Implantable Cardioverter Defibrillator Therapy: Ten Years Experience in a Medical Center

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Background: An implantable cardioverter defibrillator (ICD) is the therapy of choice for survivors of life-threatening ventricular tachyarrhythmias or sudden cardiac death. To date there is little data concerning the clinical features and outcome of ICD therapy among Taiwanese. This study identifies factors related to the outcome of ICD therapy over a ten-year period at this institution.

Methods: Forty-nine ICDs were implanted in 46 patients between August 1996 and January 2006. The mean follow-up duration was 32 ± 21 months. Patient data, primary cardiac diagnosis, presenting cardiac arrhythmia, echocardiographic parameters, hemodynamic indexes, electrophysiologic findings, and follow-up observations were analyzed. The findings were compared to those of the Taiwan ICD Multicenter Registry (TIMR) Study and major secondary prevention ICD trials in the literature.

Results: The patients in this study were comparable to those of TIMR but were younger and had better left ventricular ejection fractions (LVEF) than those in Western countries. Furthermore, higher mortality on follow-up was observed in patients with any of the following: LVEF < 35%, New York Heart Association (NYHA) functional class III or IV, a left atrial dimension ≥ 55 mm, a left ventricular end diastolic dimension ≥ 75 mm, an end systolic dimension ≥ 60 mm, triple vessel disease, a prior anterior myocardial infarction, and amiodarone or diuretic therapy. Patients with structural heart disease other than ischemic heart disease or dilated cardiomyopathy had higher event recurrence rates.

Conclusion: Left ventricular function is a major determinant affecting the outcome in ICD recipients. Aggressive treatment for heart failure is warranted in these patients.

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Key words: implantable cardioverter defibrillator, sudden cardiac death, ventricular tachycardia, ventricular fibrillation, heart failure

An implantable cardioverter defibrillator (ICD) is the current therapy of choice for prevention of sudden cardiac death in patients with life -threatening ventricular tachyarrhythmias.[1-3] ICD therapy has also been shown to decrease mortality in high risk populations such as patients with advanced structural

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heart disease with left ventricular ejection fractions less than 35%.[4-9] Many randomized controlled trials for primary and secondary prevention have been reported, however, little data has been reported among Taiwanese with ICD therapy. Herein, we examine ICD implantation over a ten-year period in our department at Chang Gung Memorial Hospital, Taipei. The patients' clinical features, and echocardiographic, hemodynamic, electrophysiologic parameters as well as medications were analyzed to identify factors that were associated with recurrent events and survival following ICD implantation.

METHODS

Patient population

Forty-nine ICD implantations were performed in 46 patients from August 1996 to January 2006 in our department. Patient data, primary cardiac diagnosis, presenting arrhythmia, usage of antiarrhythmic agents, laboratory data, echocardiographic parameters, hemodynamic indexes, electrophysiologic findings and results of coronary angiography were analyzed. The ICD manufactures included Medtronic Inc. (Minneapolis, MN, U.S.A.), Guidant (St. Paul, MN, U.S.A.) and St. Jude Medical (St. Paul, MN, U.S.A.). Episode summary and device stored electrograms were collected during follow-up. The left atrial (LA) dimension, left ventricular (LV) end diastolic dimension (EDD), and LV end systolic dimension (ESD) were acquired from echocardiography in the parasternal long axis view. The left ventricular ejection fraction (LVEF) was estimated by echocardiography. Coronary artery disease (CAD) were documented by coronary angiography or excluded by Thallium-201 myocardial perfusion scan. All patients received ICD implantation using transvenous lead systems with single chamber or dual chamber ICDs. All ICD implantations were performed for secondary prevention in patients with a documented life-threatening ventricular tachyarrhythmia and none for ventricular tachyarrhythmias related to acute myocardial infarction (MI), acute myocarditis, electrolyte imbalance, usage of proarrhythmic drugs or ventricular tachycardia (VT) / ventricular fibrillation (VF) that could be treated with radiofrequency ablation. Clinical presentations included aborted sudden cardiac death with or without documentation of ventricular tachyarrhythmia, VT with or without syncope, and unexplained syncope with inducible VT/VF. All patients except one underwent electrophysiologic study before ICD implantation and all patients were followed in this institution after ICD implantation. The ICD was checked every 3 months and whenever patients returned to the hospital because of rcurrent events or ICD therapy. ICD therapy was divided into anti-tachycardia pacing (ATP) and direct shock delivery after failure of ATP therapy or when fast VT or VF developed. The primary outcome variable was the first ICD therapy after implantation. The primary end point of the study was all cause mortality and the secondary end points were recurrent sustained VT/VF or cardiac arrest. The study ended May 31, 2006. The clinical characteristics of the study population were compared with those in the Taiwan ICD Multi-center Registry Study (TIMR),[10] as well as those in Western population studies including the Cardiac Arrest Study Hamburg (CASH),[1] the Antiarrhyth-mics versus Implantable Defibrillator (AVID) trial[2] and the Canadian Implantable Defibrillator Study (CIDS).[3]

