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Effects of obesity on arrhythmic events and survival in patients with an implantable cardioverter defibrillator

Background — Studies have shown that increased body weight and obesity may be associated with an increased risk of arrhythmic events. The aim of this study was to evaluate the effect of obesity on the risk of arrhythmic events, hospitalization, and death in patients who received implantable cardioverter defibrillator (ICD) therapy for primary or secondary prevention.

Material and Methods — A single-center, prospective, observational study was conducted. Patients with body mass index (BMI) <30 kg/m^2 were classified as non-obese, and patients with BMI ≥30 kg/m^2 were classified as obese. The primary endpoints were arrhythmic events and device interventions. The secondary endpoints were all-cause mortality, cardiac mortality, cardiac rehospitalization, and a composite endpoint of mortality and hospitalization.

Results — Among a total of 340 patients, 78.2% were male, and 22.1% were obese. The mean age was 60.9 yrs. Ventricular tachycardia (VT) was more frequent in non-obese patients (HR 0.57, [CI] 0.38–0.87, p=0.009). All-cause mortality and cardiac mortality in all patients tended to be more frequent in non-obese (HR 2.71, [CI] 0.93–7.93, p= 0.069 for all-cause mortality; HR 3.29, [CI] 0.97–11.17, p=0.056 for cardiac mortality). In the subgroup analysis, VT, all-cause mortality, and cardiac mortality were more common for non-obese patients in primary prevention and ischemic heart failure (HF) groups.

Conclusion — While VT was more frequent in non-obese patients, VF, ICD appropriate shock, inappropriate shock, and antitachycardia pacing were similar in obese and non-obese patients. All-cause mortality and cardiac mortality were more frequent in non-obese patients.

Keywords — Obesity; Implantable Cardioverter Defibrillator; arrhythmia

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Introduction

With the increase in the indications for implantable cardioverter-defibrillator (ICD), the possibility of arrhythmic events in treated patients with different demographic characteristics have increased. In a study conducted by Samanta et al. of ICD patients with ischemic heart failure (HF), ventricular arrhythmia recurrence and death occurred less frequently in obese patients, while a trend towards increased mortality was observed in normal-weight patients [1]. In a retrospective analysis of ICD patients with non-ischemic cardiomyopathy (CMP), overweight and obesity were protective against mortality as compared with underweight and normal weight patients, but these conditions had only a neutral effect on risk of ventricular arrhythmias [2].

The adverse effects of obesity on cardiovascular risk factors, such as hypertension, left ventricular hypertrophy, dyslipidemia, diabetes mellitus, and metabolic syndrome, are known [3]. Zacharias et al. showed that left ventricular hypertrophy, QT length, and heart rate variability increased in obese individuals [4]. It is known that obesity causes fatty infiltration and degeneration of the conduction system, and, therefore, obesity increases arrhythmias, especially atrial fibrillation (AF). Thus, obese patients are at risk of sudden cardiac death (SCD) [5]. However, in a study conducted in patients with ICD, a low body mass index (BMI) was found to be associated with mortality [6]. In addition, a subgroup analysis of the MADIT-II population of obese patients found independent inverse relationships between obesity and all-cause mortality and between obesity and SCD [7].

The primary endpoint of the current study was to compare arrhythmic events and device interventions in obese and non-obese ICD patients. Secondary endpoints were all-cause death, cardiac mortality, cardiac rehospitalization, and cardiac rehospitalization in obese and non-obese ICD patients.

Material and methods

Study Population

The study was prospective, observational, and single center. Patients aged 18 yrs and over who underwent ICD or cardiac resynchronization therapy (CRT) implantation for

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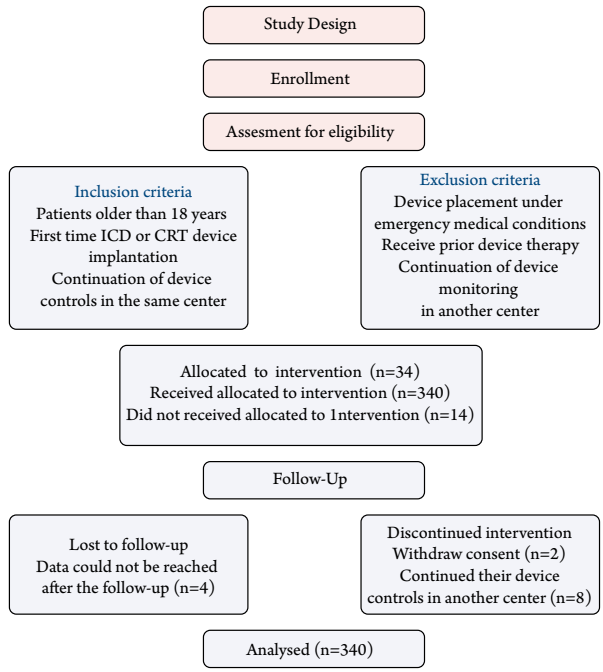
primary or secondary prevention and who were followed-up in the same cardiology clinic were included in the study. Medtronic ICD and CRT devices were used in the study. All patients underwent device implantation for the first time.

At the first monitoring, which was performed within 1 mo after implantation, the study consent form was signed and the necessary information for the study was collected. The first patient was included in the study on September 2017, and the study end date was January 2020. Data of 340 of the 354 patients included in the study were analyzed. Patients who did not give written consent or who were continuing their follow-up at another center were not included in the study. Inclusion criteria were receiving implantable device therapy with ICD shock and antitachycardia pacing (ATP) features, being over 18 yrs of age, and continuing device monitoring at a single center. Exclusion criteria were device placement under emergency medical conditions, receiving prior device therapy, and continuing device monitoring at another center. The flowchart of the research protocol is shown in Figure 1.

