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Common ECG Changes and Prognostic Importance of ECG Findings in COVID-19 Patients Presenting to the Emergency Department

Acil Servise Başvuran COVID-19 Hastalarında sık görülen EKG Değişiklikleri ve EKG Bulgularının Prognostik Önemi

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Abstract

Introduction: It is known that cardiac involvement may occur in patients with COVID-19 infection. And one of the best diagnostic tools of cardiac involvement is the ECG. The aim of this study is to investigate the common ECG findings in COVID-19 infection and the effect of these findings on the prognosis.

Material and Method: 215 patients who applied to our emergency department between June 4 and August 4, 2022 and met the study criteria were included in this study. All patient results and ECG images were accessed from the hospital data recording system. The results were used for statistical analysis.

Results: Of 215 patients, 118 were female and 97 were male, and the mean age was 58±21 years. Of these patients, 52 were hospitalized in the service and 17 were hospitalized in intensive care units, and 146 patients were discharged from the emergency department. The most common ECG finding was ST-T wave change. It was observed that there was a correlation between the detection of VT in the ECG and the intensive care unit admission. It was observed that the ECG findings of the patients had no effect on the prognosis.

Conclusion: All ECG findings can be seen in patients admitted to the emergency department with COVID-19 infection. The most common ECG finding is ST-T wave change. In addition, long QTc, sinus tachycardia and AF are also common. However, no correlation was found between ECG findings and disease prognosis.

Keywords: COVID-19, ECG, ST-T wave change.

Öz

Giriş: COVID-19 enfeksiyonu olan hastalarda kardiyak tutulumun olabileceği bilinmektedir. Kardiyak tutulumun en iyi tanı araçlarından biri de EKG'dir. Bu çalışmanın amacı COVID-19 enfeksiyonunda sık görülen EKG bulgularını ve bu bulguların prognoza etkisini araştırmaktır.

Gereç ve Yöntem: 04 Haziran2022 ile 04 Ağustos 2022 tarihleri arasında acil servisimize başvuran ve çalışma kriterlerini karşılayan 215 hasta bu çalışmaya dahil edildi. Tüm hasta sonuçları ve EKG görüntülerine hastane veri kayıt sisteminden ulaşıldı. Sonuçlar istatistiksel analiz için kullanıldı.

Bulgular: 215 hastanın 118'i kadın, 97'si erkek olup, yaş ortalaması 58±21 yıl idi. Bu hastalardan 52'si serviste, 17'si yoğun bakıma yattı, 146 hasta ise acil servisten taburcu edildi. En sık görülen EKG bulgusu ST-T dalga değişikliği idi. EKG'de VT saptanması ile yoğun bakıma yatış arasında ilişki olduğu gözlendi. Hastaların EKG bulgularının prognoza etkisinin olmadığı görüldü.

Sonuç: Acil servise COVID-19 enfeksiyonu ile başvuran hastalarda tüm EKG bulguları görülebilmektedir. En sık görülen EKG bulgusu ST-T dalga değişikliğidir. Ayrıca uzun QTc, sinüs taşikardisi ve AF de sık görülür. Ancak EKG bulguları ile hastalık prognozu arasında bir ilişki bulunamadı.

Anahtar Kelimeler: COVID-19, EKG, ST-T dalga değişikliği.

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INTRODUCTION

COVID-19 infection is a disease with high mortality, declared as a global pandemic by the World Health Organization(WHO) (1). It has been shown in previous studies that COVID-19 infection progresses with acute cardiovascular diseases (2,3). It may trigger acute cardiovascular events and sudden cardiac death (4).

