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Comparing ICD shock ratios between Type 1, Type 2 and non diabetic patients

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ABSTRACT

Objective: The use of permanent pacemakers and implantable cardioverter defibrillators (ICDs) is increasing. With technological advances, the devices' implantation techniques and programmable features are improving, and indications are expanding. Several technical and clinical problems are encountered during implantation and follow-up of these devices.

Methods: Our study retrospectively evaluated diabetic and non-diabetic patients who underwent ICD implantation in Mersin University Cardiology Department between January 2010 and December 2013 according to current indications. All clinical characteristics, baseline, 1-month and 6-month follow-up pacemaker data and baseline laboratory values were recorded.

Results: A total of 106 ICD patients (57 diabetics and 49 nondiabetics) were enrolled at the 1st and 6th months of follow-up. 47.2% of the patients were male and the mean age was 56±7.3 years. ICDs were implanted for secondary prevention in 83.9% of patients. ICD was implanted for coronary artery disease +/- ventricular tachycardia (VT) or ventricular fibrillation (VF)+/- synchronization disorder. 75.4% of patients had CAD, and 89.6% had heart failure. The mean ejection fraction ratio (EF) was 31.3%. Early complications were observed in 10.3% of patients. 47.1% of patients received any treatment by the ICD, 34.9% had the appropriate shock, and 12.2% had inappropriate shock. The complication rate was 10.3%. While there was no difference in ventricular impedance and threshold values in diabetic patients compared to the control group, ventricular lead R amplitude values were found to be higher. The rate of atrial fibrillation was significantly different in the treated group. Treatment response was obtained in 71.4% of patients who underwent treatment change due to appropriate shock, incorrect shock and ATP.

Conclusion: In conclusion, the incidence of appropriate shock and anti-tachycardic pacing was higher in diabetic patients than non-diabetic patients.

Keywords: Diabetes, implantable cardioverter defibrillator

Research Article

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INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disease characterized by hyperglycemia caused by genetic and environmental causes, insufficient amount of insulin secreted from β-cells or insensitivity to insulin in peripheral tissue. The prevalence of DM is increasing worldwide and it is estimated that by 2030 the prevalence of diabetes will be 10% and the number of DM patients worldwide will be approximately 552 million. In our country, the prevalence of DM was determined as 7.2%. It has been calculated that there are 2.6 million DM patients in Turkey, and 0.8 million of them are unaware of their disease (1-3).

Diabetes is an important cardiovascular risk factor, and late mortality rates have increased in diabetic patients compared to non-diabetic patients due to comorbid conditions such as diabetic cardiomyopathy (DCP) autonomic neuropathy and endothelial dysfunction (4). Again, cardiac conduction defects are seen with increasing frequency due to cardiac autonomic neuropathy (CON) seen in DM in the community and accordingly, there is an increase in the need for permanent pacemakers in these patients (5).

The implantable cardioverter defibrillator (ICD) is a small electronic device that is currently implanted in patients at high risk for sudden cardiac death due to life-threatening ventricular arrhythmia (6,7). Defibrillators have recently been recognized as successful in preventing tachycardia with life-threatening ventricular arrhythmias and sudden cardiac death that cannot be adequately controlled with antiarrhythmic drugs (6). Defibrillator therapy reduces death from cardiovascular causes in patients with high-risk cardiovascular disease, ischemic heart disease, cardiomyopathy, congestive heart failure and new-onset ventricular arrhythmias (8).

Pacemaker-ICD implantation is an invasive procedure; some problems may occur early and late. In the early period, pneumothorax, hemothorax, arterial injury, hematoma, air embolism, arteriovenous fistula, brachial plexus injuries, perforation, electrode misplacement, electrode displacement, diaphragmatic stimulation can be seen in relation to venous intervention. In addition, problems related to the battery pocket such as hematoma and wound infections are detected. In the late period, problems such as venous thrombosis, skin erosion, Twiddler syndrome (battery rotation), battery displacement, electrode breakage, displacement, insulation defect and late perforation can be observed (8-12).