Figure 1. Flowchart of patient selection and the research protocol



ICD: Implantable cardioverter defibrillator,
CRT: Cardiac resynchronization therapy.

Definitions and Endpoints

Weight and height measurements were obtained from the patients after enrolling in the study. For analysis of primary and secondary endpoints, the patients were classified as non-obese (BMI <30 kg/m^2) or obese (BMI≥30 kg/m^2).

Appropriate ICD shocks were defined as shock therapy for ventricular tachycardia (VT) and ventricular fibrillation (VF) with the potential to cause hemodynamic instability. Inappropriate ICD shocks were defined as shocks for supraventricular tachycardias including atrial fibrillation, T wave oversensing, atrial far-field sensing, double or triple sensing of the ventricular signal, myopotentials (diaphragm, pectoral muscle, etc.), lead or connector malfunctions, and electromagnetic interference.

Patients in the combined population (n=340) were assessed with respect to the following features: demographic data, biochemistry data, device indication, device features (single chamber, double chamber, biventricular), physical capacity (NYHA), physical activity intensity (International Physical Activity Survey (low-level activity, less than 600 MET-min/week, more than medium-level activity, 600 MET-min/week), admission to hospital or emergency unit, ECG, echocardiography, comorbid diseases, social support, economic income, educational status, medical treatment, and compliance with treatment. Device monitoring was performed every 6 mos after the first monitoring, except for emergency applications. After the first check, the following device data was collected at each subsequent check: supraventricular and ventricular arrhythmias, and appropriate-inappropriate ICD shock and ATP. Mortality and rehospitalization data were obtained from hospital records or from patients or from their relatives. The differences in patient characteristics between obese and non-obese patients were examined, first in the primary and secondary prevention groups, and then in the ischemic heart failure and in the non-ischemic cardiomyopathy groups.

The primary endpoints of this study were comparisons of arrhythmic events (VT, and VF) and device interventions (appropriate shock, inappropriate shock, and ATP) in obese and non-obese ICD patients. Secondary endpoints were individual all-cause death, cardiac mortality, cardiac rehospitalization, and the composite endpoint all-cause mortality or cardiac mortality or cardiac rehospitalization in obese and non-obese ICD patients. In the subgroup analysis, obese and non-obese primary and secondary prevention patients were compared first, then followed by obese and non-obese ischemic HF patients. Non-ischemic CMP patients were compared for primary and secondary endpoints.

Statistical Analysis

Baseline characteristics by the prespecified BMI categories were compared using the chi-square test and the Fisher exact test when appropriate. Student t-tests were used to compare the means of parametric groups with two continuous data sets and to determine the significance of mean differences. Mann–Whitney U tests were used to compare the means of nonparametric groups with two

Table 1. Characteristics of obese and non-obese patients who have an ICD for primary and secondary prevention

Patient characteristics	Primary prevention (306)			Secondary prevention (34)		
	Obese (240)	Non-obese (66)	p value	Obese (25)	Non-obese (9)	p value
Age, yrs	59.8	62.7	0.2	65.4	64.3	0.9
Gender (male), %	80.4	78.8	0.7	52	88.9	0.1
ICD mod (DDD), %	44.8	28.1	0.05*	48	44.4	1
Hospitalization in the past year, %	31.7	33.3	0.9	32	44.4	0.7
Emergency Unit admission in the past year, %	41.7	37.9	0.7	44	44.4	1
Functional capacity (>NYHA-II), %	25.8	34.8	0.1	32	44.4	0.7
Physical activity (600-3000 MET-min/week), %	27.9	25.8	0.9	28	11.1	0.4
ECG, SR, %	82.1	68.2	0.016*	66.7	66.7	1
ECG QRS (≥130), %	35	28.8	0.7	44	44.4	1
HT, %	53.8	77.3	0.001*	80	100	0.3
DM, %	33.3	53	0.003*	32	55.6	0.3
COPD, %	12.9	25.8	0.01*	24	11.1	0.6
Malignancy, %	6.3	1.5	0.2	4	11	0.5
CVD, %	4.2	15.2	0.003*	8	33.3	0.1
AF, %	26.7	43.9	0.007*	36	66.7	0.1
CRF, %	19.6	27.3	0.2	24	33.3	0.7
Hyperlipidemia, %	50.4	51.5	0.9	52	55.6	1
Active smoking, %	13.3	21.2	0.1	100	100	1
Active alcohol drinker, %	10.8	16.7	0.2	4	11.1	0.5
Social support (living with family), %	91.3	90.9	0.9	80	100	0.3
High income (>7500 TL)	10.8	6.1	0.6	24	33.3	0.7
Education (graduate and higher), %	15.8	18.2	0.08	8	11.1	1
Sacubitril valsartan, %	3.8	3	0.8	0	11.1	0.3
ACEI/ARB, %	73.3	84.8	0.05*	96	88.9	0.5
BB, %	94.6	93.9	0.8	88	100	0.6
MRA, %	39.2	51.5	0.07	24	44.4	0.4
Loop diuretic, %	60.8	78.8	0.007*	52	88.9	0.1
CCB, %	10	18.2	0.07	8	33.3	0.1
Statin, %	53.8	47	0.3	48	55.6	1
Amiodarone, %	11.3	18.2	0.1	36	22.2	0.7
Anticoagulant, %	25.5	40.9	0.01*	50	71.4	0.6
Noncompliance with medication, %	7.9	9.1	0.7	8	0	1
EF, %	34	33.2	0.7	51	38	0.2
LVED diameter, (mm)	57.8	58.6	0.5	54	53.8	1
LVES diameter (mm)	45.5	46.9	0.4	39.5	40.9	1
RV disfunction, %	27.5	28.8	0.8	12	11.1	1
HGB, (g/dl)	13.3	13.5	0.5	12.8	13.4	0.9
GFR, (ml/min/1.73 m^2)	79.9	76.5	0.5	75.3	81	1
proBNP, (pg/ml)	2715	2010	0.9	1840	1767	0.7
Troponin, (pg/ml)	53.3	46.7	0.3	20	19	1
CK-MB, (U/l)	22.2	23.4	0.2	19	19	1
LDL, (mg/dl)	107.9	102.7	0.2	104	89	0.2
Glucose, (mg/dl)	115.6	118.2	0.8	121	116	0.9

