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Original Article

THE RELATIONSHIP BETWEEN EPISODE FREQUENCY AND FUNCTIONAL CAPACITY IN PATIENTS TREATED WITH IMPLANTABLE CARDIOVERTER DEFIBRILLATORS

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ABSTRACT

Introduction: Left ventricular ejection fraction (EF) is an important parameter for determining the frequency of ventricular arrhythmia episodes in patients treated with implantable cardioverter defibrillators (ICD). However, the relationship between heart failure and ICD episode frequency is controversial. This study aimed to evaluate the relationship between ICD episode frequency and functional capacity in patients classified according to the New York Heart Association (NYHA).

Methods: The frequency of ventricular arrhythmia episodes was examined in patients who had a ICD implanted between January 1998 and April 2004. Seventy consecutive patients were retrospectively reviewed. Class I-II, II, and II-III patients were grouped into Group A, and Class III patients were grouped into Group B. The patients' demographic data, echocardiography findings, EFs, NYHA clinical status, indications for ICD implantation, and ICD episodes were examined.

Results: The mean follow-up period for patients was 3.08±1.31 years. Two patients were NYHA class I-II, 15 patients were NYHA class II, 41 patients were NYHA class II-III, and 12 patients were NYHA class III. A total of 791 appropriately treated episodes of sustained ventricular tachycardia or ventricular fibrillation were observed in 70 patients. When these episodes were analyzed according to NYHA group, the frequency of ventricular arrhythmia episodes was higher in the Group B patient group (8.36±21.18 vs 25.33±27.63, p=0.019).

Conclusions: NYHA class III heart failure is an easily assessable clinical measure and an important risk factor for the need for ICD treatment of ventricular arrhythmias. The rate of benefit from ICD treatment is higher in patients in the NYHA class III group.

Keywords: Implantable Cardioverter Defibrillator, ventricular tachycardia, ventricular fibrillation, heart failure, NYHA

INTRODUCTION

Sudden cardiac death is an unexpected death due to a cardiac cause within one hour of symptom onset (1). Although its incidence has decreased with advances in diagnostic and treatment technologies, coronary artery disease remains the most common cause (1, 2). Following coronary artery disease, cardiomyopathies, arrhythmias, and valve diseases are other causes of sudden cardiac death (1, 2).

One of the major causes of sudden cardiac death is heart failure (HF) (3). The European Society of Cardiology Heart Failure Guideline recommends ICD implantation as a Class I recommendation for patients with a life expectancy of more than 1 year who have been receiving optimal medical therapy for more than 3 months, have an LV EF ≤ 35%, and are in NYHA Class II-III. It also recommends CRT as a Class I indication for patients with sinus rhythm, a QRS duration of 130-149 ms, and LBBB morphology with LV EF ≤ 35%. Furthermore, it recommends a Class IIb recommendation for CRT evaluation in patients with heart failure symptoms that have become apparent due to right ventricular (RV) pacing in those with an implanted ICD or pacemaker (4).

Other indications for ICDs for primary prevention, excluding HF, include patients with ischemic cardiomyopathy who have an EF ≤ 35% at least 40 days after myocardial infarction (MI) despite receiving optimal medical therapy; in these cases, an ICD is recommended as a Class I recommendation. In patients with prior MI and EF ≤40%, ICD is recommended as a Class I recommendation if ventricular tachycardia (VT) or ventricular fibrillation (VF) is observed during an electrophysiological study. In arrhythmogenic right ventricular dysplasia, if VT is observed and LV EF or RV EF is ≤35%, ICD is recommended as Class I (4). In hypertrophic cardiomyopathy, if VT is present, an ICD is recommended as a Class I recommendation, while if the 5-year predicted mortality rate is 6% or higher according to the scoring system based on risk factors for sudden cardiac death, an ICD is recommended, and if it is between 4% and 6%, a patient-based assessment for an ICD is recommended (4,5). Another indication for ICD is high-risk patients with Long QT syndrome who have inadequate response to beta-blocker therapy or intolerance to treatment (4). Another channelopathy to consider for ICD therapy

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is Brugada Syndrome, for which ICD is recommended as Class I in sustained ventricular arrhythmia.

Indications for ICD in secondary prevention after sudden death include VT without a reversible cause, hemodynamically unstable VT, and documented VF in patients with a life expectancy of more than one year (4).

The New York Heart Association (NYHA) classification is a classification used to assess functional capacity, disease severity, device indications, transplantation, and hospitalization in heart patients (6,7,8). NYHA Class I is the group with no symptoms in daily life and physical activity, Class II is the group that can perform daily activities but has limitations in physical activity, Group III is the group with severe limitations in physical activity and limitations in daily activities, while Group IV is the group with severe exertion even at rest in daily activities and unable to perform any physical activity (9).

