ICD Treatment in Patients with Severe Ventricular Tachycardia

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Summary

In this study, five patients suffering from symptomatic ventricular tachycardia were implanted with implantable cardioverter-defibrillators. The evolution of the disease process in our patients was similar to that described in the literature. All patients underwent electrophysiologic examinations, which confirmed severe ventricular arrhythmia refractory to standard pharmacological treatment. Two patients had good ventricular function and others had dilated cardiomyopathy and coronariopathy. All patients had a satisfactory response to the implantable cardioverter-defibrillators therapy.

Key Words

Severe ventricular arrhythmia, ventricular tachycardia, implantable cardioverter-defibrillator

Introduction

Sudden cardiac death is the leading cause of mortality in the United States. It is estimated that 200,000 – 400,000 sudden deaths occur annually. The vast majority of these deaths is encountered among patients with symptomatic heart failure associated with reduced left ventricular function. In the Framingham study, the sudden death rate for patients with heart failure was nine times the general age-adjusted population rate [1].

The annual incidence of sudden death is expected to increase with the increasing incidence of heart failure. There are 4 – 5 million people living with chronic heart failure, and an additional 400,000 new cases are diagnosed each year. The increasing incidence of heart failure is primarily due to the advancing age of the population with coronary artery disease, which is now the principal cause of heart failure associated with reduced ventricular function [2].

Mortality due to progressive heart failure associated with reduced left ventricular function has declined. In the Framingham study, total mortality was 24 % and 55 % within 4 years of developing symptomatic heart failure for women and men, respectively. These statistics approximate well the natural history of heart failure as the subject population was untreated by contemporary standards [3].

Recognition of the beneficial effects of angiotensin-converting enzyme (ACE) inhibitors, diuretics, digoxin, and beta-blockers have yielded substantial reductions in mortality due to progressive pump failure. However, despite these improvements in medical therapy, symptomatic heart failure still poses a 20 – 25 % risk of premature death in the first 2 years after diagnosis. Approximately 50 % of these premature deaths are sudden and attributable to ventricular tachycardia (VT) or ventricular fibrillation (VF) [4].

Though appropriate shocks probably saved the lives of those patients who received them, the mortality rate remained high (25 – 30 % at 2 years). In our study, five patients suffering from symptomatic ventricular tachycardia were implanted with implantable cardioverter-defibrillators (ICDs). This small study does not prove that ICDs prolong survival compared to alternate therapy (amiodarone and pacemakers) in similar populations. However, the high incidence of appropriate treatment with ICD shocks and the association of recurrent syncope with ventricular arrhythmias support the treatment of patients with nonischemic dilated cardiomyopathy, unexplained syncope, and a negative EP study [5].

This proportionate contribution of sudden death to total mortality in heart failure associated with reduced

left ventricular function has not changed substantially between the Framingham data and the present time [6].

Presentation of Five Cases from Our Hospital

Case 1

The patient, a 28 year-old male, was first examined in March 2000. Several syncopal episodes, from left-sided VT, were confirmed during EP study; these probably originated from arrhythmogenic dysplasia. These events presented with three distinct morphology and frequency patterns. Radiofrequency ablation was first used to treat the problem, but no success was achieved. The clinical response to amiodarone was inadequate in controlling the symptomatic episodes of tachyarrhythmia. On May 31, 2000, the patient was implanted with a Phylax XM ICD and a Kainox SL 75/13 lead (Biotronik, Germany). The R-wave measured during implantation was 8.1 mV, slew-rate 0.8 V/s, pacing impedance 578 Ω, and pacing threshold 1.2 V. The defibrillation test was successful at a minimum energy of 14 J. The ejection fraction (EF) measured by Doppler echocardiography was 64.7 %.

Case 2

The patient, a 33 year-old male, was followed for 6 months before an ICD implantation. He presented with episodes of symptomatic VT that were unable to control with standard medications. Routine visits revealed a normal ECG. The EF was 64 %, indicating normal functioning of cardiac chambers. During tachycarda, QRS complexes became widened. VF was inducible during the EP examination by a rapid pacing (220 ms) of the right ventricular outflow tract, which was reverted by electrical cardioversion with 300 J. On June 6, 2000, the patient was implanted with a Phylax AV ICD, an RX 53J BP atrial lead, and a Kainox SL 75/13 ventricular lead (Biotronik). Atrial measurements during implantation revealed a P-wave of 6.0 mV, slew-rate of 1.3 V/s, pacing impedance of 469 Ω, and pacing threshold of 0.6 V. In the ventricle, R-wave was 29.1 mV, slew-rate 2.9 V/s, pacing impedance 957 Ω, pacing threshold 0.4 V, and shock impedance 47 Ω. The defibrillation test was successful at a minimum energy of 10 J.