Statistical methods

Continuous variables were presented as mean $\pm$ SD and were analyzed by Student's t test. Categorical variables were analyzed by Chi-square test or Fisher's exact test. Cumulative mortality and event rates were analyzed by Kaplan-Meier estimation and the survival rates of different groups were compared by the log-rank test. The following co-variables were selected for calculation of mortality and recurrent events: LVEF, New York Heart Association (NHYA) functional class, LA and LV chamber size, underlying heart disease, CAD, vessel number in CAD, prior MI and prior MI location, prevalence of arrhythmia, heart failure medications and antiarrhythmic medications. For all analyses, $p < 0.05$ was considered statistically significant. Analyses were performed using the STATA statistical package, version 9.0 (Stata Corp., College Station, TX, U.S.A.).

RESULTS

Demographic data

From August 1996 to January 2006, 49 transvenous ICD implantations, including 3 pulse generator replacements, were performed in 46 patients. Two of the replacements were performed following recalls

by the pacemaker company. Thirty-one of the 49 (63.2%) were dual chamber and 18 (36.8%) were single chamber ICDs. Single chamber ICDs were implanted between 1996 and 1998, and after 1999 in patients with permanent atrial fibrillation (Af) or organic heart disease without severe heart failure. Dual chamber ICDs were implanted in patients with sinus rhythm after 1999. Figure 1 shows the number of ICD implantations per year as well as the distribution of single and dual chamber ICD implantations. Thirty-three of the 49 (68%) ICDs were Medtronic, including 28 (85%) dual chamber and 5 (15%) single chamber ICDs. The others included 14 St. Jude single chamber ICDs, and 2 Guidant dual chamber ICDs. The ages of the patients ranged between 30 and 78 years old; the age distribution of the patients is shown in Figure 2.

Baseline characteristics and clinical arrhythmic events

The baseline characteristics of the study population and comparison with previous trials are shown in Table 1. The mean age of the patients was 60 ± 11 years with a predominance of men (79%). The mean LVEF was 43 ± 20%. Symptomatic heart failure with NYHA functional class III or IV was noted in 52% of the patients. VT was the presenting arrhythmia in 78% of the patients, including 11% with syncopal VT and 67% with non-syncopal VT; VF was the presenting arrhythmia in 20% of the patients, and the other 2% presented with unexplained syncope with inducible VT/VF.

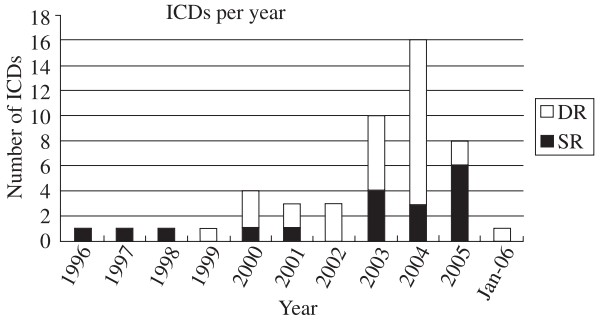

Fig. 1 Implantable cardioverter defibrillator (ICD) numbers over 10 years. The number of ICD implantations was low before 2003. Only single chamber ICDs were used before 1998 and both single (SR) and dual chamber (DR) ICDs were used after 1999.

Primary cardiac diagnosis

The primary cardiac diagnoses of the study patients are shown in Figure 3. Ischemic heart disease (IHD) was noted in 42%, dilated cardiomyopathy (DCM) in 26%, arrhythmogenic right ventricular dysplasia (ARVD) in 7% and idiopathic ventricular fibrillation in 7%. Less common causes included Brugada syndrome (4%), obstructive hypertrophic cardiomyopathy (HOCM) (4%), nonobstructive hypertrophic cardiomyopathy (HCM) (4%), muscular dystrophy (2%), short QT syndrome (2%), and idiopathic right ventricle outflow tract VT (2%). No patient with long QT syndrome was included in this study.