Apart from these technical problems, rhythm problems that develop during follow-up, sensing and stimulation problems of the device may cause the device not to work as programmed and may impair the patient's quality of life by causing inappropriate shocks, especially in patients with ICDs (13). Finally, data from recent studies have shown that apical stimulation of the right ventricle in patients with permanent pacemakers may cause heart failure (14).

For all the reasons mentioned above, patients with permanent pacemakers or ICDs are periodically checked in the pacemaker-ICD control outpatient clinic and necessary adjustments and treatment changes are made in line with the problems detected. For this purpose, pacemaker-ICD controls are regularly performed in the cardiology outpatient clinic in our hospital.

In our study, we aimed to determine whether there was a difference between appropriate and inappropriate shock rates in diabetic and non-diabetic patients with ICDs, to evaluate the factors affecting this difference and their effect on mortality rates, and to contribute to reducing mortality rates in diabetic patients with ICD implantation with appropriate treatment.

MATERIAL and METHODs

This study is a single-center and retrospective study. Before starting the study, approval was obtained from Mersin University Ethics Committee on August 22, 2013 with decision number 2013-283. This study included 106 patients who underwent implantable pacemaker implantation according to the current indication between January 1, 2010 and December 1, 2013 at Mersin University Cardiology Department.

Patients who volunteered for the study were questioned in terms of age, gender, smoking, presence of CAD, AF, DM, HT), CRF, and age, sex, and clinical evaluation, including hospital file documentation. Patients were divided into two groups: a patient group with DM and a control group without DM. Patients under 40 years of age, patients with acute coronary syndrome in the last 6 months, pregnant women, patients with severe liver and end-stage renal failure requiring dialysis, and patients with severe psychiatric disorders were excluded from the study. VVIR-ICD, DDD-R ICD, CRT-ICD pacemaker modes were included in the study.

Battery measurements of the patients included in the study were performed with ICS 3000 implant module programmable battery analyzers of Guidant, Biotronik and Medtronik and St.jude companies. During the 1st and 6th month routine battery checks, threshold, impedance, R wave amplitude measurements and the number of shocks and reasons for shocks at the 1st and 6th months were recorded. The baseline battery stimulus threshold was defined as the lowest voltage that produced 5 consecutive stimuli of 0.4 pulse width. Basal impedance was recorded as 400-1000 ohms (Ω) and R wave > 4 mV.

Hemoglobin, HbA1c level, and creatinine values were recorded from all patients included in the study.

Diabetic patients were defined as patients with an HbA1c value >6.5 and a previous diagnosis of type 1 or type 2 diabetes.The coronary artery patients included in the study were defined as patients with non-critical vessel stenoses (visible plaques and <70% stenosis in the LAD, <70% stenosis in the LAD, <50% stenosis in the CX and RCA) who had previously undergone stent implantation or coronary artery bypass graft surgery or who did not require intervention.

Echocardiographic evaluation was performed with an echocardiography-ultrasound device (Philips HD11 ultrasound system, Bothell, USA). Standard echocardiography was used to evaluate systolic myocardial function, wall motion, wall thickness, heart valves, left and right heart chambers. Left ventricular ejection fraction (LVEF) <50% was used for the diagnosis of heart failure.

In this study, ventricular threshold values, impedances, R wave amplitudes, number of ICD shocks and their causes were recorded in patients who underwent ICD implantation according to the current indication at Mersin University Cardiology Clinic at the 1st and 6th months after implantation. Patients who underwent ICD implantation were divided into two groups as diabetic (patient group) and non-diabetic (control group) and the number, type and response to treatment of the above-mentioned shocks were compared between the two groups.

Statistical Analysis

Kruskal-Wallis and Chi-square tests were used in the analysis of cross-tabulations to test the differences between the measurements of patients with and without DM at 1 and 6 months, and pairwise ratio comparisons were made for significant results. Categorical variables were summarized in numbers and percentages. Mean and standard deviation values are given as descriptive statistics. Analyses were obtained from MedCalc.13.02 program. $p<0.05$ was taken as statistical significance.