The aim of this study is to evaluate the relationship between ICD episode frequency and functional capacity in patients classified according to the New York Heart Association (NYHA).

METHODS

Study Design and Settings

This is a retrospective study. The study was conducted at the arrhythmia clinic of a cardiovascular hospital.

Selection of the Participants

Seventy consecutive patients with complete data in the arrhythmia laboratory who had implantable cardioverter defibrillators implanted according to guideline recommendations between January 1998 and April 2004 were included in the study.

Measurements and Outcomes

Patients' implantable cardioverter defibrillator indications, demographic data, echocardiographic findings, medical treatments, and functional capacities were evaluated. The arrhythmia recordings of patients' defibrillator devices were examined.

Patients are grouped into Group A for those in NYHA classes I-II, II, and II-III, and Group B for those in Class III.

An episode of VT is defined as at least 8 consecutive ventricular beats, with a rate of 120-150 beats per minute for slow VT and 150-175 beats per minute for fast VT. A rate above 175 beats per minute is considered VF.

Statistical Analysis

The analysis was performed using SPSS Inc. (Statistical Package for the Social Sciences Incorporated) version 11.5. Quantitative data are presented as mean ± standard deviation, and qualitative data are presented as percentages. The Student's t-test was used for the comparison of parametric data, and the chi-square test was used for the comparison of nonparametric data. $p<0.05$ was considered statistically significant.

RESULTS

Seventy consecutive patients who received an ICD between January 1998 and April 2004 were studied. Sixty-three (90%) patients were male, and 7 (10%) were female. The mean age was 64.6±8.5 years.

Six patients had dual-chamber ICDs implanted, while 64 had single-chamber ICDs implanted. The reasons for dual-chamber implantation were: HV interval exceeding 100 ms in 3 patients, sinus node dysfunction in 2 patients, and atrial tachycardia attacks in 1 patient.

The mean follow-up period was 3.08±1.31 years. Sixty patients (85.7%) were alive, and 10 patients (14.3%) had died. When the deceased patients were examined, sudden arrhythmic death was the cause of death in 2 patients (20%), non-cardiac causes (cerebral event, respiratory arrest) in 2 (20%), and congestive heart failure in 6 (60%).

Regarding etiology, 53 (75.7%) patients had ischemic cardiomyopathy, 13 (18.6%) had dilated cardiomyopathy, and 4 (5.7%) had hypertrophic cardiomyopathy. The mean EF at the time of implantation was 34.7±6.5 (Table 1).

Table 1: Clinical characteristics of patients

Variables		N(%)
Gender	Male	63 (90)
	Female	7(10)
Age	64.68±8.57	
Etiology	Dilated CMP	13(18.6)
	Ischemic CMP	53(75.7)
	Hypertrophic CMP	4(5.7)
Indication	VT	54(77.1)
	VF	2(2.9)
	VT-VF	12(17.1)
	Polymorphic VT	2(2.9)
EF(%)	34.71±6.57	
Functional capacity	I-II	2(2.9)
	II	15(21.4)
	II-III	41(58.6)
	III	12(17.1)
Medications	Amiodarone	39(55.7)
	Beta Blocker	5(7.1)
	Amiodarone + Beta Blocker	26(37.1)

CMP: Cardiomyopathy, **VT:** Ventricular tachycardia, **VF:** Ventricular fibrillation.

NYHA Class I-II: 2 (2.9%) patients, Class II: 15 (21.4%), Class II-III: 41 (58.6%) patients, Class III: 12 (17.1%) patients were present. All patients had ventricular arrhythmia. Prior to implantation, the following antiarrhythmic conditions were present: sustained VT in 54 (77.1%) patients, VT and VF in 12 (17.1%) patients, VF in 2 (2.9%) patients, and polymorphic VT in 2 (2.9%) patients. During follow-up, 39 (55.7%) patients used amiodarone, 26 (37.1%) patients used beta-blockers and amiodarone together, and 5 (7.1%) patients used only beta-blockers (Table 1).

When patients in Group A (NYHA Class I-II, II, II-III) and Group B (NYHA Class III) were compared based on ventricular episode frequency, a statistically higher episode frequency was observed in Group B (8.36 ±21.18 vs 25.33±27.63, $p=0.017$) (Table 2). When looking at the groups individually, there were a total of 5 episodes (2.5 per patient) in 2 patients in Class I-II, a total of 113 episodes (7.53 per patient) in 15 patients in Class II, 41 patients in Class II-III had a total of 339 episodes (8.26 per patient), and 12 patients in Class III had a total of 334 episodes (27.83 per patient) (Table 3).