Survival

Seven patients (15%) died during follow-up. Three deaths were associated with cardiac disease, one after heart transplantation, one with terminal heart failure, and the other with incessant VT refractory to medication and shocks by the device and subsequent failure of cardiopulmonary resuscitation. The other four patients had non-cardiac deaths, 3 from sepsis and one from suicide due to emotional stress after multiple shocks following an electrical storm. The probability of overall survival after an ICD implantation as calculated by the Kaplan-Meier curve was 93.4% at 12 months [95% confidence interval (CI): 80.8%-97.8%]; 90.4% at 24 months (95% CI: 76.0%-96.3%), 85.3% at 36 months (95% CI: 66.4%-94.1%), 76.8% at 48 months (95% CI: 49.9%-90.5%), and 61.5% at 60 months (95% CI: 25.2%-84.2%). (Fig. 4)

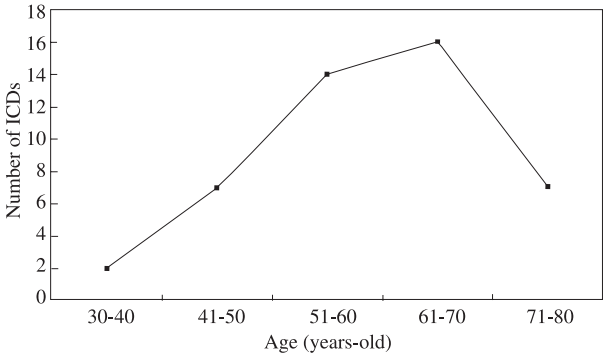

Fig. 2 Age distribution in patients with ICD implantation. The ages ranged between 30 and 78 years with a peak at 61-70 years.

Table 1. Comparison of Baseline Characteristics, Presenting Arrhythmias, and Underlying Heart Disease with Previous ICD Studies

	CGMH (n = 46)	TIMR (n = 92)	AVID (n = 507)	CASH (n = 99)	CIDS (n = 328)
Clinical characteristics					
Age (years)	60 ± 11	59 ± 16	65 ± 11*	58 ± 11	63 ± 9*
Gender (% Male)	79%	84%	78%	79%	85%
LVEF (%)	43 ± 20	48 ± 19	32 ± 13*	46 ± 19	34 ± 15*
NYHA Fc III/IV (%)	52%	–	7%*	18%*	11%*
Presenting arrhythmia					
VT	78%	56%*	55%*	0%*	40%*
Syncopal VT	9%	27%	21%	0%*	16%
Non-Syncopal VT	69%	29%*	34%*	0%*	24%*
VF	17%	38%	45%*	100%*	45%*
Unexplained syncope with inducible VT/VF	4%	6%	0%	0%	15%*
Underlying heart disease					
IHD	42%	29%	82%*	73%*	83%*
Prior MI	39%	12%*	67%*	51%	76%*
Non-ischemic structural heart disease	43%	48%	15%*	18%*	13%*
DCM	26%	35%	–	12%*	8%*
Other structural heart disease	17%	13%	–	6%*	5%*
No structural heart disease	15%	23%	3%*	9%	4%*

Abbreviations: CGMH: Chang Gung Memorial Hospital; TIMR: Taiwan ICD Multicenter Registry study; AVID: Antiarrhythmics versus Implantable Defibrillators trial; CIDS: Canadian Implantable Defibrillator Study; CASH: Cardiac Arrest Study Hamburg trial; LVEF: left ventricular ejection fraction; NYHA: New York Heart Association; VT: ventricular tachycardia; VF: ventricular fibrillation; IHD: ischemic heart disease; MI: myocardial infarction; DCM: dilated cardiomyopathy; *: p value < 0.05.

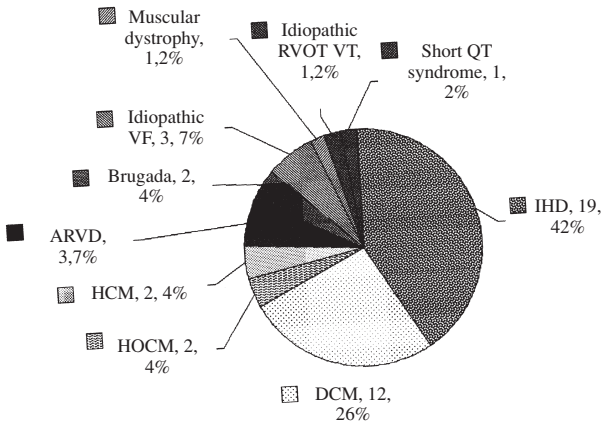

Fig. 3 Primary cardiac diagnosis. Forty-two percent of the patients had ischemic heart disease, 26% had dilated cardiomyopathy, and the rest had other heart diseases. IHD: ischemic heart disease; DCM: dilated cardiomyopathy; HOCM: hypertrophic obstructive cardiomyopathy; HCM: hypertrophic non-obstructive cardiomyopathy; AVRD: arrhythmogenic right ventricular dysplasia; VF: ventricular fibrillation; RVOT: right ventricular outflow tract; VT: ventricular tachycardia.