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RESULTs

A total of 106 ICD implanted patients were included in this retrospective study. The mean age of the patients was 56.8±7.3 years, 47.2% were male, and 52.8% were female. Of the patient population, 75.4% had ischemic CMP, 9.4% had nonischemic CMP, 1.8% had HCMP, 0.9% had long QT syndrome, 0.9% had Brugada syndrome, 9.4% had sudden cardiac death, and 0.9% had idiopathic VT. ICDs were implanted in 83.9% of these patients for secondary prevention and 16.1% for primary prevention. Descriptive statistics (mean and standard deviation) in diabetic and control groups are given in table 1.

Table 1: Characteristics of the patient and control groups

	DM group (n=57)	Control group (n=49)	p value
Age (years)	56.7±8.0	57.3±6.5	0.223
Gender (% female)	24 (42.1)	26 (53.0)	0.935
KAH	42 (73.6)	38 (77.5)	0.370
KBY	3 (5.2)	4 (8.1)	0.521
AF	22 (38.5)	15 (30.6)	0.654
HbA1c	7.4±1.0	6.0±0.4	***<0.001***
VVIR-ICD	30 (28.3)	37 (34.9)	0.595
DDD-ICD	15 (14.1)	15 (14.1)	0.370
KRT-D	6 (10.5)	3 (6.1)	0.632

There was no statistical difference between the mean age and gender distribution of the subjects in the patient and control groups (p>0.05). As expected, there was a statistically significant difference between the groups in HbA1c values (p<0.001). When both groups were evaluated regarding coronary artery disease and CRF, both diseases were statistically similar (p=0.3 and p=0.5, respectively). No statistically significant difference was observed when both groups were compared in terms of battery modes (p>0.05).

Time-dependent evaluation of battery measurements

Descriptive statistics (mean and standard deviation) of ventricular impedance measurements in the groups are given in table 2 and table 3.

Table 2: Comparison of ventricular impedance between groups.

Ventricular impedance	DM (+) (n=57)	DM (-) (n=49)	p value
Month 0	968.56±256.16	921.81±58.45	>0.05
Month 1	825.83±265.41	767.59±130.14	>0.05
Month 6	821.67±254.80	735.25±112.28	>0.05

Table 3: Time-dependent comparison of ventricular impedance

Comparison of dual impedance measurements	p value for pairwise comparisons	Interaction p value
0-1 month	***<0.001***	0.865
month	0.835	
0-6 month	<0.001	

According to table 2 and table 3, when the ventricular impedance parameter was analyzed, it was observed that the impedance values gradually decreased after implantation in the diabetes and control groups. When the impedance averages between the groups (with and without diabetes) were compared at month 0 (baseline), month 1 and month 6, the difference was not statistically significant (p= 0.278), but when all patients were evaluated regardless of whether they had diabetes or not, the differences between repeated measurements were found to be significant (p<0.001). When the differences were analyzed, the difference between the mean measurements at month 0 and month 1 was significant (p<0.001), and the differences between baseline measurements and measurements at month 6 were significant (p<0.001). When the interactions between the groups were analyzed, the diabetes interaction was not significant. In other words, the differences observed between diabetics and non-diabetics in terms of averages do not differ according to time or the differences observed between repeated measurements do not change according to diabetes or not.

Descriptive statistics (mean and standard deviation) of ventricular threshold measurements in the groups are given in table 4 and table 5.

Table 4. Comparison of ventricular threshold value between groups

Ventricular threshold	DM (+) (n=57)	DM (-) (n=49)	P value
After implantation (month zero)	0.56±0.22	0.53 ± 0.22	>0.05
1st month	0.58±0.18	0.61 ± 0.12	>0.05
6th month	0.59±0.21	0.74 ± 1.03	>0.05

Table 5. Time-dependent comparison of the ventricular threshold value

Comparison of binary threshold measurements	P value for pairwise comparisons	Interaction P value
0-1 month	>0.05	0.674
1-6 month	>0.05	
0-6 month	>0.05	

When ventricular threshold values were analyzed, it was found that ventricular threshold values gradually increased after the 0th month in the DM group and the control group. However, no statistically significant difference was found between the diabetic and the control groups regarding threshold values (p=0.325). Again, when repeated measurements were evaluated, no significant difference was found in the comparison of month 0, month 1 and month 6 (p=0.6). When the interaction between the groups was analyzed, the diabetes interaction was not significant (p=0.674).