AF, Atrial fibrillation; ACEI/ARB, Angiotensin converting enzyme inhibitor / angiotensin receptor blocker; BB, Beta blocker, CCB, Calcium channel blocker; CVD, Cerebrovascular disease; COPD, Chronic obstructive pulmonary disease; CK-MB, Creatine kinase myocardial band; CRF, Chronic renal failure; DM, Diabetes mellitus; ECG, Electrocardiography; EF, Ejection fraction; GFR, Glomerular filtration rate; HGB, Hemoglobin; ICD, Implantable cardioverter defibrillator; LDL, Low density lipoprotein; LVED, Left ventricular end diastolic; LVES left ventricular end systolic; MET, Metabolic equivalent; MRI, Mineralocorticoid receptor inhibitor; NYHA, New York Heart Association; pro-BNP, pro brain natriuretic peptide; RV, Right ventricle; SR, Sinus rhythm; TL, Turkish Lira.

continuous data sets and to determine the significant of medium differences.

The Cox proportional-hazards regression model was used to evaluate the independent contribution of obesity to the endpoints. Kaplan-Meier estimates for endpoints, stratified by obesity category, were determined, and statistically evaluated with the log-rank test. The results were evaluated at a 95% confidence interval, and the statistical

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Table 2. Characteristics of obese and non-obese patients receiving ICD therapy for ischemic HF and non-ischemic CMP

Patient characteristics	Ischemic HF (187)			Non-Ischemic CMP(119)		
	Non-obese (151)	Obese (36)	p value	Non-obese (89)	Obese (30)	p value
Age (yrs)	65.5	66.6	0.6	50.2	58	0.008*
Gender (male) %	83.4	83.3	1	75.3	73.3	0.8
ICD mod (DDD), %	41.1	27.8	0.1	51.7	30	0.04*
Hospitalization in the past year, %	36.4	38.9	0.8	23.6	26.7	0.7
Emergency Unit admission in the past year, %	47	44.4	0.8	32.6	30	0.8
Functional capacity (>NYHA-II), %	31.1	50	0.03*	16.9	16.7	1
Physical activity (600-3000 MET-min/week), %	20.5	16.7	0.6	40.4	36.7	0.7
ECG, SR, %	78.8	63.9	0.09	87.6	73.3	0.08
ECG QRS (≥130), %	37.1	30.6	0.7	31.5	26.7	0.6
HT, %	63.6	80.6	0.05*	37.1	73.3	0.01*
DM, %	44.4	72.2	0.03*	14.6	30	0.06
COPD, %	17.2	25	0.3	5.6	26.7	0.04*
Malignancy, %	8.6	2.8	0.3	2.2	0	1
CVD, %	4.6	13.9	0.06	3.4	16.7	0.02*
AF, %	32.5	41.7	0.3	16.9	46.7	0.01*
CRF, %	25.8	50	0.05*	9	0	0.2
Hyperlipidemia, %	68.9	77.8	0.3	19.1	20	0.9
Active smoking, %	14.6	19.4	0.7	11.2	23.3	0.2
Active alcohol drinker, %	11.9	11.1	1	9	23.3	0.06
Social support (living with family), %	90.1	86.1	0.6	93.3	96.7	0.7
High income	13.9	11.1	0.9	5.6	0	0.2
Education (graduate and higher), %	12.6	13.9	0.9	21.3	23.3	0.7
Sacubitril valsartan, %	4.6	5.6	0.9	2.2	0	1
ACEI/ARB, %	83.4	83.3	1	56.2	86.7	0.03*
BB, %	94.7	94.4	1	94.4	93.3	1
MRA, %	44.4	50	0.5	30.3	53.3	0.02*
Loop diuretic, %	72.8	83.3	0.2	40.4	73.3	0.02*
CCB, %	10.6	16.7	0.4	9	20	0.1
Statin, %	76.2	77.8	0.9	15.7	10	0.6
Amiodarone, %	6.6	22.2	0.009*	19.1	13.3	0.5
Anticoagulant, %	29.8	38.9	0.5	17.9	43.3	0.01*
Noncompliance with medication%	9.9	11.1	0.9	4.5	6.7	0.9
EF	29	29	1	42.6	38.2	0.3
LVED diameter (mm)	59.7	58.9	0.1	54.4	58.2	0.5
LVES diameter (mm)	48.3	48.4	0.9	40.9	45.1	0.1
RV disfunction, %	31.8	38.9	0.4	22	16.7	0.7
HGB (g/dl)	13	13	1	14	14	1
GFR (ml/min/1.73m^2)	69.4	64.2	0.2	97.6	91.2	0.6
proBNP (pg/ml)	3040	2415	0.6	2163	1523	0.5
Troponin (pg/ml)	60.2	51.8	0.8	41.5	40.5	0.8
CK-MB (U/l)	22	22.8	0.9	22.7	24.2	0.7
LDL (mg/dl)	102	99.8	0.8	117.7	106.1	0.2
Glucose (mg/dl)	120.8	130.3	0.7	107	103.6	0.5