Factors affecting survival

The clinical features were compared between survivors and non-survivors during follow-up are shown in Table 2. Non-survivors had a significantly higher mean serum creatinine level, larger LA dimension, larger LV chamber size, lower LVEF, and advanced NYHA functional class. Moreover, they

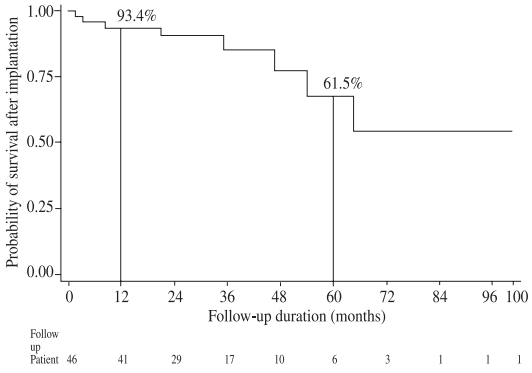

Fig. 4 Kaplan-Meier survival curve after ICD implantation. The 12 month survival was 93.4% and the 60 month survival was 61.5%.

Table 2. Comparison of Clinical Features during Follow-up between Survivors and Non-survivors

Number of patients (%)	Non-survivors (n = 7)	Survivors (n = 39)	*p* value
Clinical findings			
Age (years)	58 ± 9	60 ± 11	0.685
Age > 65 years	2 (29%)	15 (38%)	0.618
Male gender	5 (71%)	31 (79%)	0.634
IHD	4 (57%)	15 (38%)	0.355
DCM	3 (43%)	9 (23%)	0.272
Structural heart disease other than IHD or DCM	0	8 (20%)	0.187
No structural heart disease	0	7 (18%)	0.223
VT as presenting arrhythmia	6 (86%)	30 (77%)	0.604
VF as presenting arrhythmia	1 (14%)	7 (18%)	0.814
Prior MI	4 (57%)	14 (36%)	0.289
Prior anterior MI	4 (57%)	7 (18%)	0.025*
Prior inferior MI	0	6 (15%)	0.266
Prior posterior MI	0	1 (2.5%)	0.668
NYHA Fc III/IV	7 (100%)	17 (44%)	0.006*
Serum creatinine (mg/dL)	2.0 ± 2.2	1.2 ± 0.4	0.035*
Echocardiographic study findings			
LA (mm)	50 ± 11	42 ± 9	0.040*
LVEDD (mm)	71 ± 8	56 ± 11	0.002*
LVESD (mm)	59 ± 12	43 ± 14	0.015*
LVEF (%)	29 ± 10	45 ± 20	0.050
LVEF < 35%	6 (86%)	15 (38%)	0.021*
Catheterization study findings			
Catheterization performed	5 (71%)	29 (74%)	0.871
CAD	5 (71%)	15 (38%)	0.020*
No. of diseased vessels (%)	2.6 ± 0.9	1.0 ± 1.2	0.009*
3-vessel CAD disease (%)	4 (57%)	7 (18%)	0.025*
Left main CAD disease (%)	0	3 (8%)	0.515
PAWP (mmHg)	38 ± 4	16 ± 12	0.003*
PAWP > 30 mmHg	2 (29%)	3 (8%)	0.008*
CABG	0	4 (10%)	0.310
Successful PCI	2 (29%)	7 (18%)	0.634
Electrophysiologic study findings			
Induction of polymorphic VT	0	5 (13%)	0.316
Induction of monomorphic VT	6 (86%)	27 (69%)	0.372
Induction of VF	4 (57%)	34 (87%)	0.354
Follow-up			
Event free period (months)	18 ± 25	18 ± 18	0.975
VT events after ICD	23 ± 28	26 ± 64	0.904
VF events after ICD	0.1 ± 0.4	0.6 ± 0.6	0.349
Paroxysmal Af	2 (29%)	12 (31%)	0.909
Permanent Af	1 (14%)	3 (8%)	0.569
Beta-blockers	5 (71%)	37 (95%)	0.043*
ACEI/ARB	6 (86%)	25 (64%)	0.261
Diuretics	6 (86%)	18 (46%)	0.054
Digoxin	4 (57%)	7 (18%)	0.028*
Antiarrhythmic agents	7 (100%)	27 (69%)	0.089
Amiodarone	7 (100%)	21 (54%)	0.025*
Sotalol	1 (14%)	2 (5%)	0.366
Mexiletine	4 (57%)	13 (33%)	0.250