Table 6: R amplitude evaluation

R amplitude	DM (+) (n=57)	DM (-) (n=49)	P value
0. month	10.01 ± 3.09	8.74 ± 1.32	**0.032**

When only the baseline R amplitude values of the diabetic and control groups were compared regardless of repeated measurements, the baseline R amplitude values were found to be higher in the diabetic group than in the control group. There was a statistically significant difference between the groups (p= 0.032).

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Implantable Cardioverter Defibrillator Implantation Information

The brands of the ICD devices implanted in the patients and the number of chambers of the devices are given in Table 10. 67 (63.2%) patients received a single-chamber ICD, 30 (28.3%) patients received a two-chamber ICD and 9 (8.4%) patients received a three-chamber (CRT-D) ICD.

Early complication information

Early complications related to device implantation are given in Table 8. In total, 11 (10.3%) patients developed early complications, and 3 (2.8%) of them required early revision. The reasons for revision were hematoma in two patients and electrode dysfunction in one patient.

Evaluation of Treatments Administered by Implantable Cardioverter-Defibrillators

The treatments administered to the patients by the ICD are given in table 9. Treatment distributions according to device modes are given in 10.

Appropriate shock was present in a total of 37 patients, and the rate of any ICD therapy was higher in the diabetic group and this difference was statistically significant (22% vs. 12% p=0.043). Among thirty-seven patients, appropriate shock occurred in 16 patients due to VT and 11 patients due to VF. No change was made in 14 patients who received an appropriate shock, only ICD program change was made in 8 patients, only drug change was made in 7 patients, both drug change and ICD program change were made in 7 patients, and VT ablation was performed in 1 patient in an external center.

Appropriate shock and false shock were present in 37 and 13 patients, respectively, and VVIR mode ICD was present in 27 of the appropriate shocks and 9 of the false shocks. Compared to other ICD modes, VVIR ICD mode had a higher proportion of appropriate and erroneous shocks and this difference was statistically significant (28% vs. 14% vs. 4% p=0.025, p=0.044).

Erroneous shock was present in 13 patients and was observed in 6 patients due to atrial fibrillation, 1 patient due to atrial tachycardia, 2 patients due to oversensing, 2 patients due to SVT, 2 patients due to sinus tachycardia and 1 patient due to parasite. No treatment was applied to 5 of these patients, 6 received only medication change and 2 received ICD program change (Table 12). Recurrent false shocks were observed in only 2 patients after these treatments.

The comparison of patients who received any of the therapies administered by the ICD and patients who did not receive any therapy by the ICD is given in Table 11. In terms of demographic characteristics, risk factors, ICD indications, EFs, ICD modes and follow-up periods, there was no difference between patients who received any treatment and those who did not. Patients with atrial fibrillation were significantly more likely to receive any treatment (p=0.04).

The response rates to the treatments applied by ICD are given in Table 13 according to the type of treatment. A total of 28 patients underwent treatment changes, 8 of whom did not respond to the treatment, and 20 of whom either completely recovered from the shocks or their frequency decreased with the treatment changes.