It has been reported in previous studies that both the COVID-19 infection itself and the drugs used in the treatment can cause electrocardiogram (ECG) changes. And this has made ECG analysis and follow-up mandatory in COVID-19 patients. It has been shown in previous studies that Hydroxychloroquine and Azithromycin, which were used for a period in COVID-19 pneumonia, prolong QT (5). However, there are studies showing that COVID-19 infection causes ECG changes even without the use of medication. It has been found that COVID-19 pneumonia causes ST-T wave changes without an increase in Troponin (6). In addition, it has been reported that the most common ECG abnormalities in patients with suspected COVID-19 infection who are eligible for outpatient treatment and who do not have comorbidities are ST-T segment and T wave abnormalities (7). However, despite all these studies, ECG findings emerging in the acute phase of COVID-19 infection and the effect of these findings on the patient's follow-up and outcome are still not fully known. The aim of this study is to investigate the common ECG findings in the acute phase of COVID-19 infection and the relationship between these findings and patient outcome.

MATERIALS AND METHOD

Study Design

This retrospective observational study was planned in the emergency department of a tertiary hospital. Ethics committee approval, dated 21.04.2022 and numbered 0206, was obtained from the university local committee for the study. All procedures were carried out in accordance with the principles of the Declaration of Helsinki and ethical rules.

Study Participants

All patients older than 18 years of age who applied to the emergency department with symptoms suggestive of COVID-19 pneumonia, such as shortness of breath, cough, fever, and confusion, and had a positive PCR test result and had an ECG were included in this study. Patients with missing electrocardiograms and examination information and patients whose outcomes could not be reached were excluded from the study.

Data Collection

Application complaints, laboratory findings and ECG records of the patients were accessed through the hospital information system and these data were recorded in the data record form. The recorded data were used for statistical analysis.

Electrocardiographic evaluation

The 12-lead triage ECG taken before the treatment and recorded in the system was accepted as the reference ECG. All ECGs (filter range 0.5–150Hz, AC filter 60Hz, 25mm/s, 10mm/mV) were analyzed by two independent emergency medicine specialists and the findings were recorded in the data record form. ECG findings were checked by two other emergency medicine specialists. Normal PR interval was defined as 120–200ms and first degree atrioventricular block (AVB) PR interval was defined as >200ms. When calculating the corrected QT interval (QTc), the QT interval measured in leads II or V5–6 was calculated using the QTc Bazett formula (QTc=QT/(√RR) (8). Right bundle branch block (RBBB) was defined as wide QRS>120ms, RSR' pattern in V1–3('M-shaped' QRS complex), wide and blurred S wave in lateral leads(I,aVL,V5–6). ST segment depressions in two anatomically adjacent leads were accepted as at least 0.05mV and horizontal and/or downward sloping ST depression (in leads V1-V6,DI,DII,aVL,aVF) seen after the J point.

ST elevation was defined as ST segment elevation at the J point of >0.1 mV in two adjacent leads. T wave inversion was detected in two adjacent leads with ≥0.1mV and R/S ratio>1.

Statistical Analysis

Descriptive statistics; frequency, percentage, standard deviation, mean, median, maximum and minimum values were obtained. Percentage and number, mean, standard deviation, maximum and minimum values for categorical variables, and interquartile range (IQR) with numerical variables were calculated. Kurtosis-skewness values, histogram curves and Shapiro-Wilks test were used to test whether continuous variables were normally distributed. All statistical calculations were done with SPSS 24.0 software and all calculations were done at 95% confidence interval. A value of $p<0.05$ was considered statistically significant.

RESULTS

Of the 215 patients included in the study, 118 were female, with a mean age of 58±21 years. Of these patients, 52 were hospitalized in the service and 17 in intensive care units. 21 of the patients resulted in death. Demographic characteristics, vital signs and outcome information of the patients included in the study are presented in **Table 1**.

ECGs of all patients included in the study were examined and all ECG findings are presented in **Table 2**.

The presence of pathology in the ECG is statistically higher in patients receiving outpatient treatment compared to patients receiving treatment in the service and intensive care unit. The length of stay is higher in patients treated in the intensive care unit. PR Interval was statistically high for all treatment types. QRS duration has a shorter interval in patients treated in the intensive care unit compared to others. QTC duration and long QTC variables were statistically similar according to treatment types. Presence of PR depression

is statistically higher in intensive care patients. Variables of right branch, left branch and stele elevation were similar according to treatment types. Presence of st depression is statistically higher in outpatients. The presence of T inversion is statistically low in intensive care patients. The presence of ST-T wave changes is statistically high in outpatients. 1st degree AV block, 2nd degree AV block, 3rd degree AV block, sinus tachycardia, sinus bradycardia, AF and SVT conditions were statistically similar according to treatment status. The presence of VT is statistically higher in intensive care patients. ECG Comparison of Patients by Treatment Status is presented in **Table 3.**