Abbreviations: IHD: ischemic heart disease; DCM: dilated cardiomyopathy; VT: ventricular tachycardia; VF: ventricular fibrillation; MI: myocardial infarction; NYHA: New York Heart Association; LA: left atrium; LVEDD: left ventricular end diastolic dimension; LVESD: left ventricular end systolic dimension; LVEF: left ventricular ejection fraction; CAD: coronary artery disease; PAWP: pulmonary artery wedge pressure; CABG: coronary artery bypass graft surgery; PCI: percutaneous coronary intervention; ICD: Implantable cardioverter defibrillator; Af: atrial fibrillation; ACEI: angiotensin converting enzyme inhibitor; ARB: angiotensin II receptor blocker; *: *p* value < 0.05.

had significantly more diseased coronary arteries, and higher pulmonary arterial wedge pressures, and more patients had a prior anterior infarction, and triple vessel disease. In addition to this, use of amiodarone in this population was higher while beta-blockers and digoxin were used less. The event free period and the appearance of paroxysmal or permanent Af were similar in the survivor and non-survivor groups.

Analysis using Kaplan-Meier survival comparing the probability of total survival in relation to individual variables revealed that patients with a lower LVEF (< 35% vs. ≥ 35%, log-rank $p = 0.018$; Figure 5A), a worse NYHA functional class (III/IV vs. I /II, log-rank $p = 0.005$), a larger LA dimension (LA ≥ 55 mm vs. < 55 mm, log-rank $p = 0.013$ Figure 5B), a dilated LV (LVEDD ≥ 75 mm vs. < 75 mm, log-rank $p = 0.018$; LVESD ≥ 60 mm vs. < 60 mm, log-rank $p = 0.027$), CAD (log-rank $p = 0.017$, Figure 5C) triple vessel disease (log-rank $p = 0.021$), and prior anterior MI (log-rank $p = 0.031$,) had poor outcomes. The Kaplan-Meier survival estimate did not show a better outcome with usage of beta blockers or digoxin, but showed a poor outcome with usage of diuretics (log-rank $p = 0.029$) and amiodarone (log-rank $p = 0.011$, Figure 5D).

Follow up and ICD therapy

During a mean follow-up of 32 ± 21 months (range 2-100), 26 of 46 patients (57%) had recurrent ventricular tachyarrhythmias and received ATP or shock therapy from their implanted ICD. Of these 26