Case 3

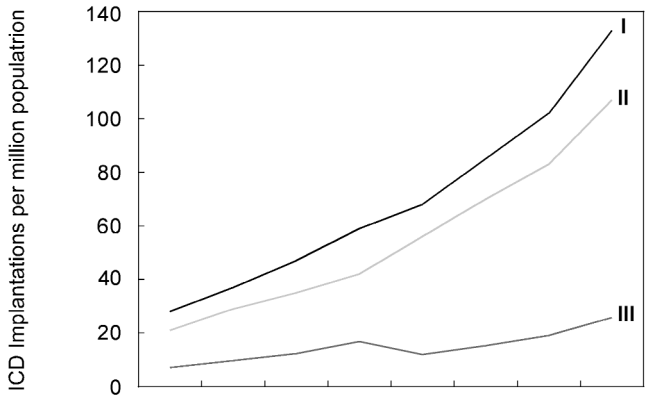
The patient, a 60 year-old male, presented ischemic cardiomyopathy and frequent episodes of symptomatic VT. There was evidence of infra and lateral wall necrosis on the ECG, as well as of the right bundle branch block. A contractile dysfunction of the right ventricular segment resulted in a severe systolic ventricular dysfunction and an EF of 44 %. During the EP study, it was possible to induce the same arrhythmia with cycles of 280 ms; this degenerated to a ventricular flutter, even with the administration of amiodarone. On April 2, 2001, the patient was implanted with a Phylax AV ICD, RX 53J BP atrial lead, and a Kainox SL 75/13 ventricular lead (Biotronik). The implant measurements indicated a P-wave of 3.0 mV, atrial pacing threshold of 0.4 V, R-wave of 10.0 mV, ventricular slew-rate of 1.0 V/s, ventricular pacing impedance of 810 Ω, ventricular pacing threshold of 0.6 V, shock impedance of 64 Ω. The defibrillation test was successful at a minimum energy of 14 J.

Case 4

This was a 61 year-old male with idiopathic dilated cardiomyopathy and frequent episodes of symptomatic VT, refractory to pharmacologic treatment. An EP study revealed a reduced Wenckebach point with a normal refractory period. Programmed ventricular pacing with 600 ms cycles and three extra-stimuli induced a sustained monomorphic VT with resultant cycles of 380 ms, left bundle branch block morphology and a downward deviated axis. The patient was able to hemodynamically tolerate the condition, and the heart was reverted with ventricular pacing. On April 20, 2001, the patient was implanted with a MycroPhylax Plus ICD and a Kainox SL 75/16 ventricular lead (Biotronik). The R-wave measured during implantation was 8.0 mV, ventricular slew-rate 1.0 V/s, pacing impedance 512 Ω, pacing threshold 0.6 V, shock impedance 38 Ω. The defibrillation test was successful at a minimum energy of 14 J.

Case 5

The patient, a 45 year-old male, had idiopathic dilated cardiomyopathy and frequent episodes of symptomatic VT, with a poor response to pharmacologic treatment. The ECG revealed a moderate increase of the left atrium and ventricle, while the EF was 44 %. The EP study revealed a slight nodal depression (probably due to drugs such as amiodarone and carvedilol). Using two extra-stimuli, it was possible to induce a sustained VT (on the right ventricular outflow tract), which degenerated into VF, and consequently required elec-



Year	1990	1991	1992	1993	1994	1995	1996	1997
I = ICD Implantations (total)	28	37	47	59	68	85	102	133
II = ICD Implantations (primary)	21	29	35	42	56	70	83	107
III = ICD Implantations (replacements)	7.1	9.7	12.3	16.8	12.0	15.3	19.1	25.8

Figure 1. Trends in implantable cardioverter defibrillators (ICDs) per million population over a 7-year period as estimated by device manufacturers: primary implants (II), replacements (III), total (I). In 1997, more than 35,600 ICDs were implanted.

trical cardioversion. On June 8, 2001, the patient was implanted with a MycroPhylax Plus ICD and a Kainox SL 75/16 ventricular lead (Biotronik). The R-wave measured during implantation was 18.0 mV, slew-rate 1.0 V/s, pacing impedance = 830 Ω, pacing threshold = 0.8 V, shock impedance = 47 Ω. The defibrillation test was successful at a minimum energy of 15 J.

Discussion

In 1997, approximately 1,425 physicians implanted a total of 35,630 ICDs in 817 hospitals in the US. Primary ICD implantations increased from 56 per million people in 1994 to 107 in 1997, which constitutes about 19 % of the implantation rate for primary pacemakers. The proportion of ICD pulse generator replacements rose slightly during the same period, from 17.7 % to 19.4 % of the total ICD implantation number (Figure 1). 69 % of surgical respondents indicated that they implanted ICDs, in contrast with 28 % in 1993 [7]. The introducer method was used in most transvenous lead placements (mean 63.4 %, median 90 %), while cephalic vein cutdown was used less frequently (mean 36.6 %, median 10 %). Primary ICD implantation was indicated for spontaneous VF or VT in 35.2 % of cases, aborted sudden death in 34.5 % of cases, and syncope with inducible VT or VF in 24.7 % of cases. Prophylactic ICD implantation accounted for 5.7 % of the population.

