Research Article

Interventional Cardiology

Impact of COVID-19 pandemic on severe ventricular arrhythmia and ICD therapy

Abstract

Background and objectives: The regular clinical follow-up of the patient with the Implantable Cardioverter-Defibrillator (ICD) device was seriously affected by the COVID-19 outbreak. Due to the high risk of contamination, patients didn't admit to the clinics for the ICD device control. It has been observed that arrhythmic events increased during the COVID-19 outbreak. In this study, we aimed to investigate the frequency of severe ventricular arrhythmias and ICD device therapy in COVID-19 patients with ICD.

Methods: In this single center-observational study, we assessed severe ventricular arrhythmias and ICD therapies by analyzing recorded data of 33 patients (24 males, 72.7%) 3 months before and after getting COVID-19 during the COVID-19 pandemic in Van, Turkey, between 15 August 2020 and 15 January 2021.

Results: Before the diagnosis of COVID-19, 6 ventricular tachycardias and 1 ventricular fibrillation episode were observed. When we analyzed the records after the diagnosis COVID-19, 17 ventricular tachycardia, and 3 ventricular fibrillation episodes were observed. Considering the ICD device therapies, 5 of these severe tachyarrhythmias were terminated by Anti-Tachycardia Pacing (ATP) and 2 with shock therapy before the diagnosis of COVID-19. After the COVID-19, 14 of them were terminated by ATP, and 6 of them were terminated by shock therapy.

Conclusion: The effects of the COVID-19 pandemic, especially on ventricular arrhythmia, have not been reported sufficiently in COVID-19 PCR (+) patients. In our study, it was observed that life-threatening ventricular arrhythmias and the ICD therapies were increased in patients with COVID-19, especially in the first month after the diagnosis of COVID-19.

Keywords: COVID-19 • Ventricular arrhythmia • Implantable cardioverter-defibrillator

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Introduction

Although COVID-19 (Corona Virus Disease 2019) mainly affects the lungs, extrapulmonary complications such as cardiac complications are also increasing day by day [1]. SARS-CoV2 (severe acute respiratory syndrome-coronavirus-2) infection is associated with many pro-inflammatory mediators that may play a role in the development of cardiac arrhythmia and complications. In a single-center study, the cardiac injury was observed in 19 percent of the hospitalized patients [2]. Therefore, it is plausible that these patients have an even higher risk of cardiac arrhythmias.

Ventricular arrhythmias mostly occur in settings associated with an increased sympathetic tone, including physical activity, illness, and emotional distress [3]. Lung

injury and hypoxemia caused by the SARS-CoV2 epidemic may cause irregularity in the electrical activity of the myocardium. In addition, SARS-CoV2 can directly damage myocardial cells and the electrical conduction system of the heart. Again, COVID-19 infection can aggravate the underlying cardiovascular disease, and the release of endogenous catecholamine may disrupt the electrical activity of the myocardium due to increased anxiety.

Patients with ICD (implantable cardioverter-defibrillator) device are always at risk of life-threatening Ventricular Arrhythmia (VA) and sudden death. We analyzed the data of the old ICD patients to determine whether the device therapy and ventricular arrhythmia burden have increased after the diagnosis of COVID-19.

Materials and Methods

This is a single center-observational study. Patients with previously implanted ICD devices (single and dual-chamber ICD) due to systolic left ventricular dysfunction or cardiac arrest and syncope and who were positive for COVID-19 PCR (+) (Polymerase Chain Reaction) were included in this study. For this study, 50 patients' ICD device records were reviewed in the cardiology clinic. 33 patients who met the inclusion criteria were included. Data obtained from the ICD of 33 patients (24 males) who were admitted to the clinic for regular pacemaker control between August 15, 2020, and January 15, 2021, and had positive PCR results for COVID-19 were examined. The period of 3 months before and 3 months after COVID-19 PCR test positivity was examined. Ventricular arrhythmias (Ventricular Fibrillation (VF) or Ventricular Tachycardia (VT)) treated by the ICD (ATP or shock) were detected. The development of Ventricular Tachycardia (VT) and Ventricular Fibrillation (VF) after COVID-19 was the primary endpoint of this study. During the study and COVID-19 infection, the ICD device treatment protocol was not changed.