AF, Atrial fibrillation; ACEI/ARB, Angiotensin converting enzyme inhibitor / angiotensin receptor blocker; BB, Beta blocker; CCB, Calcium channel blocker; CVD, Cerebrovascular disease; COPD, Chronic obstructive pulmonary disease; CK-MB, Creatine kinase myocardial band; CRF, Chronic renal failure; DM, Diabetes mellitus; ECG, Electrocardiography; EF, Ejection fraction; GFR, Glomerular filtration rate; HGB, Hemoglobin; ICD, Implantable cardioverter defibrillator; LDL, Low density lipoprotein; LVED, Left ventricular end diastolic; LVES left ventricular end systolic; MET, Metabolic equivalent; MRI, Mineralocorticoid receptor inhibitor; NYHA, New York Heart Association; Pro-BNP, pro brain natriuretic peptide; RV, Right ventricle; SR, Sinus rhythm.

significance was defined as $p<0.05$. All analyses were performed using IBM SPSS-25 (Statistical Package for Social Sciences, Chicago, Illinois, USA).

Results

A total of 340 patients from September 2017 to January 2020 were allocated to the study. Average follow-up time was

16.1 (6-28) months, 78.2% (266) of the patients were male and 21.8% (74) were female. The mean age of the patients was 60.9±14.3 years. Obese patients constituted 22.1% of the patient group. The characteristics of obese and non-obese patients in the primary prevention and secondary prevention groups were compared in Table 1.

Patient Characteristics in Obese and in Non-Obese Primary Prevention Patients

The mean age and male gender were similar in obese and non-obese primary prevention patients. Dual chamber pacemaker-defibrillators (DDD–ICD) were used more frequently in non-obese patients, and single-chamber defibrillators (VVI ICD) were used more frequently in obese patients (p=0.05). Hospitalization and emergency admission during the past year were similar for both groups. Functional capacity and physical activity were similar for obese and non-obese patients. ECG sinus rhythm was more frequent for non-obese patients (p=0.016), however, the number of patients with QRS widths longer than 130 ms was similar in both groups. Hypertension (HT), diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), AF, and cerebrovascular disease (CVD) were more frequent in obese patients (p=0.001, 0.003, 0.01, 0.003, 0.007, respectively), while the frequency of malignancy, chronic renal failure (CRF), and hyperlipidemia was similar in both groups. There was no difference between the two groups in terms of active smoking and alcohol use, educational status, or income and social support. The use of angiotensin converting enzyme inhibitor/angiotensin receptor blocker (ACEI/ARB), loop diuretics, and anticoagulant therapy was more frequent in obese patients (p=0.05, 0.007, 0.01, respectively). Nonadherence to treatment was similar in both groups. There were no significant differences in echocardiographic and biochemical parameters among the groups.

Patient Characteristics in Obese and in Non-Obese Secondary Prevention Patients

There were no significant differences in demographic and clinical characteristics of obese and non-obese secondary prevention patients. The characteristics of obese and non-obese patients with ischemic HF and with non-ischemic CMP are compared in Table 2.

Patient Characteristics in Obese and in Non-Obese, Ischemic Heart Failure Patients

Mean age and male gender were similar in obese and non-obese patients with ischemic HF. DDD, VVI ICD, and hospitalization and emergency admission during the past year were similar for both groups. Functional capacity was higher in non-obese patients (p=0.03), but physical activity was similar between obese and non-obese patients. Sinus rhythm and QRS width >130 ms were similar for both groups. HT, DM, and CRF were more frequent in obese patients (p=0.05, 0.03, 0.05, respectively), while COPD, malignancy, CVD, and hyperlipidemia were similar. There were no differences between the two groups for active smoking and alcohol use, educational status, income, and social support. While amiodarone treatment was more frequent in obese patients, other medical treatments were similar for obese and non-obese patients. Nonadherence to treatment was similar in both groups, and there were no significant differences in echocardiographic and biochemical parameters.

Patient Characteristics in Obese and in Non-Obese, Non-Ischemic Cardiomyopathy Patients

When obese and non-obese. non-ischemic CMP patients were compared, the mean age was higher for obese patients (p=0.008), but for male sex, the group data were similar. DDD ICD was used more frequently in non-obese patients (p=0.003), whereas VVI ICD was used more frequently in obese patients (p=0.04). Hospitalization and emergency admission during the past year were similar for obese and non-obese groups, as was functional capacity, physical activity, and the number of patients with sinus rhythm and QRS width >130 ms. HT, COPD, AF, and CVD were more frequent in obese patients (p=0.01, 0.04, 0.02, 0.01, respectively), while DM, malignancy, CRF, and hyperlipidemia were similar. There were no differences between the two groups in terms of active smoking and alcohol use, educational status, income, and social support. The use of ACEI/ARB, MRA, loop diuretics and anticoagulants were more frequent in obese patients (p=0.03, 0.02, 0.02, 0.01, respectively), while other medical treatments were similar in obese and non-obese patients. Nonadherence to treatment was similar in both groups. There were no significant differences in group echocardiographic and biochemical findings.

Primary Endpoints

During a mean period of 16.1 mos, VT was observed more frequently in non-obese patients than in obese patients (hazard ratio [HR] 0.57, confidence interval [CI] 0.38–0.87, p= 0.009). VF, appropriate shock, inappropriate shock, and ATP were similar in obese and non-obese patients during the follow-up period. The effect of patient characteristics on VT in obese and non-obese patients is shown in the forest plot graph of Figure 2.