Table 7: Distribution of device brands and modes

DEVICE BRAND	TOTAL n=106	Single chamber VVIR ICD	Two chambers DDD-R ICD	Three chambers CRT-D ICD
Guidant n%	8 (7.5)	6 (5.6)	2 (1.8)	
Medtronic n%	47 (44.3)	33 (31.1)	9 (8.4)	5 (4.7)
St. Jude n%	6 (5.6)	3 (2.8)	3 (2.8)	
Biotronik n%	45 (42.4)	25 (23.5)	16 (15.0)	4 (3.7)

Table 8: Early complications

	Number of patients (n=106)	Percentage %
Pneumothorax	3	2.8
Hemothorax	0	0
Perforation	2	1.8
Dislodgement	1	0.94
Diaphragmatic stimulation	1	0.94
Hematoma	4	3.7
Total	11	10.3
Revision requirement	3	2.8

Table 9: Detailed distribution of shock treatments administered by ICD during follow-up. (ATP:antitachycardic pacing).

	Number of patients (n=106)	Percentage %	DM (+)	DM (-)	P value
Any shock field	50	47.1	32 (30.1)	18 (16.9)	***0.033***
No treatment Non-taking	56	52.9	25 (23.5)	31 (29.2)	0.85
***Subset of treatmentsgroup* distribution**					
Total eligible shock	37	34.9	24 (22.6)	13 (12.3)	***0.043***
Total faulty shock	13	12.2	8 (7.5)	5 (4.7)	0.063
Total ATP	33	31.1	21 (19.8)	12 (11.3)	***0.048***
Treatment types Detailed breakdown					
In the same patient ATP only	3	2.7	2 (1.8)	1 (0.9)	0.61
In the same patient just the right shock	6	5.6	4 (3.7)	2 (1.8)	0.62
In the same patient only erroneous shock	10	9.4	6 (5.6)	4 (3.7)	0.54
ATP + appropriate shock	28	26.4	18 (16.9)	10 (9.4)	0.78
ATP+ false shock+Appropriate shock	2	1.8	1 (0.9)	1 (0.9)	0.09
Erroneous shock + appropriate shock	1	0.9	1 (0.9)	0	0.32

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Table 10: Distribution of Shock Treatments Received by Patients in Follow-up According to ICD Modes

	Total (n=106)	VVIR n=67	DDD-R n=30	KRT-D n=9	p value
Any Shock field	50 (47.9)	30 (28.3)	15 (14.1)	5 (4.7)	***0.036***
No treatment Non-taking	56 (52.1)	37 (34.9)	15 (14.1)	4 (3.7)	***0.042***
***Subset of treatments group* distribution**					
Total eligible shock	37	27 (25.4)	5 (4.7)	5 (4.7)	***0.025***
Total faulty shock	13	9 (8.4)	3 (2.8)	1 (0.9)	0.064
Total ATP	33	21 (19.8)	6 (5.6)	6 (5.6)	0.056
Treatment types Detailed breakdown					
In the same patient ATP only	3 (2.8)	2 (1.8)	1 (0.9)	0	0.85
In the same patient just the right shock	6 (5.6)	4 (3.7)	1 (0.9)	1 (0.9)	0.64
In the same patient only erroneous shock	10 (9.4)	5 (4.7)	3 (2.8)	2 (1.8)	0.054
ATP + appropriate shock	28 (26.4)	17 (16)	9 (8.4)	2 (1.8)	***0.032***
ATP+ false shock+Appropriate shock	2 (1.8)	1 (0.9)	1 (0.9)		0.34
Erroneous shock + appropriate shock	1(0.9)	1 (0.9)	0	0	0.11

Table 11: Comparison of Patients Receiving Any of the Shock Treatments and Patients Receiving None of t Treatments

	Those receiving any of the treatments n= 50	Treatments those who take none n=56	p value
Age (average)	58.8	56.7	0.87
EF (average) %	31.2	31.4	0.86
Ischemic kmp n %	34	36	0.76
Nonischemic CMP	11	16	0.64
Brugada	1	0	0.25
Hypertrophic CMP	1	2	0.26
ARVD n	1	0	0.25
Long QT syndromen %	1	0	0.25
Idiopathic VT	1	2	0.26
Primary protection n%	8	9	0.28
Secondary protection n %	42	47	0.27
VVI n %	30	37	0.48
DDD n %	15	5	0.36
CRT n %	5	4	0.42
Male gender n %	38	42	0.09
Female gender n %	12	14	0.08
Hypertension n %	27	28	0.49
Diabetes mellitus n %	32	25	0.48
Cigarette n%	18	21	0.56
Coronary Artery Disease n %	39	41	0.78
COPD n %	8	6	0.14
Chronic renal failure n %	3	2	0.24
Atrial fibrillation	24	13	0.043
Functional capacity			
NYHA I	12	14	0.87
NYHA ii	20	28	0.65
NYHA ii	18	14	0.98