Inclusion criteria

• Prior ICD implantation with or without subsequent spontaneous, Ventricular Tachycardia/Ventricular Fibrillation (VT/VF) episodes causing hemodynamic disturbances, or syncope

• Patients with a positive COVID-19 PCR test and hospitalized for a moderate-to-severe infection

• Patient above 18 years of age

• And patients on stable optimal pharmacologic therapy for their cardiac condition

Exclusion criteria

• Patients treated with catheter ablation for VT

• Patients diagnosed with acute coronary syndrome

• And those who received inappropriate ATP or shock therapy were not included in the study

This study was reviewed and approved by the Ethics Committees of the Van Training and Research Hospital Van, Turkey. Also, all methods were performed in accordance with the relevant current guidelines and regulations.

Statistical analysis

All statistical analyzes were done with SAS University Edition (SAS/STAT, SAS Institute Inc, NC, USA). The 90 days following COVID-19 was compared with each of the 90-day before and after this period. The number of patients who had an arrhythmic event during the 3 months before and after the COVID-19 infection was compared using McNemar's test. Mantel-Haenszel statistic was used to calculate the Relative Risk (RR) estimated for the paired data. The number of arrhythmic events was compared using the Wilcoxon-signed rank test between paired data. Kaplan-Meier survival curves (time to the first event) were reproduced and Gehan's test for paired data was used for comparison survival curves. 90-day discharge rates over the follow-up period were estimated using a PROC GENMOD procedure (A modified Poisson regression approach to prospective studies with binary data) [4] and a generalized estimating equation was performed to account for within-subject correlation. The Loess curves with a span of 0.15 were used to illustrate the estimated 10-day periods of arrhythmic events over time. The prediction of arrhythmic event 90-day after COVID-19 by predictors was performed by using logistic regression analysis. A p-value <0.05 was considered significant.

Results

Baseline characteristics

A total of 33 patients (24 male 72,7%); mean age was 62,4 ± 17,7 years) were enrolled in our study. All patients were using beta-blockers. In the study, 51.5 percent of patients had an ICD implanted for primary prevention. In patients who had an ICD implanted for secondary prevention, 68,8% were implanted due to VT, 18,8 due to cardiac arrest, and 12,4 due to syncope (Table 1).

Clinical events

Ventricular arrhythmic events were analyzed by reviewing intracardiac EGM records. When looking at the records before getting COVID-19, 7 (6 VT, 1 VF) arrhythmia episodes were detected. 5 of these arrhythmias were terminated by ATP and 2 by shock therapy. After the COVID-19 diagnosis, 20 arrhythmias (17 VT, 3 VF) episodes were detected. 14 of these arrhythmias were terminated by ATP and 6 by shock therapy (Table 2). Regarding the type of arrhythmia and the device therapy, no statistical difference was found before and after COVID-19.

Table 1: Characteristics of the study population (N=33).

Characteristics	
Age (mean ± SD)	62.4 ± 17.7
Gender , %	
Male	72.7
Female	27.3
BMI (mean ± SD)	27.6 ± 3.05
Comorbidities, %	
CAD	57.6
DM	39.4
HT	66.7
COPD	9.1
Cigarette smoking, %	39.4
Medications, %	
Diuretics	66.7
ACEI/ARB	100
ASA	78.8
Clopidogrel	9.1
Digoxin	24.2
Beta blockers	100
Amiodarone	3
Calcium channel blockers	15
ICD indication, %	
Primary prevention %	51.5
Secondary prevention, %	48.5
VT	68.8
Cardiac arrest	18.8
Syncope/inducible VT	12.5
LV ejection fraction, %	36.9 ± 10.2

Abbreviations: CAD: Coronary Artery Disease; DM: Diabetes Mellitus; HT: Hypertension; COPD: Chronic Obstructive Pulmonary Disease; ACEI: Angiotensin-Converting-Enzyme İnhibitors; ARB: Angiotensin Receptor Blockers; ASA: Acetylsalicylic Acid, ICD: Implantable Cardioverter-Defibrillator, VT: Ventricular Tachycardia, LV: Left Ventricle

Table 2: Characteristics of ventricular arrhythmias and device therapies.