Secondary Endpoints

During a mean follow-up period of 16.1 mos, mortality, and cardiac mortality in non-obese patients tended to occur more frequently (HR 2.71, [CI] 0.93–7.93, p=0.069 for all-cause mortality and (HR 3.29, [CI] 0.97–11.17, p=0.056)

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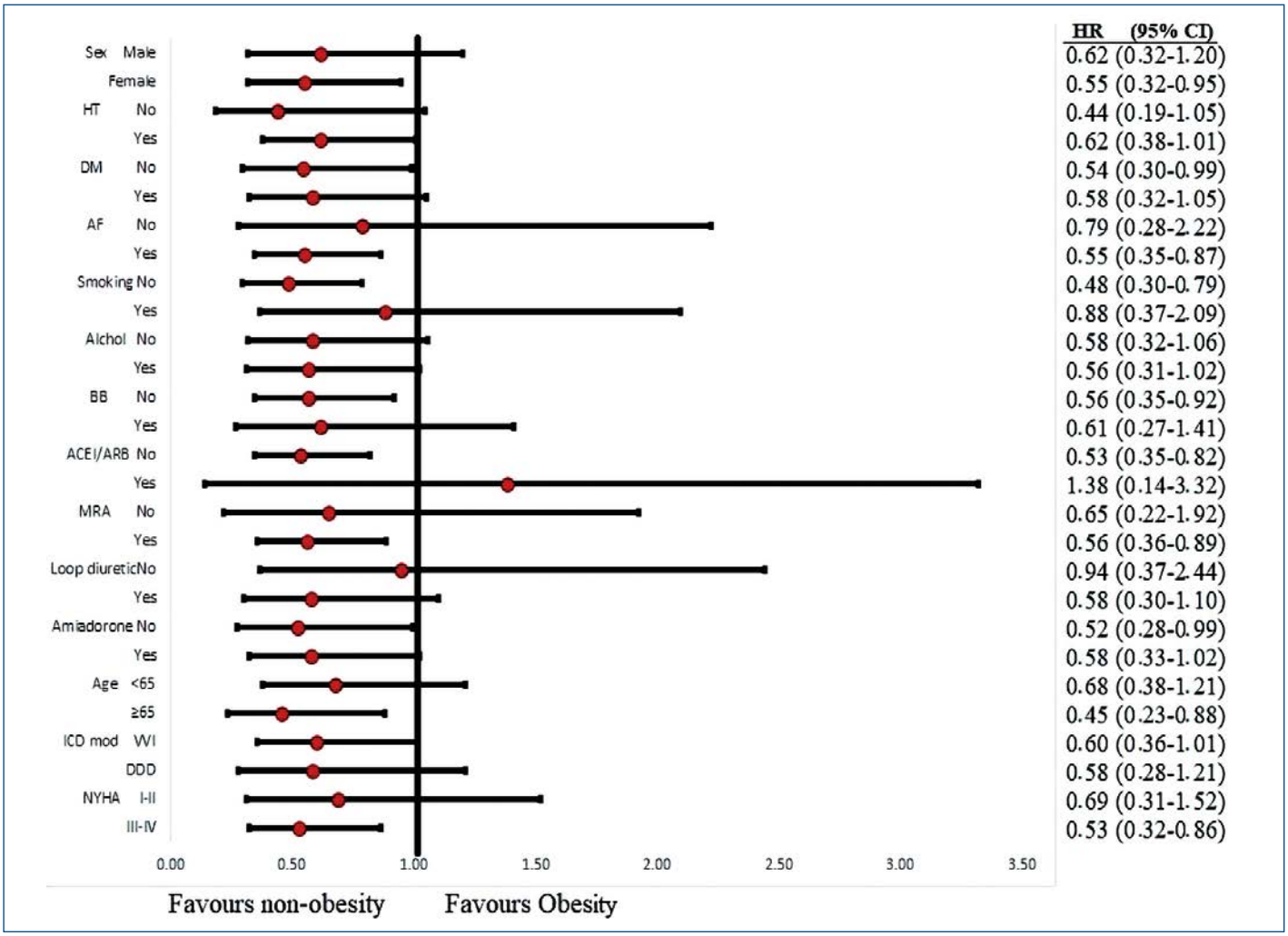
Figure 2. The effect of patient characteristics on the VT endpoint in obese and non-obese patients



for cardiac mortality. In log rank analysis, no significant difference was found between obesity groups in all-cause mortality (p=0.055), whereas cardiac mortality was significantly more common in non-obese patients (p=0.041). Cardiac rehospitalization and composite endpoints were similar for obese and non-obese patients.

The forest plot graph according to the Cox regression analysis results of the primary and secondary endpoints in obese and non-obese patients is shown in Figure 3.

Subgroup Analysis

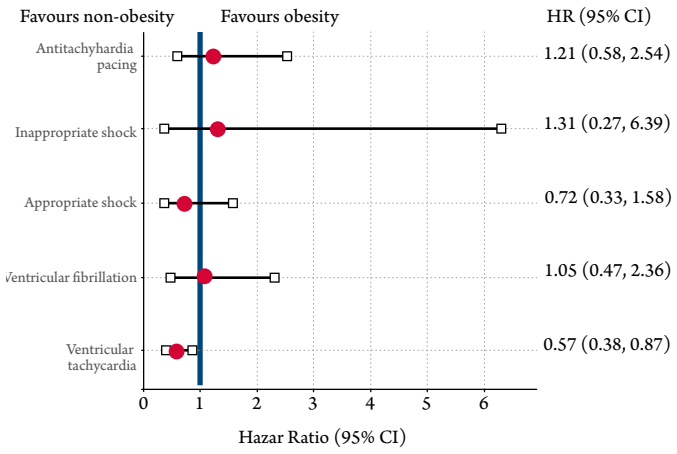
VT was observed more frequently in obese patients than in non-obese patients in primary prevention patients (HR 0.54, [CI] 0.35–0.84, p= 0.006). VF, appropriate shock, inappropriate shock, and ATP were similar in obese and non-obese patients. VT, VF, appropriate shock, inappropriate shock, and ATP in secondary prevention patients were similar in obese and non-obese patients.