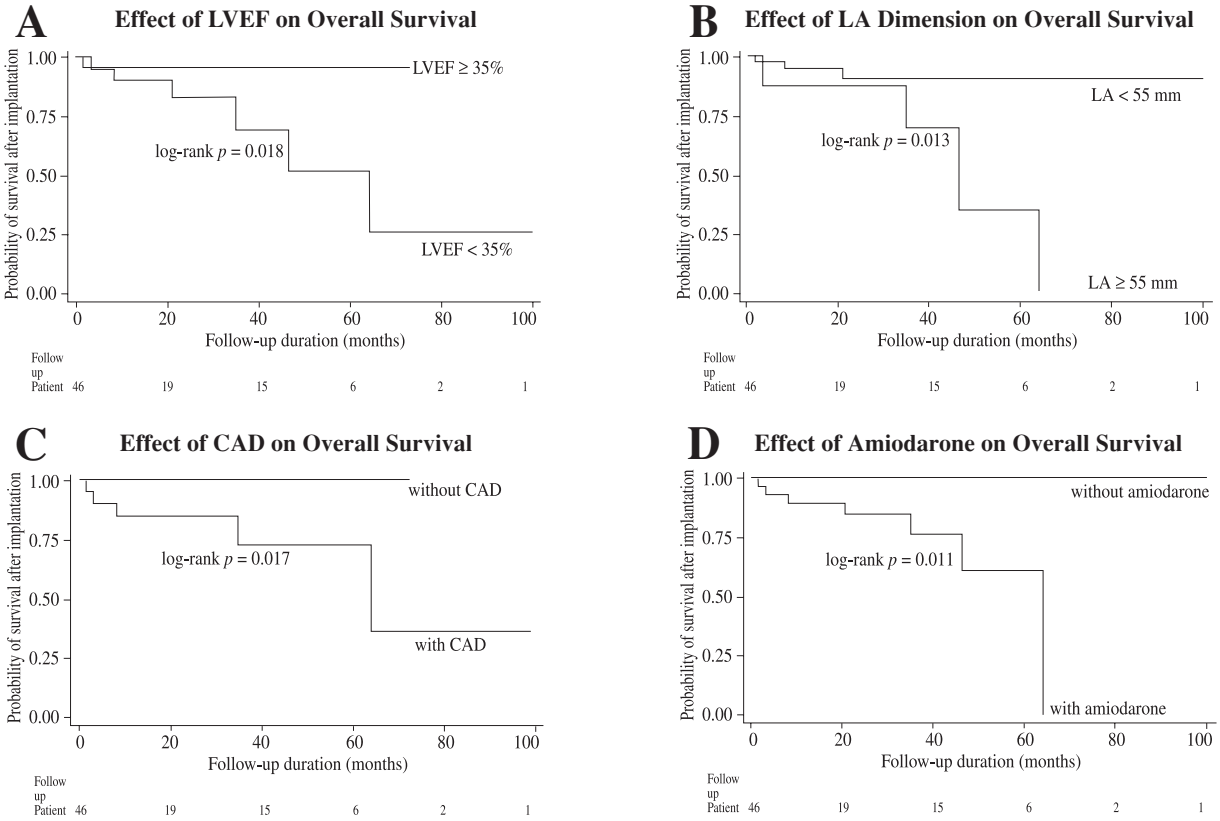

Fig. 5 Effects of different factors on Kaplan-Meier estimation of overall survival after ICD implantation. (A) Effect of left ventricular ejection fraction (LVEF) on overall survival. Survival in the first year was 96.0% in patients with LVEF ≥ 35% and remained stable afterward. In contrast, survival at the 12th month was 90.2% in patients with LVEF < 35% and declined to 26.0% after 60 months. (B) Effect of left atrial (LA) dimension on overall survival. Survival at the 12th month was 94.6% in patients with LA < 55 mm and remained stable afterward. In contrast, survival at the 12th month was 87.5% in patients with LA ≥ 55 mm; it declined rapidly with no survival after 64 months. (C) Effect of coronary artery disease (CAD) on overall survival. There were no deaths in patients without CAD during follow-up. All deaths occurred in patients with CAD; the survival at the 12th month was 84.4% and declined to 36.1% after 60 months. (D) Effect of amiodarone therapy on overall survival. There were no deaths in patients not taking amiodarone during follow-up. The survival at the 12th month was 89.1% in patients treated with amiodarone, it declined rapidly with no survival after 64 months.

patients, 4 received ATP alone, 4 received only shock therapy, and 18 received both ATP and shock therapy. One other patient received inappropriate ATP and two received inappropriate shock therapy due to episodes of paroxysmal Af. Overall, 123 shocks occurred in the 29 patients who received ICD therapy during follow-up with 26 (21%) inappropriate shocks, and 1111 episodes of ATP occurred with 25 (2.3%) episodes of inappropriate ATP. Thus, the overall ratio of inappropriate therapy was 4%.

Factors affecting recurrent events

The clinical features were compared between patients with and without recurrent events during follow-up (Table 3). A significantly higher percentage of recurrent events were noted in patients with heart disease other than IHD or DCM including ARVD, HCM, HOCM and muscular dystrophy (17% vs. 0%, $p = 0.006$), and in patients on antiarrhythmic drugs (54% vs. 20%, $p < 0.001$) including amiodarone ($p = 0.03$), and mexiletine ($p < 0.001$) but not sotalol ($p = 0.12$).

DISCUSSION

The number of ICD implantations was low (2 ±

Table 3. Comparison of Clinical Characteristics of Patients with and without Recurrent Ventricular Arrhythmia during Follow-up

