



Relationship Between Successful Antitachycardic Pacing Delivery and ICD Device Settings

Başarılı Antitaşikardi Pacing Uyarımı ile ICD Cihaz Ayarları Arasındaki İlişki

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ABSTRACT

Objective: The delivery of shock in patients with intracardiac defibrillators (ICD) devices is extremely inconvenient, and therefore it is desirable to terminate ventricular arrhythmias with antitachycardic pacing (ATP) as much as possible. In this study, we investigated the relationship between delivery of successful ATP and device measurement values.

Methods: A total of 31 patients were enrolled in the cross-sectional case-control study. Patients who were diagnosed with ATP or ICD shock therapy during pacemaker/lead control measurements performed in our outpatient clinic and patients who were admitted to our coronary intensive care unit due to appropriate ICD shock were included in the study. The patients were divided into two groups as those who successfully terminated ventricular tachycardia with ATP as the "successful ATP group" and those who did not terminate successful ventricular tachycardia with ATP as the "unsuccessful ATP group."

Results: In the correlation analysis performed between the demographic characteristics, clinical characteristics, battery and lead measurements of the patients and successful ATP, a statistically significant correlation was found between the mean ventricular tachycardia (VT) detection rate and the number of burst pacings and successful ATP ($r = -0.699$, $p = 0.036$, and $r = 0.414$, $p = 0.036$, respectively). Moreover, the presence of diabetes mellitus (DM) was significantly associated with successful ATP ($r = -0.406$, $p = 0.024$). There was no significant relationship between other clinical and device measurement values and successful ATP.

Conclusion: Our study revealed that the presence of DM, the number of burst pacings, and the VT zone detection may be associated with ATP success in patients with ICD.

Keywords: Antitachycardic pacing, ventricular arrhythmias, shock delivery

ÖZ

Amaç: İntrakardiyak defibrilatör (ICD) cihazları olan hastalarda şok verilmesi son derece rahatsız edicidir ve bu nedenle ventriküler aritmilerin mümkün olduğunca antitaşikardi pacing (ATP) ile sonlandırılması arzu edilir. Bu çalışmada başarılı ATP verilmesi ile cihaz ölçüm değerleri arasındaki ilişkiyi araştırdık.

Gereç ve Yöntem: Kesitsel olgu kontrol çalışmasına toplam 31 hasta alındı. Polikliniğimizde yapılan kalp pili/lead kontrol ölçümlerinde ATP veya ICD şok tedavisi uygulanan hastalar ve uygun ICD şoku nedeniyle koroner yoğun bakım ünitemize başvuran hastalar çalışmaya dahil edildi. Hastalar ATP ile ventriküler taşikardi başarıyla sonlandıranlar "başarılı ATP grubu", ATP ile başarılı ventriküler taşikardi sonlandırmayanlar "başarısız ATP grubu" olarak iki gruba ayrıldı.

Bulgular: Hastaların demografik özellikleri, klinik özellikleri, pil ve lead ölçümleri ile başarılı ATP arasında yapılan korelasyon analizinde ortalama ventriküler taşikardi (VT) tespiti ve burst pacing sayısı ile başarılı ATP arasında istatistiksel olarak anlamlı korelasyon saptandı ($r = -0,699$, $p = 0,036$ and $r = 0,414$, $p = 0,036$, sırasıyla). Ayrıca, diabetes mellitus (DM) varlığı başarılı ATP ile anlamlı olarak ilişkiliydi ($r = -0,406$, $p = 0,024$). Diğer klinik ve cihaz ölçüm değerleri ile başarılı ATP arasında anlamlı bir ilişki yoktu.

Sonuç: Biz bu çalışmamızda, ICD'li hastalarda DM varlığının, burst pacing sayısının ve VT bölgesi tespitinin ATP başarısı ile ilişkili olabileceğini ortaya çıkardık.

Anahtar Kelimeler: Antitaşikardi uyarım, ventriküler aritmiler, şok uyarımı

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INTRODUCTION

Intracardiac defibrillators (ICDs) are recommended as a first-line treatment for treating malignant ventricular tachyarrhythmias due to the mortality benefit shown in comparative studies with medical treatment, particularly secondary prevention (1,2). The basic philosophy of these devices is to intervene in arrhythmia before hemodynamic deterioration and sudden cardiac arrest occur. ICDs attempt to restore the rhythm in ventricular tachycardias in two ways. Firstly, the devices attempt to terminate tachycardia by stimulation with a cycle length shorter than the detected cycle length, which is known as antitachycardic pacing (ATP). If this fails, secondly delivering shock according to the previously established treatment algorithms. The need for ICD shock is associated with a poor prognosis and is undesirable due to the negative effects of the shock itself (3). Therefore, it is critical to identify patients at high risk of ICD shock, develop patient-specific ICD programming algorithms, and avoid shocking by terminating arrhythmia with ATP (4,5). In this study, we investigated the relationship between ICDs' s ventricular lead measurement values and successful ATP or shock treatment.