Parameter	Before COVID-19	After COVID-19	p value
Arrhythmia type			
Ventricular tachycardia (%)	6/7 (85.7)	17/20(85)	NS
Ventricular fibrillation (%)	1/7(14.3)	3/20(15)	NS
Termination (%)			
ATP	5/7(71.4)	14(70)	NS
Shock	2/7(28.6)	6(30)	NS

Abbreviations: COVID-19: Coronavirus Disease 19; ATP: Antitachycardia Pacing; NS: Not Statistically Significant

Although none of 33 patients had VA episodes in 30 days prior to COVID-19, 14 (42,4%) of 33 patients had at least one arrhythmia episode treated by the ICD device in the first 30 days after COVID-19. Arrhythmias were detected in 7 patients both before and after the COVID-19. The first severe VA after COVID-19 was seen on the 6th day. Serious arrhythmic events increased cumulatively and occurred on average 21,8 ± 13,7 days post COVID-19. Kaplan-Meier curve analysis displayed that arrhythmic events after COVID-19 period were statistically significantly higher than before COVID-19 infection (Log-rank p-value<0,0001). 14 (70%) of 20 ventricular arrhythmias detected after COVID-19 were seen in the first month (Figures 1 and 2).

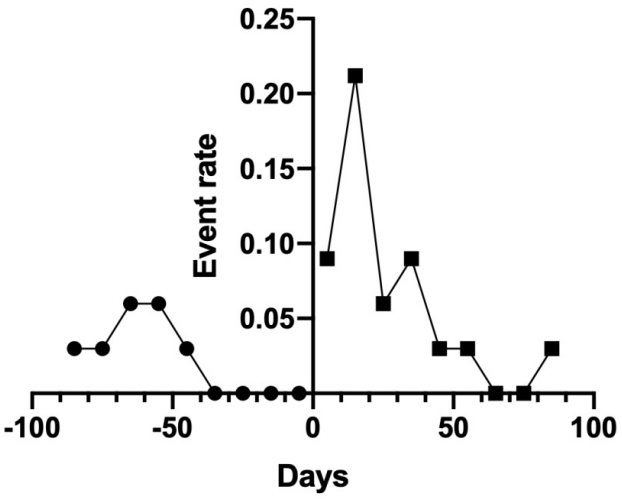

Figure 1: Kaplan-Meier curve analysis displayed that arrhythmic events after COVID-19 period were statistical significant before COVID-19 period (Log-rank p value<0,0001). 14 (70%) of 20 ventricular arrhythmia detected after COVID-19 were seen in the first month. **Note:** (—●—) pro-COVID, (—■—) post- COVID

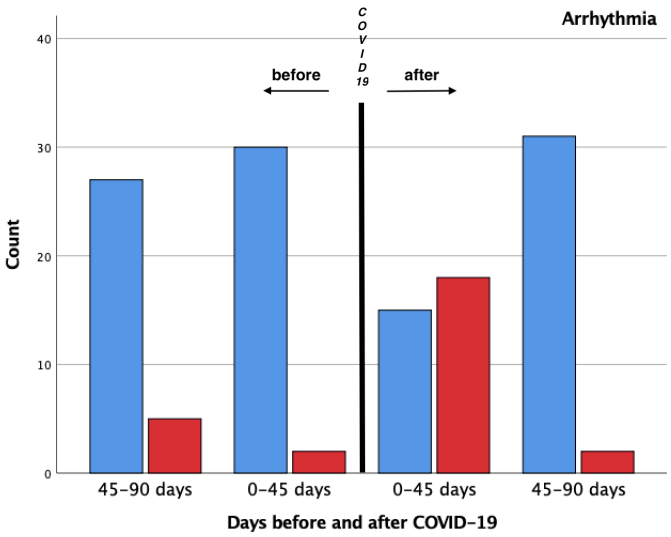

Figure 2: Compared between 45-90 days before COVID-19, the risk of ventricular arrhythmias for the 45 days after covid-19 increased 3,6-fold (95% CI 1.62 to 8, p value: 0.003). **Note:** (▬) patients free of arrhythmia, (▬) patients with arrhythmia

Comparing the incidence of arrhythmia in 3 months before and after COVID-19, it was seen that the risk of tachyarrhythmia increased 2.86 times, which is statistically significant according to paired analysis (95% Confidence Interval (CI) 1.57 to 5.19, p<0,0006). The number of all arrhythmic events including life-threatening and total sustained and nonsustained ventricular tachycardia/ fibrillation episodes was higher after the COVID-19 diagnosis (116 in the pre-COVID-19 period, and 400 mean in post-COVID-19 (p-value<0.001)).