Number of patients (%)	Recurrence (n = 26)	No recurrence (n = 20)	*p* value
Clinical findings			
Age (years)	58.4 ± 11.2	62.1 ± 10.1	0.258
Age > 65 (yeas)	8 (31%)	9 (45%)	0.332
Male gender	21 (81%)	15 (75%)	0.638
IHD	9 (35%)	10 (50%)	0.293
DCM	7 (27%)	5 (25%)	0.883
Structural heart disease other than IHD or DCM	8 (31%)	0	0.006*
No structural heart disease	2 (8%)	5 (25%)	0.105
VT as presenting arrhythmia	22 (85%)	14 (70%)	0.234
Syncopal VT	4 (15%)	0	0.083
Non-syncope VT	18 (69%)	14 (70%)	0.083
VF as presenting arrhythmia	3 (12%)	5 (25%)	0.232
Unexplained Syncope with inducible VT/Vf	1 (4%)	1 (5%)	0.859
Prior MI	9 (35%)	9 (45%)	0.474
Prior Ant wall MI	7 (27%)	4 (20%)	0.585
Prior Inf. wall MI	2 (8%)	4 (20%)	0.219
Prior Post-lat wall MI	0	1 (5%)	0.249
NYHA Fc III/IV	16 (62%)	8 (40%)	0.147
Echocardiographic study findings			
LA (mm)	44 ± 10	41 ± 8	0.306
LVEDD (mm)	59 ± 13	57 ± 10	0.588
LVESD (mm)	46 ± 13	45 ± 13	0.728
LVEF (%)	43 ± 22	43 ± 13	0.991
LVEF < 35%	14 (54%)	7 (35%)	0.203
Catheterization study findings			
Catheterization performed	18 (69%)	15 (75%)	0.821
CAD	10 (38%)	10 (50%)	0.242
No. of diseased vessels	1.09 ± 1.03	1.46 ± 1.25	0.385
3VD	6 (23%)	5 (25%)	0.880
LM stenosis	2 (8%)	1 (5%)	0.805
PAWP (mmHg)	17.8 ± 10.9	18.9 ± 11.0	0.830
PAWP > 30 mmHg	3	2	0.882
s/p CABG	3 (12%)	1 (5%)	0.260
s/p PCI successful	3 (12%)	6 (30%)	0.519
Electrophysiological study findings			
EPS	25 (96%)	20 (100%)	0.375
Induction of polymorphic VT	2 (8%)	3 (15%)	0.430
Induction of monomorphic VT	21 (81%)	12 (60%)	0.122
Induction of VF	21 (81%)	17 (85%)	0.707
Follow-up			
Event free period (months)	7.8 ± 10.7	30.3 ± 19.2	< 0.001*
Paroxysmal Af	9 (35%)	5 (25%)	0.482
Permanent Af	4 (15%)	0	0.066
Beta-blockers	13 (50%)	19 (95%)	0.435
ACEI/ARB	16 (62%)	15 (75%)	0.334
Diuretics	15 (58%)	9 (45%)	0.393
Digoxin	8 (31%)	3 (15%)	0.214
Anti arrhythmic medication	25 (96%)	9 (45%)	< 0.001*
Amiodarone	19 (73%)	9 (45%)	0.033*
Sotalol	3 (12%)	0	0.116
Mexiletine	16 (62%)	1 (5%)	< 0.001*
Amio + mexiletine	10 (38%)	1 (5%)	0.008*
Sotalol + mexiletine	3 (12%)	0	0.116

Abbreviations: IHD: ischemic heart disease DCM: dilated cardiomyopathy; VT: ventricular tachycardia; VF: ventricular fibrillation; Af: atrial fibrillation; MI: myocardial infarction; CAD: coronary artery disease; 3VD: triple vessel disease; LM: left main (coronary artery); PAWP: pulmonary artery wedge pressure; CABG: coronary artery bypass graft surgery; PCI: percutaneous coronary intervention; LVEF: Left ventricular ejection fraction; LA: left atrium; LVEDD: left ventricular end diastolic dimension; LVESD: left ventricular end systolic dimension; EPS: electrophysiological study; ACEI: angiotensin converting enzyme inhibitor; ARB: angiotensin receptor blocker; *: *p* value < 0.05.

1 per year) before ICD therapy was approved by the Bureau of National Health Insurance in 2003; it has grown rapidly since then (11 ± 4 per year). Our data showed a significantly higher ratio of dual chamber ICD implantations per year (76 ± 26%) than the year 2000 Taiwan ICD data (14%).[11] Compared to the TIMR, we had more patients with a prior MI (39% vs. 12%) in this study. Our patients were younger than those in Western trials. The LVEF was higher in this study than in the AVID and CIDS but was similar to that in the CASH trial. However, the NYHA functional class in this study was greater than in other trials, despite a better LVEF. This discrepancy may be due in part to a difference in the patient population, This study had fewer patients with ischemic heart disease and more patients with other structural heart disease, including HOCM, HCM, muscular dystrophy and ARVD. A higher percentage of patients with normal heart structures were also noted in this study, as well as in the TIMR study than in Western trials. In Asian populations, sudden cardiac death or ventricular tachyarrhythmia result less frequently from IHD but are more common among patients without structural heart disease, such as those with Brugada syndrome or idiopathic VF.[12-14]

The incidence of VT in this study was higher than that in the TIMR study (78% vs. 56%), and most cases were non-syncopal VT (69%).

Factors associated with poor outcomes

1. LV dysfunction, dilated heart chamber and advanced NYHA class

Non-surviving patients had worse LV function than surviving patients (29% vs. 45%, $p = 0.05$) and the majority (86%) had a LVEF < 35%. Patients with a larger heart chamber size, i.e. LVEDD ≥ 75 mm, LVESD ≥ 60 mm, and a LA chamber size ≥ 55 mm also had worse outcomes (Figure 5). These findings are in accord with the TIMR study.[10] Although ICD therapy reduces mortality in patients with LV failure,[4-9] the survival is related to the degree of LV dysfunction.[15,16] Our data also showed a significantly higher mortality in patients with NYHA functional class III or IV (100% vs. 44%, $p = 0.036$).