The length of hospital stay is higher in patients with ex. Presence of PR interval was statistically similar in groups. QRS and QTC durations are statistically higher in patients with ex. The presence of long QTC is not statistically different in discharged and ex-patients. Presence of PR depression is statistically low in discharged patients. The presence of RBBB is statistically higher in discharged patients. Presence of left bundle branch block and ST elevation were similar in the groups. Presence of ST depression, T inversion and ST-T wave change is high in discharged patients. Presence of 1st degree AV block, 2nd degree AV block, 3rd degree AV block is similar in discharged and ex patients. Presence of sinus tachycardia is statistically high in discharged patients. Sinus bradycardia, presence of af and svt were statistically similar in the groups. ECG Comparison of Patients by Outcome Status is presented in **Table 4.**

Table 1: Introductory Information of the Patients

Variables	Statistics
Age	
$\bar{x}$±ss	57,70±20,55
M (min-max)	59 (18-95)
Gender, n (%)	
Female	118 (54,9)
Male	97 (45,1)
Systolic Blood Pressure (mmHg)	
$\bar{x}$±ss	130,15±9,66
M (min-max)	130,0 (107,0-180,0)
Diastolic Blood Pressure (mmHg)	
$\bar{x}$±ss	74,88±9,67
M (min-max)	75,0 (40,0-95,0)
Pulse	
$\bar{x}$±ss	83,32±16,81
M (min-max)	82,0 (42,0-145,0)
Respiratory Rate	
$\bar{x}$±ss	17,79±3,89
M (min-max)	17,0 (10,0-25,0)
Treatment	
Outpatient Treatment	146 (67,9)
Service Admission	52 (24,2)
Intensive care	17 (7,9)
Outcome	
Discharge	194 (90,2)
Ex	21 (9,8)
Duration of Hospitalization (days)	
$\bar{x}$±ss	1,89±3,59
M (min-max)	0,0 (0,0-19,0)

$\bar{x}$: Average, ss: Standard deviation, M: Median

Table 2: General distribution of patients' ECG findings

Variables	Statistics
PR Interval	
$\bar{x}$±ss	147,89±25,03
M (min-max)	145,50 (92,0-212,0)
QRS Duration (ms)	
$\bar{x}$±ss	87,68±19,89
M (min-max)	82,0 (54,0-192,0)
Qtc Duration (ms)	
$\bar{x}$±ss	441,72±34,95
M (min-max)	435,0 (384,0-571,0)
Long Qtc	
Normal	156 (72,6)
Long	59 (27,4)
PR Depression	
No	210 (97,7)
Yes	5 (2,3)
Right Bundle Branch Block	
No	206 (95,8)
Yes	9 (4,2)
Left Bundle Branch Block	
No	207 (96,3)
Yes	8 (3,7)
ST Elevation	
No	205 (95,3)
Yes	10 (4,7)
ST Depression	
No	160 (74,4)
Yes	55 (25,6)
T Inversion	
No	158 (73,5)
Yes	57 (26,5)
ST-T Wave Change	
No	129 (60,0)
Yes	86 (40,0)
1st-Degree Atrioventricular Block	
No	205 (95,3)
Yes	10 (4,7)
2nd-Degree Atrioventricular Block	
No	215 (100,0)
3th-Degree Atrioventricular Block	
No	214 (99,5)
Yes	1 (0,5)
Sinus Tachycardia	
No	186 (86,5)
Yes	29 (13,5)
Sinus Bradycardia	
No	212 (98,6)
Yes	3 (1,4)
Atrial Fibrillation	
No	200 (93,0)
Yes	15 (7,0)
Supraventricular Tachycardia	
No	208 (96,7)
Yes	7 (3,3)
Ventricular Tachycardia	
No	211 (98,1)
Yes	4 (1,9)

