ORIGINAL ARTICLE

Electrocardiographic Manifestations of Hospitalized Adult Patients with Coronavirus Disease 19 (COVID-19): UP-PGH DCVM ECG Study

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ABSTRACT

Background and Objective. COVID-19 has been associated with cardiac injury, often detectable through electrocardiographic (ECG) changes. This study seeks to characterize the cardiovascular and electrocardiographic profiles of adult patients diagnosed with COVID-19.

Methods. This study included adult patients with confirmed COVID-19 from June 2021 to June 2022. Clinical profiles and 12-lead ECG tracings were obtained from electronic medical records and reviewed independently by three cardiologists. Descriptive analysis was performed to summarize the cardiovascular and electrocardiographic findings in this population.

Results. The study included 998 COVID-19 patients (mean age: 50 years; 53.7% male). The most common comorbidities were hypertension, diabetes, and dyslipidemia. A majority (31.36%) presented with severe COVID-19 infection. The most frequent significant ECG abnormalities observed at admission were sinus tachycardia (22.8%), and atrial fibrillation (11.02%). Additional ischemic findings included ST segment depression (2.91%), T-wave inversion (1.70%), and ST segment elevation (2.71%).

Conclusion. The baseline ECG findings among COVID-19 patients were predominantly normal; however, significant abnormalities were also identified. The most frequent abnormalities included sinus tachycardia, atrial fibrillation, and ischemic changes, all of which may have clinical implications.

Keywords: Coronavirus Disease-19 (COVID-19), electrocardiography, atrial fibrillation

INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a highly infectious virus that causes COVID-19, a respiratory syndrome associated with high rates of critical illness and mortality. Aside from respiratory problems, concurrent cardiac injury cannot be ignored since it may be an independent predictor for adverse outcomes.[1] Myocardial injury has been reported variously at 12% and 7.2%[2], and to be much higher in critically ill patients with COVID-19. Patients infected by different variants of SARS-CoV-2 can have different ECG findings, including ST segment and rhythm abnormalities, which may increase their risk of sudden cardiac death.[3] Other studies has also shown that sinus tachycardia and atrial fibrillation were the most common arrhythmia noted which were significantly associated with mortality.[4] A local study conducted in the

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Philippines analyzed the electrocardiographic results of confirmed COVID-19 patients over a one-month period. The findings indicated that nearly all abnormalities were associated with QT prolongation, followed by ischemic changes and fascicular blocks as the next most common observations.[5] Notably, this is the largest local study to date providing insights into the electrocardiographic profiles of COVID-19 patients, including data collected during the surges of the Delta and Omicron variants.

METHODS

This is a descriptive study that aimed to determine the cardiovascular and electrocardiographic profile of patients with COVID-19. Specific objectives included determining the comorbidities, severity of infection (COVID-19), degree of oxygen support, and medication given throughout the admission. Furthermore, the study aimed to describe the electrocardiographic findings in terms of rate, rhythm, axis, conduction abnormalities, chamber enlargement and ST-T wave changes. This study included all adult patients admitted with COVID-19 infection confirmed with nasopharyngeal swab in Philippine General Hospital from June 2021 to June 2022. The list of adult confirmed COVID-19 patients were obtained from the admitting diagnosis of the PGH Medical Records Section. Patients in whom SARS-CoV-2 infection was not confirmed by RT-PCR pharyngeal swab, pediatric patients, expired upon admission, tagged as COVID-recovered, and patients without admission ECG were excluded (Figure 1).

Clinical Profile and Outcomes

Demographic and cardiovascular profile of confirmed COVID-19 patients were determined from the hospital's electronic medical record. Data collected included demographics, comorbidities, COVID-19 severity on admission, oxygen requirement on admission, cardiovascular drugs, and COVID-19 treatment received.

Electrocardiographic Profile

ECG tracings of confirmed COVID-19 patients were collected from the University of the Philippines-Philippine General Hospital (UP-PGH) ECG Station, subsequently interpreted using standardized criteria, and adjudicated by three cardiologists who were blinded to the clinical status of the patients. Any disagreement in interpretation were resolved by consensus. ECG data extracted included rate, rhythm, axis, intervals (PR, QRS, QT), atrioventricular block, bundle branch block, chamber enlargement, myocardial infarction and ischemia, ST segment and/or T-wave changes, and ectopic beats. ECG abnormalities that we specifically looked for included sinus bradycardia, sinus tachycardia, specific arrhythmias (atrial fibrillation, supraventricular tachycardia, and ventricular arrhythmias), chamber enlargement (left ventricular hypertrophy, right ventricular hypertrophy, left atrial enlargement, and right atrial enlargement), conduction abnormalities (atrioventricular and bundle branch blocks), ST segment deviations (ischemia and infarction), premature atrial and ventricular complexes, QT abnormalities and non-specific ST-T wave changes. Clinical and ECG data were inputted to the Divisional Cardiovascular Database, which was kept in a password-protected computer and saved as a password-protected file.