DISCUSSION

In this study evaluating patients with ICDs, ventricular arrhythmia episodes were most frequently observed in the NYHA class III group. This indicates that this group benefited the most.

Table 2: Comparison of clinical characteristics according to functional capacity

Variables	Group A (n=58)	Group B (n=12)	P value
Age	64.2±8.15	66.9±1.9	0.326
Etiology			
Dilated CMP	11	2	0.852
Ischemic CMP	47	10	
Indication			
VT	48	8	0.205
VF	10	4	
EF(%)	34.7±6.8	34.5±4.9	0.940
Ventricular Arrhythmia Episodes	8.36±21.18	25.33±27.63	0.019
Medications			
Amiodarone	32	8	0.301
Amiodarone + Beta Blocker	21	4	
Average follow-up period	3.08±1.31	3.08±1.01	>0.05

CMP: Cardiomyopathy, **VT:** Ventricular tachycardia, **VF:** Ventricular fibrillation. p<0.05 was considered statistically significant.

In a study published in 2025, the cumulative incidence of VT/VF during a 3-year follow-up of patients with ICDs was 28% in patients with LV EF ≤20%, 23% in those with LV EF 21–29%, and 20% in those with LV EF 30–35%. Patients with EF ≤20% showed a significant 23% increase in VT/VF risk and 31% more appropriate ICD shocks. Furthermore, patients with EF ≤20% had a significantly 1.5 times higher all-cause mortality compared to those with EF >20% (10). The Multicenter Automatic Defibrillator Implantation Trial II (MADIT-II) study showed that primary ICD implantation in patients with low LV EF reduced mortality by 34% at 8-year follow-up, demonstrating the long-term benefit of ICD implantation (11). Mehta et al., who again examined the relationship between EF and ICD, showed in their study that prognosis in patients with ICD is related to the degree of LV function (12).

Table 3: Comparison of ventricular tachyarrhythmia episode frequency according to functional capacity

	Average number of ventricular arrhythmia episodes per patient
Group A+ Grup B(n=70)	15.8±16.4
Group A (n=58)	8.36±21.18
Group B (n=12)	25.33±27.63
Class I-II (n=2)	2.5
Class II (n=15)	7.53
Class II-III (n=41)	8.26
Class III (n=12)	27.83

Group A: NYHA Class I-II, II, II-III, **Group B:** NYHA Class III

Functional classification provides meaningful information beyond LV EF. The degree of systolic dysfunction independently affects ventricular arrhythmogenesis (13). Whang et al. demonstrated that appropriate episodes for VT and VF were more frequent in patients with Class III heart failure who had an ICD (14). In advanced heart failure, in NYHA class IV patients, deaths are generally not arrhythmia-related but rather due to pump failure; therefore, ICD implantation is not recommended except in special circumstances (15). Furthermore, a study has shown that LV EF does not always correlate with functional capacity (13). Böcker et al. demonstrated in their study that functional capacity may be a better predictor than EF, finding that NYHA class II and III patients benefited more from ICD (16).

In our study, the ventricular episode frequency in patients with functional capacity Class III was higher than in other groups, consistent with the literature. When looking at functional capacity groups internally, it was observed that ICD episode frequency increased as functional capacity deteriorated.

In view of the limitations of our study, the most significant limitation is that new-generation heart failure medications were not available or in use during the period when our study was conducted. Another limitation is that our patients' clinical functional capacity was not assessed using a concrete measure such as the 6-minute walk test.

CONCLUSION

Functional capacity is a clinical classification that can be readily obtained from the medical history of patients with heart failure and can provide early information for easily predicting the future frequency of ventricular arrhythmia episodes in these patients. In addition, NYHA class III heart failure has been observed to be the treatment group with the highest incidence of ventricular arrhythmia episodes and the greatest response to ICD therapy.

Ethics Committee Approval: This study was conducted with the approval of the thesis approval committee of Dr. Siyami Ersek Training and Research Hospital for Thoracic and Cardiovascular Surgery (Number: E-28001928-929-298115744)

Informed Consent: Written informed consent has been obtained from patients during their initial admission to the hospital, indicating that their data may be used in studies.

Authorship Contributions: Concept – SS, AE ; Design – SS, AE; Supervision – AE ; Resource – SS, AE; Materials – SS, AE; Data collection &/or processing – SS, AE; Analysis &/or interpretation – SS, AE ; Literature search – SS, EP, ED, AE; Writing – SS, EP, ED, AE; Critical review – SS, EP, ED, AE.

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