Compared with 90 days before covid-19, the risk of ventricular arrhythmias for the 90 days after covid-19 increased 9-fold (95% CI 2.44 to 33,2, p-value: 0.001). Compared between 90 days before covid-19, the risk of ventricular arrhythmias for the 90 days after COVID-19 increased 3,6-fold (95% CI 1.62 to 8, p-value: 0.003) (Figure 2). According to the univariate logistic regression analysis adjusted for demographic and clinical parameters, demonstrated no significant relationship with arrhythmic events after COVID-19.

Discussion

To the best of our knowledge, this is the first study to report the effect of COVID-19 on severe ventricular arrhythmia in patients with ICD devices and COVID-19 PCR (+). In many studies, it has been determined that cardiac arrhythmias increase in viral infections. Arrhythmia and conduction system disease are not early or common symptoms of COVID-19 disease, and most symptoms in COVID-19 disease are associated with the respiratory system [5]. Sinus tachycardia is the most common arrhythmia, and sinus tachycardia is a physiological response secondary to viral infection, and arrhythmias other than sinus tachycardia have been reported frequently and are typically caused by viral myocarditis affecting the cardiac conduction system [6]. In particular, relatives of the current COVID-19 virus such as SARS and MERS tend to have many arrhythmias, including sinus bradycardia [7,8]. Arrhythmias in COVID-19 disease can also occur due to side effects of drugs, hypoxia and lung disease, and myocarditis. Sinus bradycardia is one of the most common arrhythmias and can last for up to 2 weeks [9].

In a study performed by O'Shea, et al. [3], a 32% reduction was observed in arrhythmias needing device therapy due to social isolation during the pandemic period and the decrease in real-life stress factors. However, the COVID-19 status of the patients was not examined in this study. In our study, only patients with COVID-19 were included, and when the device records of the patients before and after COVD-19 were compared, a statistically significant increase was observed in ventricular arrhythmia and device therapy. In addition, in a study conducted by Sassone, et al. it was objectively measured that the patients decreased their physical activities due to isolation during the pandemic period [10]. In this study, a 25% decrease in the physical activities of patients who had an ICD for primary prevention was detected. Although a decrease in the incidence of arrhythmia was expected due to the decrease in physical activities, an increase in the number of arrhythmias was observed in our study. This may be due to the drugs used in the treatment of COVID-19, myocardial injury, hypoxia, and pro-inflammatory mediators, and COVID-19.

In a study conducted by Adabag, et al. ICD device records of 14665 patients in 2020 were examined and compared with the same period one year ago. Although it was observed that ICD shock therapy increased, the number of patients receiving shock therapy did not increase during the period of the COVID-19 pandemic [11]. Compared to the pre-COVID-19 period, an increase was observed in the number of patients receiving appropriate ICD therapy and in total ICD therapy in our study. Although, there is a paucity of data on the cause of COVID-19-related cardiac arrests outside the hospital, asystole or pulseless electrical activity has been reported to be the cause of cardiac arrest in critically ill and hospitalized COVID-19 patients [12]. These findings differ from previous reports from China that showed a high ventricular arrhythmia burden. Contrary to previous studies, only patients with positive COVID-19 PCR tests were included in our study, and the findings in our study are consistent with previous studies showing that ventricular arrhythmia is the predominant arrhythmia in cardiac arrests outside the hospital.

Conclusion

In our study, it was observed that life-threatening ventricular arrhythmias and device therapy increased in patients with COVID-19, especially in the first month after COVID-19. However, delaying routine control due to the risk of catching COVID-19 at hospitals, high anxiety and stress due to quarantine, and difficulties in accessing cardiovascular drugs can be cited as reasons for the increase in ICD treatment. Cardiovascular symptoms of COVID-19 can range from mild myocyte injury to fulminant myocarditis, life-threatening ventricular arrhythmia, and refractory shock. Close hemodynamic and electrocardiographic follow-up should be performed for all patients with COVID-19, especially if they are under COVID-19 treatment.

Study Limitations

The small number of patients is the main limitation of our study. Results from this study should be confirmed by future prospective studies or records.

Authors' Contributions

TA and FS designed the research. MA and FS wrote the paper. AS and FS analyzed data. All authors reviewed the manuscript. All

authors read and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Written Ethics approval and consent to participate were obtained by the Ethics Committees of the Van Training and Research Hospital when conducting this study.

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