$\bar{x}$: Average, ss: Standard deviation, M: Median

Table 3: ECG Comparison of Patients by Treatment Status

	Treatment			Test Statistics	
	Outpatient	Service	Intensive Care	Care Test	p value
ECG, n (%) No Yes	118 (80,8)[a] 28 (40,6)[a]	25 (17,1)[b] 27 (39,1)[b]	3 (2,1)[b] 14 (20,3)[b]	40,261	<0,001
Hospitalization Duration (days) M (min-max)	0 (0-1)	5 (0-19)	6 (1-14)	188,264	<0,001
PR Interval M (min-max)	146 (92-210)	138 (92-212)	144 (118-188)	0,632	0,729
QRS Duration (ms) M (min-max)	82 (62-192)[a]	88 (54-146)[a]	82 (68-152)[b]	8,369	0,015
QTC Duration (ms) M (min-max)	432 (390-550)	437 (384-529)	441 (408-569)	5,103	0,057
Long QTC, n (%) No Yes	113 (72,4) 33 (55,9)	33 (21,2) 19 (32,2)	10 (6,4) 7 (11,9)	5,489	0,056
PR Depression, n (%) No Yes	146 (69,5)[a] 0 (0,0)[a]	50 (23,8)[ab] 2 (40,0)[ab]	14 (6,7)[b] 3 (60,0)[b]	21,574	0,001
Right Bundle Branch Block, n (%) No Yes	142 (69,9) 4 (44,4)	49 (23,8) 3 (33,3)	15 (7,3) 2 (22,2)	3,521	0,111
Left Bundle Branch Block, n (%) No Yes	142 (68,6) 4 (50,0)	50 (24,2) 2 (25,0)	15 (7,2) 2 (25,0)	3,465	0,133
ST Elevation, n (%) No Yes	141 (68,8) 5 (50,0)	49 (23,9) 3 (30,0)	15 (7,3) 2 (20,0)	2,582	0,199
ST Depression, n (%) No Yes	129 (80,6)[a] 17 (30,9)[a]	26 (16,3)[b] 26 (47,3)[b]	5 (3,1)[b] 12 (21,8)[b]	49,273	<0,001
T Inversion, n (%) No Yes	119 (75,3)[a] 27 (47,4)[a]	35 (22,2)[a] 17 (29,8)[a]	4 (2,5)[b] 13 (22,8)[b]	27,616	<0,001
ST-T Wave Change, n (%) No Yes	107 (82,9)[a] 39 (45,3)[a]	18 (14,0)[b] 34 (39,5)[b]	4 (3,1)[b] 13 (15,1)[b]	34,124	<0,001
1st-Degree Atrioventricular Block,n (%) No Yes	140 (68,3) 6 (60,0)	48 (23,4) 4 (40,0)	17 (8,3) 0 (0,0)	2,010	0,407
2nd-Degree Atrioventricular Block,n (%) No	146 (67,9)	52 (24,2)	17 (7,9)	-	-
3th-Degree Atrioventricular Block , n (%) No Yes	146 (68,2) 0 (0,0)	52 (24,3) 0 (0,0)	16 (7,5) 1 (100,0)	11,701	0,080
Sinus Tachycardia, n (%) No Yes	132 (71,0) 14 (48,3)	41 (22,0) 11 (37,9)	13 (7,0) 4 (13,8)	5,990	0,088
Sinus Bradycardia, n (%) No Yes	144 (67,9) 2 (66,7)	52 (24,5) 0 (0,0)	16 (7,5) 1 (33,3)	3,224	0,230
Atrial Fibrillation, n (%) No Yes	136 (68,0) 10 (66,7)	47 (23,5) 5 (33,3)	17 (8,5) 0 (0,0)	1,837	0,467
Supraventricular Tachycardia, n (%) No Yes	143 (68,8) 2 (42,9)	48 (23,1) 4 (57,1)	17 (8,2) 0 (0,0)	4,490	0,154
Ventricular Tachycardia, n (%) No Yes	146 (69,2)[a] 0 (0,0)[a]	52 (24,6)[a] 0 (0,0)[a]	13 (6,2)[b] 4 (100,0)[b]	47,471	<0,001