Table 12: Program and Treatment Changes Following the Treatments Implemented by ICD

	No change in treatment n=22	ICD program change n=11	Addition of medication n=14	Medicines and ICD program change n=2	VT ablatior n=1	AV node ablation n=0	Total n = 50
ATP only patients undergoing	2	0	1	0	0	0	3
Just the right shock Patients	3	1	1	0	1	0	6
Simply false shock Patients	4	3	2	1	0	0	10
ATP + appropriate shock Patients	13	6	8	1	0	0	28
ATP appropriate shock inaccurate shock patients	0	1	1	0	0	0	2
Suitable+ erroneous shoc patients	0	0	1	0	0	0	1

Table 13: Response to treatment change

	Change of treatment Patient made Number of	Patient with response Number of	%Percent
ATP only patients undergoing	1	1	100
Just the right shock Patients	3	2	66.6
Only faulty shock Patients	6	4	66.6
ATP + appropriate shock Patients	15	11	73.3
ATP+appropriate shock+inaccurate shock patients	2	1	50
Suitable + erroneous shock patients	1	1	100
Total	28	20	71.4

ATP: antitachycardic pacing

DISCUSSION

Diabetes is now recognized as a major risk factor for the development of cardiovascular disease and is a major cause of mortality with increasing age. Although CAD, cardiomyopathy and left ventricular hypertrophy are the most common cardiovascular complications in patients with diabetes, cardiac conduction disorders, which are seen with increasing frequency in the elderly population, stand out (15).

The etiologic factors in the development of cardiac conduction system defects in diabetic patients have not yet been definitively established. Although ischemic heart diseases are estimated to be more prominent in the etiology, microangiopathy and increased cholinergic activity may play a role (16).

In clinical and experimental studies on the effect of diabetes on the cardiovascular system, it is known that diabetes causes cardiac dysfunction due to myocardial fibrosis in the chronic period (17). In a study on diabetic rats, it was shown that Transforming Growth Factor β1 (TGF- β1) increased in the left ventricle with the possible effect of hyperinsulinemia and hyperglycemia and this caused cardiac fibrosis (18).

In another study conducted to show the effect of diabetes on myocardial tissue, myocardial tissue sections taken from diabetic dead rats were examined pathologically and it was found that myocardial necrosis and fibrosis developed biventricularly, but fibrosis in the right ventricle was higher than in the left ventricle (19).

In a retrospective study published by Mohaved MR et al. in 2005, it was found that diabetes caused a defect in the cardiac conduction system, and multiple analyses showed that the relationship between AV complete block and diabetes was independent of CAD or congestive heart failure (15). Although the reason for the association between diabetes and atrioventricular (AV) complete block is not known exactly, it is thought that KON and metabolic disorders, one of the most important complications of diabetes, may explain this association. Cardiac autonomic neuropathy is one of the most feared cardiovascular complications of diabetes, affecting the sympathetic and parasympathetic nervous system, causing heart rate variability, orthostotic hypotension, silent ischemia and fatal cardiac arrhythmias that can result in sudden cardiac death (15-23).