2. CAD, prior anterior wall infarction and the effects of reperfusion

The presence of CAD, the number of diseased coronary arteries, and the presence of 3-vessel disease were determinants of survivals. Although a history of MI was not a factor determining survival, prior anterior myocardial infarction was associated with a higher mortality. Patients who had reperfusion therapy with bypass surgery or percutaneous coronary intervention did not show survival advantages in this study.

3. Renal insufficiency and high pulmonary artery wedge pressure

Non-surviving patients in this study had worse renal function than patients in the literature, with more having elevated serum creatinine levels or receiving renal dialysis therapy.[17] Non-surviving patients also had higher pulmonary artery wedge pressures measured during cardiac catheterization than surviving patients, consistent with patients with a larger heart chamber size, poorer LVEF and worse NYHA functional class.

4. Medications for heart failure and antiarrhythmic agents

Beta-blocking agents, angiotensin converting enzyme inhibitors and angiotensin II receptor blockers are drugs prescribed to patients with LV dysfunction, while digoxin, diuretics, amiodarone, sotalol, and mexiletine are added for patients with heart failure symptoms or arrhythmias. Although surviving patients tended to use beta-blockers and digoxin more oftenly in this study than in previous studies,[18,19] Kaplan-Meier estimation failed to show a favorable effect on survival in the study population. Similar to the SCD-HeFT trial,[9] patients on amiodarone had more recurrent VT/VF and higher mortality during follow-up. A poor outcome was also noted in patients receiving diuretics, reflecting patients with worse heart failure.

Factors associated with recurrent events

There were more recurrent events in patients with heart disease other than IHD or DCM in this study according to univariate analysis. However, the result was not substantiated further by Kaplan-Meier estimation due to the small sample size. A significantly higher percentage of usage of antiarrhythmic drugs in patients with recurrent events was noted, suggesting that antiarrhythmic agents were prescribed more in patients with recurrent events for prevention of ICD shocks. As antiarrhythmic agents were prescribed after recurrent events, the Kaplan-Meier estimation failed to demonstrate effects of antiarrhythmic agents on prevention of recurrent events. This study also failed to show an association of prior MI and usage of beta-blockers with recurrent events as illustrated in previous studies (Table 3).[10,20]

Limitations of the study

Because of small sample size in the study, statistical methods were limited and multivariate analysis, such as Cox proportional-hazards regression models, could not be applied. Many factors that can potentially affect the outcome of ICD therapy may not have been appropriately evaluated.

Conclusions

Despite the small number of patients, factors affecting the outcome and recurrent events following ICD therapy were identified in this study. Mortality was related to the degree of LV dysfunction, severity of CAD and amiodarone usage, while recurrent events often occurred in patients with heart disease other than IHD or DCM.

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植入型心臟去顫復律器—單一醫學中心之十年治療經驗

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背 景： 植入型心臟去顫復律器 (implantable cardioverter defibrillator-ICD) 是治療致命性心律不整或心因性猝死的主要選擇，然而在台灣有關 ICD 治療的臨床特徵及治療預後的資料相當有限。本研究藉由分析單一醫學中心過去十年之 ICD 治療經驗找出影響預後的因子。

方 法： 自 1996 年至 2006 年一月，計有 49 顆 ICD 植入 46 位病患。平均追蹤 32 ± 21 個月，蒐集並分析人口統計學資料，原始心臟病診斷，心律不整之表現，心臟超音波檢查，血流動力學檢查，電氣生理檢查的數據及回診追蹤的臨床特徵與 ICD 治療紀錄。分析結果並與台灣 ICD 登錄研究 (Taiwan ICD Multicenter Registry-TIMR) 以及文獻上大型次級預防性 ICD 研究報告相比較。

結 果： 本研究之病患與 TIMR 相似，但較西方國家報告的病患年輕，且有較佳左心室輸出分率 (LVEF)。結果發現 LVEF < 35%，紐約心臟協會功能分級 III 或 IV，左心房直徑 ≥ 55 mm，左心室舒張末期直徑 ≥ 75 mm 或收縮末期直徑 ≥ 60 mm，有冠狀動脈心臟病，三條血管病變或是曾有前壁心肌梗塞，以及在追蹤過程中使用過 amiodarone 或利尿劑的病患，有較高的死亡率。病患有非缺血性心臟病或是擴張性心肌病變的結構性心臟病，有較高的心律不整復發率。

結 論： 左心室功能是 ICD 接受者預後的主要影響因子，此類病患應當積極治療其心臟衰竭。

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關鍵詞： 植入型心臟去顫復律器，心臟猝死症，心室頻脈，心室顫動，心臟衰竭

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