%: Row percent, M: Median, χ2: Chi-square test statistic, H: Kruskal Wallis test

Table 4: ECG Comparison of Patients by Outcome Status

	Treatment		Test Statistics	
	Outpatient	Service	Intensive Care	Care Test
ECG, n (%) No Yes	 140 (95,9) 54 (78,3)	 6 (4,1) 15 (21,7)	16,523	<0,001
Hospitalization Duration (days) M (min-max)	0 (0-19)	5 (0-9)	4,791	<0,001
PR Interval M (min-max)	146 (92-212)	132 (118-188)	1,302	0,193
QRS Duration (ms) M (min-max)	82 (62-192)	86 (54-152)	2,201	0,028
QTC Duration (ms) M (min-max)	432 (390-550)	446 (384-569)	2,835	0,005
Long QTC, n (%) No Yes	 144 (92,3) 50 (84,7)	 12 (7,7) 9 (15,3)	2,778	0,121
PR Depression, n (%) No Yes	 192 (91,4) 2 (40,0)	 18 (8,6) 3 (60,0)	14,656	0,007
Right Bundle Branch Block, n (%) No Yes	 188 (91,3) 6 (66,7)	 18 (8,7) 3 (33,3)	5,919	0,046
Left Bundle Branch Block, n (%) No Yes	 187 (90,3) 7 (87,5)	 20 (9,7) 1 (12,5)	0,070	0,567
ST Elevation, n (%) No Yes	 186 (90,7) 8 (80,0)	 19 (9,3) 2 (20,0)	1,246	0,254
ST Depression, n (%) No Yes	 154 (96,3) 40 (72,7)	 6 (3,8) 15 (27,3)	25,697	<0,001
T Inversion, n (%) No Yes	 150 (94,9) 44 (77,2)	 8 (5,1) 13 (22,8)	14,964	<0,001
ST-T Wave Change, n (%) No Yes	 126 (97,7) 68 (79,1)	 3 (2,3) 18 (20,9)	20,265	<0,001
1st-Degree Atrioventricular Block,n (%) No Yes	 184 (89,8) 10 (100,0)	 21 (10,2) 0 (0,0)	1,135	0,603
2nd-Degree Atrioventricular Block,n (%) No	 194 (90,2)	 21 (9,8)	-	-
3th-Degree Atrioventricular Block , n (%) No Yes	 193 (90,2) 1 (100,0)	 21 (9,8) 0 (0,0)	0,109	>0,999
Sinus Tachycardia, n (%) No Yes	 171 (91,9) 23 (79,3)	 15 (8,1) 6 (20,7)	4,537	0,033
Sinus Bradycardia, n (%) No Yes	 192 (90,6) 2 (66,7)	 20 (9,4) 1 (33,3)	1,917	0,266
Atrial Fibrillation, n (%) No Yes	 181 (90,5) 13 (86,7)	 19 (9,5) 2 (13,3)	0,233	0,646
Supraventricular Tachycardia, n (%) No Yes	 188 (90,4) 6 (85,7)	 20 (9,6) 1 (14,3)	0,168	0,518
Ventricular Tachycardia, n (%) No Yes	 192 (91,0) 2 (50,0)	 19 (9,0) 2 (50,0)	7,468	0,050

%: Row percent, M: Median, χ2: Chi-square test statistic, z: Mann-Whitney U test

DISCUSSION

Despite the studies the effect of COVID-19 on the ECG is still not fully understood. In this study, ECG findings frequently encountered in the acute phase of COVID-19 infection and the effect of these findings on prognosis were examined.

COVID-19 infection may cause ST elevation, ST depression, T wave inversion and other ST-T wave changes due to myocardial damage (9-11). In a study by Li Y.et al., it was reported that the most common ECG feature in patients hospitalized in intensive care units was ST-T wave changes as 40% (12).