This is the first symptom in approximately 30% of patients who develop sudden cardiac death. Coronary artery disease (CAD) is the cause of 75% of sudden cardiac death (24-25). The underlying mechanism in these deaths is known to be ventricular malignant arrhythmias in 80-90% (26). However, very few patients with sudden cardiac death have the chance to respond to resuscitation, and this rate has been found to be a maximum of 3% even in regions with the best health conditions (27). It is known that malignant arrhythmias that cause sudden cardiac death in all patient populations are usually episodes of ventricular tachycardia that degenerate into ventricular fibrillation (VF) (28). If these patients are not treated appropriately, the arrhythmias' recurrence rate has been high. It is also a known fact that approximately half of these patients die within 2 years if not treated appropriately. Therefore, ICD implantation, especially for secondary prevention, is of vital importance in this patient group. Although there are many studies demonstrating that defibrillator implantation reduces long-term mortality, particularly in patients with low left ventricular ejection fraction (LV-EF), there are also studies indicating that its effectiveness is limited. In this context, the general opinion that emerged as a result of clinical trials in this context is that patients implanted with ICDs have been found to reduce arrhythmia-related mortality by up to 50% compared to patients receiving medical treatment (MADIT 1 trial). In the multicenter automatic defibrillator implantation trial (MADIT 1), 196 patients with a history of myocardial infarction, left ventricular stroke volume <35% and no sustained VT were included. Patients were randomized to medical therapy and ICD groups and after approximately 30 months of follow-up, a 54% relative risk reduction was found in the ICD group. In the MADIT-2 study, 1232 patients with LVEF of 30% or less were followed up for 20 months regardless of whether they had sustained or discontinuous VT episodes, resulting in a 31% risk reduction in the ICD group (29). In a similar study, the multicenter unsustained tachycardia trial (MUSTT), 1651 patients with a history of myocardial infarction and inducible ventricular tachycardia detected by the electrophysiologic study were divided into ICD and drug arms and after 5 years of follow-up, arrhythmic mortality was reduced by 37% to 9% in the ICD implanted group compared to the group receiving medical therapy. On the other hand, there are studies in which the benefit of ICD implantation is limited. For example, in the Coronary artery bypass graft patch (CABG-PATCH) study of bypassed patients, no benefit of ICD implantation was found in patients with LVEF >35%. In addition, in the defibrillators in acute myocardial infarction trial (DINAMIT), 674 patients with new myocardial infarction and increased mean heart rate were included, and as a result of the study, arrhythmic deaths decreased in the ICD group, but no reduction in total mortality was detected (30).

In our study, 56.7% of the patients implanted with defibrillators were male, mean age was 56.3±7 years, heart failure rate was 89.3%, CAD rate was 74.5%, and mean EF was 31%. ICD was implanted in most of our patients for secondary prevention. The characteristics of our patient population are similar to those of secondary prevention studies. In the AVID study, similar to our patients, the mean age of the patients was 65 years, and the mean EF was 31% (31). Again in the CIDS study, the mean age was 64 years, and the mean EF was 33%. In the Medicare system analysis of more than thirty thousand ICD patients, heart failure was found in approximately 60% of patients (32). In meta-analyses of the AVID, CIDS, CASH studies, 80% of patients were male and 70% had CAD (33). In the Evaluation Medico-Economique du Defibrillateur Automatique Implantable (EVADEF) study in France, which followed 2296 ICD patients, the rate of ischemic CMP was 57%, nonischemic CMP 18%, other cardiomyopathies 12%, idiopathic VF or unknown CMP in 6%.

In our study, 83.9% of ICDs were implanted for secondary prevention, and only 16.1% of patients received an ICD for primary prevention. The rate of ICD implantation for primary prevention was 18% in the EVADEF study. The slightly low rate of primary prevention in our study may be explained by the fact that, considering the economic conditions of our country, we, like many physicians, avoid ICD implantation for primary prevention because it would require implantation in a large number of patients and cause a high financial burden, and the reimbursement system excludes most patients who are candidates for primary prevention. The most common indication for ICD implantation was CAD+/- VT or VF +/- desynchronization, and 80 (75.4%) patients underwent ICD implantation for this indication. This rate was found to be between 73-83% in secondary prevention studies in the literature and is consistent with the rates in our study (34-36).