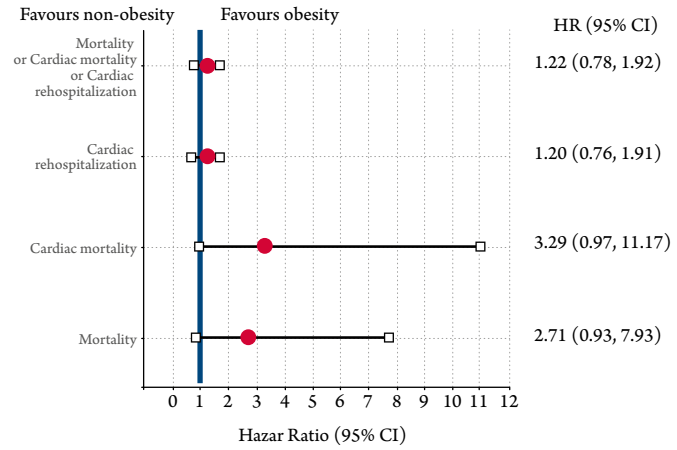
In primary prevention patients, all-cause mortality and cardiac mortality were more frequent in non-obese patients than in obese patients (HR 6.04, [CI] 1.4–26.3, p=0.02) for all-cause mortality and (HR 5.37, [CI] 1.22–23.59, p=0.03) for cardiac mortality. Cardiac rehospitalization and all-cause mortality or cardiac mortality or cardiac rehospitalization endpoints were similar for obese and nonobese patients. In secondary prevention patients, mortality, cardiac mortality, cardiac rehospitalization and mortality, cardiac mortality, and cardiac rehospitalization in obese patients tended to occur more frequently, although these differences were not significantly different compared to non-obese patients (Supplementary Figure 1).

VT was observed more frequently in obese patients than in non-obese patients of the ischemic HF group (HR 0.42, [CI] 0.24–0.76, p=0.004). VF, appropriate shock, inappropriate shock, and ATP were similar in obese and non-obese patients. VT, VF, appropriate shock, inappropriate shock, and ATP in non-ischemic CMP patients were similar in obese and non-obese patients.

In ischemic HF patients, all-cause mortality and cardiac mortality were more frequent in non-obese patients than in obese patients (HR 6.89, [CI] 1.49–31.92, p=0.014) for all-cause mortality and (HR 5.58, [CI] 1.19–26.26, p=0.03) for cardiac mortality. Cardiac rehospitalization, all-cause mortality, cardiac mortality, and cardiac rehospitalization

Figure 3. Primary and secondary endpoints illustrated with forest plots for obese and non-obese patients





endpoints were similar in obese and nonobese patients. In non-ischemic CMP patients, all-cause mortality, cardiac mortality, and cardiac rehospitalization were similar in obese and non-obese patients (Supplementary Figure 2).

Statistically significant results with Kaplan-Meier estimations and log-rank tests determined for endpoints classified according to obesity category are shown in Figure 4.

Discussion

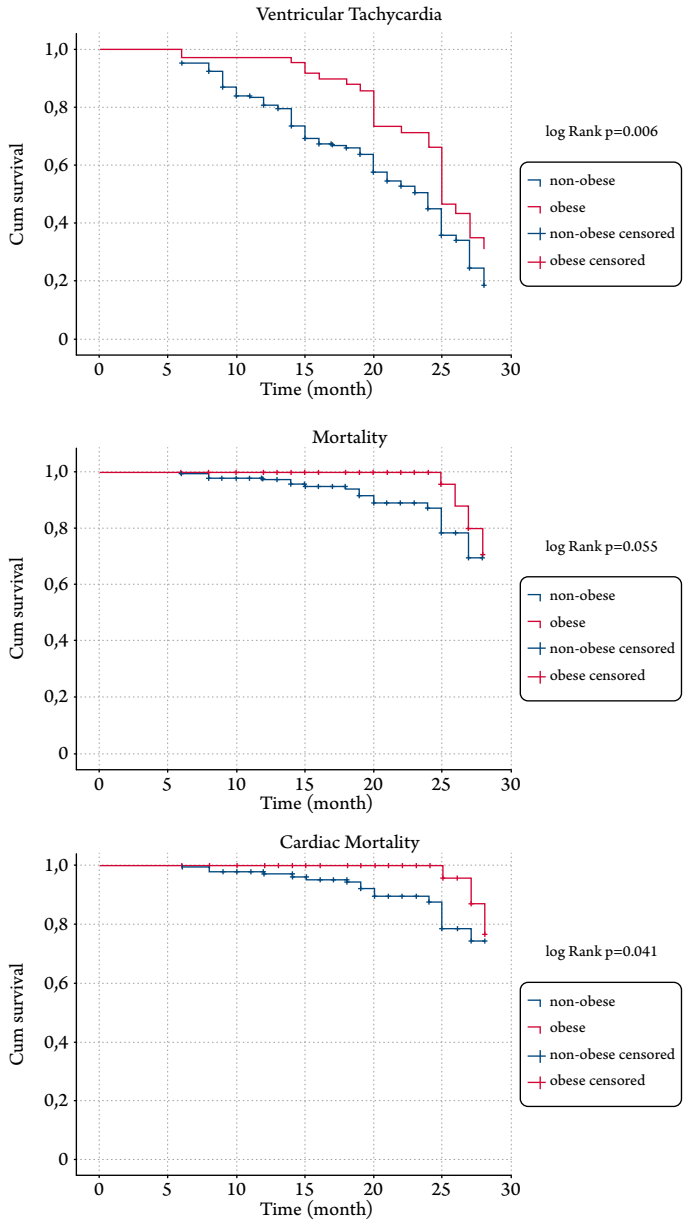
The main findings of this study were that VT, all-cause mortality, and cardiac mortality were more frequent in non-obese patients than in obese patients, both in all patients and in primary prevention patients and in secondary prevention, ischemic HF patients. While mortality and rehospitalization were more frequent in obese, secondary prevention patients, no statistically significant differences were found in primary and secondary endpoints in non-ischemic, HF patients.