The typical choices for pulse generator placement were the left infraclavicular space (79.1 %), the right infraclavicular space (7.8 %), the anterior abdominal wall (13.1 %) and < 0.1 % for other locations. Endocardial electrodes and an electrically active pulse generator housing ("hot can") accounted for 82.2 % of the primary ICD implantations; endocardial electrodes alone accounted for 14.8 %, and other configurations comprised the remaining 3.0 %. During the first 6 months of 1997 only 0.4 % of the implanted ICD leads required replacement. In 1997 almost half (49.2 %) of the ICDs implanted did not deliver shocks during the first year. Most (80.7 %) shocks were deemed appropriate, as determined by stored electrograms in 81.1 % of cases, RR interval data in 13.3 %, and the patient's symptoms in 5.6 % of cases.

Prior to the advent of large clinical trials comparing randomized therapies for heart failure or sudden death associated with reduced ventricular function, the importance of classification and mechanism of death received more attention. By systematically analyzing 142 deaths, Hinkle and Thaler [8] described a classification scheme based on the circulatory condition immediately prior to death. Arrhythmic deaths were those in which the subject abruptly collapsed and the pulse ceased prior to circulatory collapse. Circulatory failure deaths were those in which the pulse ceased only after the peripheral circulation had collapsed. Using this scheme, 58 % of deaths were arrhythmic and 42 % were due to circulatory collapse. Nearly equal amounts of arrhythmic deaths occurred out of the hospital, whereas deaths due to circulatory collapse occurred in the hospital. Similarly, nearly equal amounts of deaths caused by an acute cardiac event were arrhythmic, whereas deaths caused by non-cardiac events (acute respiratory failure, hemorrhage, infection, stroke) were due to circulatory collapse.

This is made worse because the classification schemes vary widely between clinical trials. In the studies of left ventricular dysfunction (SOLVD) [9] deaths were classified as cardiovascular or noncardiovascular, then further classified as being due to arrhythmia without worsening congestive heart failure, progressive heart failure with or without worsening arrhythmia, myocardial infarction, stroke, or other vascular events. In SOLVD, 23 % of deaths were classified as "arrhythmic without worsening the heart failure CHF". In the Vasodilator-Heart Failure Trails (VHeFT) [10], deaths were classified as:

- sudden, observed to be instantaneous on the basis of the clinical setting;
- sudden, but with premonitory worsening (hours, days, or weeks) of cardiac status;
- pump failure, usually with progressively worsening of heart failure symptoms even if the terminal episode was an arrhythmia;
- other cardiovascular event; or
- noncardiovascular event.

In V-HeFT I, 43.8 % of deaths were classified as sudden with no warning symptoms; in V-HeFT II, 36.5 % of deaths were similarly classified. Death events were adjudicated by site in SOLVD, whereas in V-HeFT I – II the mode of death was reviewed centrally. In the Survival Trial of Amiodarone Therapy in Congestive Heart Failure (STAT-CHF) [11] trial, deaths were reviewed by a blind committee and classified as sudden or non-sudden cardiac, or death from other causes. Using this schema, 49 % of the deaths in the amiodarone group and 52 % of the deaths in the placebo group were characterized as sudden. Differences in the definition of sudden death contribute to the variable incidence between studies involving similar patient populations. Steinberg et al. reported on the outcome of patients in the Antiarrhythmic Versus Implantable Defibrillators (AVID) registry who present with unexplained syncope, reduced left ventricular end-diastolic diameter (mean 0.34), and inducible VT. The study population included patients with ischemic and non-ischemic cardiomyopathy. The majority (85 %) of these patients received ICDs. Actuarial analysis showed arrhythmia recurrence rates of 22 % and 35 % at 1- and 3-year follow-up, respectively. Most of these were due to VT, some of which were fatal among patients without ICDs. Left ventricular EF was the only predictor of arrhythmia recurrence [12]. Andrews et al., using a retrospective case-controlled design, reported a high incidence (57 % at 1 year) of spontaneous VT logged by ICDs among patients with unexplained syncope, predominantly ischemic heart disease and inducible sustained ventricular arrhythmias. The incidence of shocks due to documented VT was not significantly different than similar patients who presented with spontaneous VT rather than syncope. The patients did not receive antiarrhythmic drugs, suggesting that the incidence of spontaneous VT approximated the natural history in the study population. The mean EF in the study population was 0.30, and 45 % of the patients had New York Heart Association (NYHA) class III or IV heart failure symptoms. 40 % of syncope patients had a recurrence due to spontaneous VT as logged by ICDs [13]. Knight et al. used a similar retrospective case-controlled study to report a high incidence (50 %) of appropriate ICD shocks among patients with non-ischemic dilated cardiomyopathy, unexplained syncope, and a negative EP study. The mean left ventricular EF was approximately 0.25 and most patients had symptomatic heart failure [14].

Conclusion

The evolution of our patients was similar to that observed in the previously cited literature. All patients were evaluated by an EP study, which confirmed the presence of severe ventricular arrhythmia. The patients were refractory to standard pharmacological therapy. Two younger patients with good ventricular function, two patients with dilated cardiomyopathy, and one patient suffering from coronariopathy all had a satisfactory response to ICD therapy.

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