So far, no study has investigated the effects of diabetes on threshold, impedance and number of shocks together. In the inhibition of Unnecessary RV pacing with AV search hysteresis in ICDs iNTRiNSiC RV trial conducted in 2010, diabetes was found to be associated with decreased false shocks in the elderly, but no association was found between false shocks and mortality. The Influence of Diabetes Mellitus on Inappropriate and Appropriate Implantable Cardioverter-Defibrillator Therapy and Mortality in the Multicenter Automatic Defibrillator Implantation Trial-Reduce Inappropriate Therapy- MADIT-RIT Trial, conducted in June 2013, investigated the effect of innovative ICD programming on inappropriate shocks, the effect of diabetes on appropriate and inappropriate shocks, and the effect of this appropriate and inappropriate shock therapy on mortality risk in diabetic and non-diabetic patients. In this study, patients were divided into two arms, diabetic and non-diabetic, and then into three arms in terms of ICD programming. The first one, arm A, was the traditional programming and was programmed to generate ATP and shock after a 2.5 s delay with a first zone at heart rates of 170-199. The second zone was programmed for ATP or shock after a 1 s delay when the heart rate was >200. The second group B arm was programmed for high cut off -high cut off programming with the first zone monitoring between 170-199 heart rates in the first zone and ATP and shock after a 2.5 s delay when the heart rate was >200. The third arm, arm C, was programmed to give ATP or shock with a delay of 60 s before treatment in the first zone when the heart rate was >170, 12 s in the second zone when the heart rate was >200, and 2.5 s in the third zone when the heart rate was >250. In conclusion, in this study, programming in arms B and C was associated with reduced false shock in both diabetic and non-diabetic patients. However, there was no difference in programming between diabetic and non-diabetic patients. We also found that false ATPs due to SVT and sinus tachycardia were significantly reduced in diabetic patients compared to non-diabetic

patients. In contrast, the two groups had similar false shocks due to atrial fibrillation. In the same study, the rate of appropriate shock was found to be increased in patients with diabetes, which is supported by two previous studies (37-39).

In our study, 24 appropriate shocks were detected in diabetic patients and 13 appropriate shocks were detected in non-diabetic patients and this difference was found to be consistent with those in the literature (p=0.043). In the literature, erroneous shocks were found to be less in diabetic patients, but in our study, the rate of erroneous shocks did not show statistical significance in diabetic patients (p=0.063). Again, basal R amplitude was found to be higher in diabetic patients compared to non-diabetic patients, suggesting that appropriate shocks may be associated with higher R amplitude, but this difference was not statistically significant, and the mean R amplitude was above 8 mv in both groups. It has also been reported in the literature that inappropriate shocks due to T wave oversensing are seen in patients with low R amplitude <3 mv rather than high R amplitude (39). The increased risk of appropriate shocks in diabetic patients may be explained by myocardial fibrosis, ischemia and scar tissue sensitized by scar tissue, decreased autonomic dysfunction and decreased coronary circulation, which may predispose to ventricular arrhythmia (36-38).

This study compared pacemaker parameters and shock rates in diabetic and non-diabetic patients. In the future, large-scale studies are needed to investigate the relationship between diabetes and these parameters in more detail. Our biggest limitation in our study was the insufficient number of patients. In addition to being a retrospective study, the limited follow-up period was another limitation. Our other limitation in the study was the inadequate recording of the medications used by the patients and the inability to evaluate them and to compare the effect of the adverse effects of the drugs on the shock rates that may occur. We could not form a pure control group in our study because of the presence of other comorbidities, although not diabetes, in patients who underwent defibrillator application. This was another limitation of our study. Apart from these, since there may be other additional measurements and factors that may affect these results seen in the diabetic patient population, this is also counted among the limitations.

CONCLUSION

The rate of appropriate shock was higher in diabetic patients compared to non-diabetic patients. 47.1% of the patients received any treatment by ICD and 34.9% of the patients had an appropriate shock and 12.2% had an inappropriate shock. The recurrence of appropriate and inappropriate shocks can be significantly reduced by medication changes and/or ICD program changes and/or interventional methods. Patients with AF, long follow-up and frequent hospitalization history seem to be more likely to receive any treatment.

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