Evidence for ICD implantation for non-ischemic CMP is not as strong as for ischemic HF [8]. In obese patients, who are expected to have lower functional capacity, ICD implantation is performed at more advanced age and with less complex procedures. The mean age of obese and non-obese patients was similar for all indication groups, except for patients with non-ischemic CMP. Among these patients, the mean age at VVI ICD implantation was higher in obese patients.

Early studies comparing men with women mostly examined secondary prevention patients and showed significant male predominance. Similar results were observed in most recent primary prevention studies, with the male/female ratio varying between 1.9/1 and 2.7/1 [9]. In our study the male/female ratio was approximately 3.6/1. The male gender proportion was similar in obese and non-obese patients for all indication groups.

Functional capacity and physical activity scores determined at the first follow-up after ICD implantation were similar for obese and non-obese patients, except for

Figure 4. Kaplan-Meier estimates for endpoints classified according to obesity category and statistically significant results according to log-rank tests



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ischemic HF. The functional capacity of obese patients was lower in ischemic HF, as could be expected. Due to the higher number of patients, it is possible that only obese patients with ischemic HF had a significantly lower functional capacity (NYHA class 3 or higher) compared to non-obese patients.

Obesity is a major risk factor for cardiovascular diseases. Obese patients receive more medical treatment due to their accompanying comorbidities. In this study, HT, DM, COPD, AF, and CVD were significantly higher in obese patients among primary prevention patients. Consistent with this result, the usage of ACEI, loop diuretics, and anticoagulants were greater in obese patients. However, medical comorbidities and drug usage were similar for obese and non-obese patients among secondary prevention patients. The echocardiographic and biochemical values were similar for both primary and secondary prevention patients among obese and non-obese groups.

In previous studies, the rate of ICD shock events in obese patients was like that of non-obese patients, but mortality was more frequent among non-obese patients [10, 11]. Increased body weight and obesity may be associated with an increased risk of arrhythmic events. It is known that obesity causes fatty infiltration and degeneration in the conduction system and therefore increases arrhythmias, which increase the risk of SCD [5]. In a study conducted in non-diabetic, ischemic HF patients, Pietrasik et al. [12] concluded that obesity is an independent risk factor for ventricular tachyarrhythmias. However, in ICD studies, including the MADIT-II study, mortality and SCD were higher in patients with lower BMI [6, 7].

In the current study, obese patients constituted 22.1% of the patient group. We compared the primary and secondary endpoints in obese and non-obese patients, both among all patients and among primary prevention, secondary prevention, ischemic HF, and non-ischemic CMP patients. The primary endpoints of VT, VF, appropriate shock, inappropriate shock, and ATP were compared in obese and non-obese patients. We found that VT occurred more frequently in non-obese patients than in obese patients. Other endpoints were observed similarly in obese and non-obese patients. In the subgroup analysis of primary prevention and ischemic HF patients, VT was observed more frequently in non-obese patients compared to obese patients. In secondary prevention patients with non-ischemic HF, no difference was observed in terms of primary endpoints for obese and non-obese patients.

During a study conducted with ICD patients, all-cause mortality was found more frequently among patients with low BMI [9]. Consistent with this finding, an independent inverse relationship was found between obesity and all-cause death and sudden cardiac death in the subgroup analysis of the obese MADIT-II population [7]. In our study all-cause mortality and cardiac mortality tended occur more frequent in non-obese patients than in obese patients, with other endpoints occurring at similar rates in obese and non-obese patients. Subgroup analysis showed that in primary prevention and ischemic HF patients, mortality and cardiac mortality were observed more frequently in non-obese patients than in obese patients. In patients with secondary prevention and non-ischemic HF, no difference was observed in terms of secondary endpoints in obese and non-obese patients.

The obesity paradox (paradoxical relationship), used to describe the hypothesis of the unexpected protective effect of obesity on survival, has been demonstrated both in the general population, in chronic diseases such as diabetes mellitus, and in cardiovascular diseases [13–15]. The protective effect of obesity in ICD patients shown in our study is consistent with the obesity paradox shown previously. The effect of traditional risk factors, such as obesity, on mortality occurs over a long term, so the effects of some other mortality factors may be more dominant in the short term. The higher optimal medical treatment in the obesity group compared to the non-obese group may also have contributed to the decrease in mortality.