METHODS

The Study Population

A total of 31 patients were enrolled in the cross-sectional case-control study conducted between September 2020 and November 2021. Patients who were diagnosed with ATP or ICD shock therapy during pacemaker/lead control measurements performed in our outpatient clinic and patients who were admitted to our coronary intensive care unit due to appropriate ICD shock were included in the study. The patients were divided into two groups as those who successfully terminated ventricular tachycardia with the ATP "successful ATP group," and those who did not terminate successful ventricular tachycardia with the ATP "unsuccessful ATP group." These two groups were compared in terms of demographic characteristics, clinical features, laboratory findings and ventricular lead measurement parameters. Patients with inappropriate shock, severe electrolyte imbalance, coronary artery stenosis requiring revascularization were excluded from the study. Written informed consent form was obtained from all patients who participated in the study, which was approved by the University of Health Sciences Turkey, Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee (decision no: 2021-18-01, date: 20.09.2021).

Data Collection

Demographic characteristics, laboratory results, echocardiographic findings, pacemaker and lead measurements of all patients included in the study were recorded. Battery and lead measurements were obtained, pacemaker characteristics and the previously set ICD treatment algorithms were determined. Arrhythmia episodes were retrospectively analyzed and the number of arrhythmia attacks in the last 6 months and the rate of arrhythmia episodes requiring shock or terminated with ATP was determined.

Statistical Analysis

Normally distributed data are shown as mean \pm standard deviation and non-normally distributed data are shown as median. The normality of the data was analyzed using the Shapiro-Wilk test. Independent sample t-test was used for parametric data and Mann-Whitney U test was used for nonparametric data in paired group comparison. Chi-square was used to compare categorical data. Spearman correlation analysis was used for the correlation analysis. Logistic regression was used to identify the predictors of successful ATP.

RESULTS

Of the 31 patients included in the study, 3 were women (9.7%) and the mean age of the patients was 61 ± 11 years. The demographic characteristics of the patients, the drugs they use and the types of ICD are shown in Table 1. There was no statistically significant difference in terms of demographic characteristics, clinical features and type of ICD in the groups of patients with and without arrhythmia termination with successful ATP.

The results of pacemaker and right ventricular lead measurements analyzed in groups of patients whose ventricular tachycardias were terminated and who were not terminated with successful ATP are shown in Table 2. There was no statistically significant difference between the two groups in terms of the pacemaker measurement values obtained. The correlation relationship between successful ATP administration and demographic characteristics, clinical characteristics of the patients and the results of the analyzed pacemaker battery and right ventricular lead measurements is shown in Table 3. In the analysis of the correlation between the successful ATP group and the demographic characteristics, clinical characteristics, battery and lead measures of the patients, a statistically significant relationship was found between the average ventricular tachycardia (VT) detection rate (bpm) and the number of

Table 1. Comparison of successful ATP and unsuccessful ATP patient groups in terms of demographic characteristics, clinical features

	Successful ATP	Unsuccessful ATP	p-value
Age (years ± SD)	63.00±12.54	57.54±10.08	0.226
Gender n (%)			
Male	10 (35.7)	18 (64.3)	0.934
Female	1 (33.3)	2 (66.7)	-
HT	4 (36.4)	7 (63.6)	0.940
CAD	7 (33.3)	14 (66.7)	0.718
DM	5 (71.4)	2 (28.6)	0.067
CRF	1 (50)	1 (50)	1.00
HOCM	2 (100)	0 (0)	0.118
Congenital long QT syndrome	0 (0)	1 (100)	0.334
Beta blocker	11 (37.9)	18 (62.1)	0.527
ACEI/ARB	6 (33.3)	12 (66.7)	0.789
MRA	5 (38.5)	8 (6.5)	0.769
ARNI	0 (0)	1 (100)	0.344
Amiodarone	4 (44.4)	5 (55.6)	0.683
Digoxin	2 (66.7)	1 (33.3)	0.281
Ranolazine	0 (0)	1 (100)	0.344
Ivabradine	0 (0)	5 (100)	0.133
Loop diuretics	4 (40)	6 (60)	0.718
ICD type			
Single chamber	8 (44.4)	10 (55.6)	-
Dual chamber	2 (20)	8 (80)	0.413
CRT-D	1 (33.3)	2 (66.7)	-
EF (% ± SD)	32.50±14.06	37.09±16.70	0.343
LA diameter (mm ± SD)	42.11±5.79	42.72±10.25	0.837

ATP: Antitachycardic pacing, HT: Hypertension, CAD: Coronary artery disease, DM: Diabetes mellitus, HOCM: Hypertrophic obstructive cardiomyopathy, CRF: Chronic renal failure, ACEI/ARB: Angiotensin converting enzyme inhibitors/angiotensin receptor blockers, MRA: Mineralocorticoid receptor antagonists, ARNI: Angiotensin receptor-neprilysin inhibitor, ICD: Implantable cardioverter-defibrillator, EF: Ejection fraction, LA: Left atrium, CRT-D: Cardiac resynchronization therapy-defibrillator, SD: Standard deviation

burst pacings and successful ATP ($r = -0.699$, $p = 0.036$, and $r = 0.414$, $p = 0.036$, respectively). There was a statistically significant negative correlation between successful ATP and only diabetes mellitus (DM) ($r = -0.406$, $p = 0.024$). There was no statistically significant correlation between other research parameters and successful ATP.