In the study conducted by Yina Wang et al., it was reported that nonspecific repolarization changes, including ST-T wave changes, were observed in 41% of the patients, and it was found to be associated with poor prognosis (13). ST-T wave changes were observed at a rate of 40%, and it was concluded that, unlike other studies, these changes were more common in the discharged group and were not associated with hospitalization and hospitalization.

This can be explained by the fact that our patients are relatively younger. Nevertheless, one of the most common changes is the ST-T wave change, which is one of the results of our study.QT interval refers to the time it takes for ventricular depolarization and repolarization. An extremely prolonged QT duration (>500ms) is known to be associated with an increased risk of ventricular arrhythmias. It has been shown in previous studies that prolongation of the QT interval occurs in more than 13% of COVID-19 patients, and that some drugs, including chloroquine, hydroxychloroquine and azithromycin, previously used for COVID-19, can prolong the QT interval (14,15).

In the study conducted by Simone G. et al., in which they investigated QT prolongation in patients with COVID-19, they reported that they detected 45% unprolonged QTc in ECGs taken during the first admission. They emphasized that this prolonged QTc could be a marker of mortality. Barman HA et al. reported 5% of patients with long QTc in their study and found that it was not associated with mortality. In this study, the rate of patients with long QTc was found to be 27.5%. However, no correlation was found between mortality and long QTc. Long QTc can be seen in the early period of COVID-19. We think that the current long QTc durations are due to personal factors (16). Although bradycardias and AV blocks constitute approximately 12% of all cardiac arrhythmias, they are less common than tachycardias (12). It has been reported in previous studies that AV block may develop in COVID-19 infection (6,17). In addition, it has been reported in recent studies that there are patients who develop a temporary high-grade AV block that does not require permanent pacing during hospitalization due to COVID-19 infection (17) (18). In this study, 1st degree AV block was observed in 2% and complete AV block was observed in only one patient.

It has been reported in previous studies that atrial arrhythmias are frequently seen in COVID-19 infection (13,19). Fabio A et al. reported in their study that AF occurs most frequently among atrial arrhythmias (17). Brit L. et al. stated that sinus tachycardia is the most common atrial arrhythmia in COVID-19 infection (20). The most common arrhythmia in this study was sinus tachycardia, and our findings were similar to the studies of Brit et al. When all atrial arrhythmias are evaluated together, it is seen that approximately 25% of all our patients have atrial arrhythmias, which is consistent with the literature. Brit L et al., in their study, found that the most common form of VT in COVID-19 patients was Monomorphic VT (20). Malignant ventricular arrhythmias are a known complication of viral myocarditis and cardiomyopathy and occur in 1-6% of patients with ventricular tachycardia (VT) and/or ventricular fibrillation (VF). In COVID-19 patients, these arrhythmias may be due to a combination of drugs that prolong the QT interval, metabolic abnormalities, and myocardial inflammation (11,21-23). In this study, VT was observed at a rate of 1.9%. In addition, the presence of VT is higher in patients hospitalized in the intensive care unit and is associated with severe disease. In this study, it was concluded that the ECG features obtained at the time of admission are not associated with the prognosis of the disease in patients admitted to the emergency department due to COVID-19 infection. Only VT was found to be statistically related to intensive care admission. ST-T changes, sinus tachycardia, and AF are common in patients presenting to the emergency department with COVID-19 infection.

Study limitations

This study includes several limitations. Its single center and relatively small number of patients were the most important limitations. In addition, the past ECGs of the patients were not available. Therefore, it was unknown whether ECG findings existed prior to COVID-19 infection.

CONCLUSION

The most common finding is ST-T wave changes. In addition, ventricular arrhythmias such as atrial fibrillation, sinus tachycardia, AV blocks, bradycardia and VT can be seen in ECGs of emergency department admissions in COVID-19 infection. In this patient group where cardiac involvement is common, ECG should be seen and evaluated during the first admission to the emergency department. However, in this study, it was concluded that ECG findings had no effect on the prognosis of the patient.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Izmir Katip Celebi University Non-interventional Clinical Researches Ethics Committee (Date: 21.04.2022, Decision No: 0206).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The author has no conflicts of interest to declare.

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