There are limitations to our study. First, the mean follow-up period was short, so a longer-term follow-up might have produced different results, especially for mortality outcomes. Secondly, we did not account for changes in BMI that could have occurred during the follow-up period. That might have influenced outcomes. Also, when investigating the effect of BMI on outcomes, using BMI instead of BMI groups would have provided clearer and more reliable results. Despite all these limitations, the data of this study provide important information that demonstrate the different clinical features of obese ICD patients compared to non-obese patients and show obesity-related differences in arrhythmic events, hospitalization, and mortality during a limited follow-up period.

Conclusions

VT was more common in non-obese patients, both among all patients and among primary prevention and ischemic HF patients. VT, VF, appropriate shock, inappropriate shock, and ATP were similar in obese and non-obese both among secondary prevention and non-ischemic CMP patients. All-cause mortality and cardiac mortality tended to be more common in non-obese patients. Among primary prevention and ischemic heart failure patients, all-cause mortality and cardiac mortality occurred significantly more frequently in non-obese patients.

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Ethical standards

All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study has not been submitted to or published in any other journal.

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REFERENCES

1. Samanta R, Narayan A, Pouliopoulos J, Kovoor P, Thiagalingam A. Influence of Body Mass Index on Recurrence of Ventricular Arrhythmia, Mortality in Defibrillator Recipients With Ischaemic Cardiomyopathy. Heart, Lung and Circulation. 2020;29(2):254–61. DOI: 10.1016/j.hlc.2018.12.018
2. Zhou B, Zhao S, Tang M, Chen K, Hua W, Su Y et al. Overweight and obesity as protective factors against mortality in nonischemic cardiomyopathy patients with an implantable cardioverter defibrillator. Clinical Cardiology. 2020;43(12):1435–42. DOI: 10.1002/clc.23458
3. Kannel WB, Wilson PWF, Nam B-H, D'Agostino RB. Risk stratification of obesity as a coronary risk factor. The American Journal of Cardiology. 2002;90(7):697–701. DOI: 10.1016/s0002-9149(02)02592-4
4. Zacharias A, Schwann TA, Riordan CJ, Durham SJ, Shah AS, Habib RH. Obesity and risk of new-onset atrial fibrillation after cardiac surgery. Circulation. 2005;112(21):3247–55. DOI: 10.1161/CIRCULATIONAHA.105.553743
5. Wang TJ, Parise H, Levy D, D'Agostino RB, Wolf PA, Vasan RS et al. Obesity and the Risk of New-Onset Atrial Fibrillation. JAMA. 2004;292(20):2471–7. DOI: 10.1001/jama.292.20.2471
6. McDonagh TA, Morrison CE, Lawrence A, Ford I, Tunstall-Pedoe H, McMurray JJ et al. Symptomatic and asymptomatic left-ventricular systolic dysfunction in an urban population. The Lancet. 1997;350(9081):829–33. DOI: 10.1016/S0140-6736(97)03033-X
7. Choy B, Hansen E, Moss AJ, McNitt S, Zareba W, Goldenberg I. Relation of Body Mass Index to Sudden Cardiac Death and the Benefit of Implantable Cardioverter–Defibrillator in Patients With Left Ventricular Dysfunction After Healing of Myocardial Infarction. The American Journal of Cardiology. 2010;105(5):581–6. DOI: 10.1016/j.amjcard.2009.10.041
8. Ponikowski P, Voors AA, Anker SD, Bueno H, Cleland JGF, Coats AJS et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC) Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. European Heart Journal. 2016;37(27):2129–200. DOI: 10.1093/eurheartj/ehw128
9. Stein KM, Mittal S, Gilliam FR, Gilligan DM, Zhong Q, Kraus SM et al. Predictors of early mortality in implantable cardioverter-defibrillator recipients. Europace. 2009;11(6):734–40. DOI: 10.1093/europace/eup055
10. González-Cambeiro MC, Rodríguez-Mañero M, Abellas-Sequeiros A, Moreno-Arribas J, Filgueira-Rama D, González-Juanatey JR. Prognostic Effect of Body Mass Index in Patients With an Implantable Cardioverter-defibrillator for Primary Prevention of Sudden Death. Revista Española de Cardiología (English Edition). 2016;69(10):990–2. DOI: 10.1016/j.rec.2016.04.055
11. Oreopoulos A, Padwal R, Kalantar-Zadeh K, Fonarow GC, Norris CM, McAlister FA. Body mass index and mortality in heart failure: a meta-analysis. American Heart Journal. 2008;156(1):13–22. DOI: 10.1016/j.ahj.2008.02.014
12. Pietrasik G, Goldenberg I, McNITT S, Moss AJ, Zareba W. Obesity As a Risk Factor for Sustained Ventricular Tachyarrhythmias in MADIT II Patients. Journal of Cardiovascular Electrophysiology. 2007;18(2):181–4. DOI: 10.1111/j.1540-8167.2006.00680.x
13. Carbone S, Canada JM, Billingsley HE, Siddiqui MS, Elagizi A, Lavie CJ. Obesity paradox in cardiovascular disease: where do we stand? Vascular Health and Risk Management. 2019;15:89–100. DOI: 10.2147/VHRM.S168946
14. Flegal KM, Kit BK, Orpana H, Graubard BI. Association of All-Cause Mortality With Overweight and Obesity Using Standard Body Mass Index Categories: A Systematic Review and Meta-analysis. JAMA. 2013;309(1):71–82. DOI: 10.1001/jama.2012.113905
15. Carnethon MR, De Chavez PJD, Biggs ML, Lewis CE, Pankow JS, Bertoni AG et al. Association of weight status with mortality in adults with incident diabetes. JAMA. 2012;308(6):581–90. DOI: 10.1001/jama.2012.9282