	31 (51.7%)

Table 3. Atrial tachyarrhythmia (AT) induction success rates in patients with documented history of AT (group I) and significant risk of developing AT (group II), and in patients with (group A) and without (group B) spontaneous atrial episodes.

as clinically indicated. Quality of life was evaluated using a validated questionnaire at enrollment and at the 3-month follow-up [10]. The success rate of the three device-based atrial tachyarrhythmia induction methods was further evaluated in different groups of patients. Patients in Group I had a documented history of AT/AF. Patients in Group II only had a significant risk of developing atrial tachyarrhythmias. Patients in Group A had spontaneous atrial episodes during the study. Patients in Group B did not present with spontaneous atrial episodes (Table 3).

Results

In order to assess whether the implanted ICD system could consistently convert the patient's atrial tachyarrhythmias, the effectiveness of atrial cardioversion was evaluated. A minimum of two successful atrial cardioversions per patient during implantation was required. The induction was considered successful only when the atrial tachyarrhythmia was sustained for longer than one minute.

During implantation atrial conversion testing was completed in 147 (84.4%) of the 175 patients. Twenty patients did not undergo atrial conversion testing because induced atrial tachyarrhythmias could not be sustained. Four patients did not complete the testing because they became unstable during the procedure. The other two patients were unable to be converted from an ongoing AT/AF episode during conversion testing. Two devices were intraoperatively explanted.

Table 3 provides an overview of the atrial tachyarrhythmia induction success rate for the different induction methods. PES induction was more successful in patients with a history of atrial tachyarrhythmia (Group I) compared to patients with a risk of developing atrial tachyarrhythmia (Group II). High-frequency burst or atrial shock induction success rates showed no difference between Groups I and II. Analysis of the data in relation to patients who presented with atrial tachyarrhythmia episodes during the course of the study versus patients who did not have atrial tachyarrhythmia episodes did not show a difference in induction success for PES, HF burst, or atrial induction shock.

Conclusion

New atrial therapies offer the physician an additional option for treating patients with coexisting arrhythmias. For these atrial therapies to be most effective, atrial induction testing should be conducted during the initial implantation procedure. This study demonstrated that atrial induction techniques have varied success rates. The data suggest that PES is associated with limited success for induction of atrial tachyarrhythmias during device implantation, particularly in patients at risk for but without documented history of atrial tachyarrhythmias. The rates of successful atrial tachyarrhythmia induction are similar for HF burst or timed atrial induction shocks. Repeated atrial induction shocks may have side effects such as emboli, LV depression, cerebral anoxia, hypotension, and elevation of cardiac enzymes [11-15]. In contrast, HF burst induction offers a less painful alternative with a lower risk of complications. Therefore, HF burst should be

the first choice when attempting atrial tachyarrhythmia induction during implant testing. Additionally, these data clearly show that multiple methods of atrial tachyarrhythmia induction must be available in ICDs to assure successful atrial induction at the time of device implantation.

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