DISCUSSION

In this study, we found a statistically significant correlation between successful ATP and average VT detection rate, the number of burst pacings, and DM. To the best knowledge, our study is the first published study in the literature in this aspect.

ICD shock is an extremely unpleasant and painful condition for the patient and seriously affects the quality of life of patients. Additionally, anxiety disorders and increase in fear levels may also develop in patients with shock. Moreover, in the studies conducted, the expected life expectancy is also reduced in patients who experience ICD shock (6,7). Therefore, it is important to reduce the number of shocks in patients with ICD who develop severe ventricular arrhythmia and to terminate this rhythm disturbances with ATP as much as possible. According to the studies conducted on the subject, it is recommended a patient-specific device programming for terminating VT with successful ATP by reducing the number of ICD shocks (5,8,9). One of the

Table 2. Comparison of successful ATP and unsuccessful ATP patient groups in terms of pacemaker and right ventricular lead measurement

	Successful ATP	Unsuccessful ATP	p-value
Age (years)	63.00±12.54	57.54±10.08	0.226
HR (bpm)	77.00 (55-120)	68.50 (60-90)	0.769
Number of burst	3.0 (1-4)	1.0 (1-3)	0.075
Number of ramp	1.0 (0-3)	1.0 (0-2)	0.148
VT detection rate (bpm)	165.83±9.41	179.00±9.84	0.092
VF zone	200.00 (188-294)	200.00 (167-220)	0.338
VT zone	169.35±8.74	176.40±14.85	0.112
Number of episodes of arrhythmia	52.00 (2-800)	8.00 (1-249)	0.123
R wave (mV)	12.25±5.68	11.31±4.27	0.638
Impedance (Ω)	456.00(320-893)	447.00 (326-929)	0.855
Shock impedance (Ω)	57.27±11.24	57.27±11.24	0.542
Threshold (V)	0.75 (0.25-3.0)	0.75 (0.25-2.0)	1.00

ATP: Antitachycardic pacing, HR: Heart rate, VT: Ventricular tachycardia, VF: Ventricular fibrillation, Ω: Ohms

Table 3. The correlation relationship between successful ATP and demographic characteristics, clinical characteristics of the patients and the results of the analyzed pacemaker battery and right ventricular lead measurements

	R	p-value
HT	-0.014	0.942
DM	-0.406	0.024*
CAD	0.065	0.728
HOCM	-0.354	0.051
EF (%)	-0.149	0.424
LA (mm)	0.030	0.878
Threshold (V)	0.00	1.000
Shock impedance (Ω)	0.106	0.572
Impedance (Ω)	0.034	0.856
R wave (mV)	0.041	0.825
VF zone	0.194	0.295
VT zone	-0.140	0.460
VT detection	-0.699	0.036*
VT monitor	-0.069	0.840
Number of burst	0.414	0.036*
Number of ramp	0.327	0.103

*Correlation is significant at the 0.05 level (2-tailed)

ATP: Antitachycardic pacing, HT: Hypertension, CAD: Coronary artery disease, DM: Diabetes mellitus, HOCM: Hypertrophic obstructive cardiomyopathy, EF: Ejection fraction, LA: Left atrium, VT: Ventricular tachycardia, VF: Ventricular fibrillation, Ω: Ohms

important consequences of our study is that as the number of burst pacings increases in the device settings, it is more likely that malignant arrhythmia will be terminated with successful ATP. For this, the device must be programmed to perform burst pacing at least 3 times. Another result of our study is that the VT zone is unnecessarily high values, which can also reduce the chances of ATP success. Setting the VT zone to be around 165 bpm may be a more suitable programming option for successful ATP. Additionally, in our study, DM was found to be negative predictors of successive ATP. This result can be related to the that myocardial pathology and tachyarrhythmias are predominantly related to ischemic etiology in the diabetic population.

Our study has some limitations. Firstly, it was a small-scale and retrospective study. Moreover, there is an inability to reach the results of the ICD device brand and the patients' laboratory and coronary angiography on admission to the hospital.

CONCLUSION

Termination of fatal ventricular arrhythmias with ATP in patients with an ICD device should be the first choice of treatment and this issue has not been sufficiently investigated in the literature. In this study, we determined that the number of burst pacings and the VT zone value in the device settings may be related to ATP success. However, there is still a need for larger-scale and prospective studies on the subject.

ETHICS

Ethics Committee Approval: This study, with protocol number 2021/412, was approved by the University of Health Sciences Turkey, Bakırköy Dr. Sadi Konuk Training and Research Hospital Clinical Research Ethics Committee decision no 2021-18-01 (date: 20.09.2021).

Informed Consent: Written informed consent form was obtained from all patients who participated in the study, which was approved by the regional ethics committee.

Authorship Contributions

Surgical and Medical Practices: O.P., A.S.E., Concept: O.P., Design: O.P., A.S.E., Data Collection or Processing: A.S.E., Analysis or Interpretation: O.P., A.S.E., Literature Search: A.S.E., Writing: O.P.

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