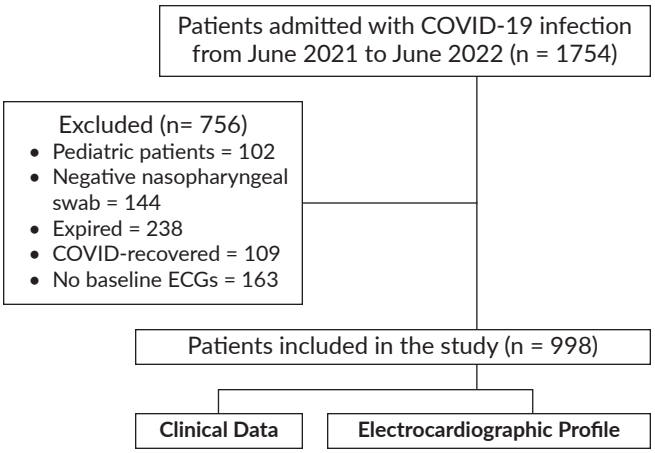

Figure 1. Flow diagram of inclusion and exclusion criteria.

Data Analysis

Descriptive statistics was used to summarize the demographic and clinical characteristics of the patients. Frequency and proportion were used for categorical variables, median and inter quartile range for non-normally distributed continuous variables, and mean and SD for normally distributed continuous variables.

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki, Philippine National Ethical Guidelines for Health Research, and Data Privacy Act of 2012. Ethical approval for the conduct of the study was sought from the UP-Manila Research Ethics Board (UPM-REB).

RESULTS

Patient Characteristics

A total of 998 COVID-19 patients were included in our cohort and their baseline characteristics are shown in Table 1. The mean age was 50 ± 19 years old, of which 53.7% were males. The most common comorbidities were hypertension (43.2%), diabetes mellitus (22.6%), and dyslipidemia (10.9%). Other cardiovascular comorbidities that were common in our cohort were previous COVID-19 infection (7.2%), chronic kidney disease (5.6%), stroke (5.0%), and asthma (5.0%). Majority of the patients were alcoholic beverage drinkers (22.1%) while 14.1% were smokers.

Table 1. Baseline Demographic and Clinical Profile of COVID-19 Patients on Admission

	Total (n=998)	Frequency
Age, years	50 ± 19	
Sex		
Male	536	53.71
Female	462	46.29
Smoking	141	14.13
Alcoholic drinkers	221	22.14
Comorbidities		
Hypertension	431	43.19
Diabetes mellitus	226	22.65
Dyslipidemia	109	10.92
Heart failure	22	2.20
Ischemic heart disease	26	2.61
Valvular heart disease	7	0.70
Chronic kidney disease	56	5.61
End-stage renal disease	8	0.80
Asthma	50	5.01
Stroke	50	5.01
PTB	32	3.21
Previous COVID-19	72	7.21
COVID-19 severity		
Mild	73	7.31
Moderate	248	24.85
Severe	313	31.36
Critical	150	15.03
Asymptomatic	214	21.44
Oxygen support		
Room air	500	50.1
Nasal cannula	261	26.15
Face mask	153	15.33
Non-rebreather mask	26	2.61
High-flow nasal cannula	22	2.20
BiPAP	1	0.10
Mechanical ventilator	35	3.51
COVID-19 and cardiovascular drugs		
Steroid	387	38.78
Remdesivir	197	19.74
Tocilizumab	73	7.31
Anticoagulant	171	17.13
Antiplatelet	75	7.52
ARB	170	17.03
ACE inhibitor	28	2.81
ARNI	9	0.90
CCB	134	13.43
Beta blockers	95	9.52
Ivabradine	6	0.60

PTB: Pulmonary tuberculosis, BIPAP: bilevel positive airway pressure, ARB: Angiotensin II receptor blockers, ACE: Angiotensin-converting enzyme, ARNI: Angiotensin receptor-neprilysin inhibitor, CCB: Calcium channel blocker

Majority of patients had severe to critical COVID-19 infection (46.4%) while 24.8% had moderate COVID-19 infection on admission. On baseline during admission, majority of patients did not require oxygen support (50.1%) while 3.5% needed intubation and mechanical ventilation. Eventually during the course of admission, some patients eventually required oxygen support. Cardiovascular drugs and COVID-19 treatment received by COVID-19 patients on admission are also presented. Majority of patients were on angiotensin II receptor blocker (17.0%), calcium channel blocker (13.4%), and beta blocker (9.5%). For the treatment for COVID-19, majority received steroid (38.8%), Remdesivir (19.7%), and parenteral anticoagulant (17.1%).

Table 2. ECG Findings on Admission of COVID-19 Patients

	Total (n=998)	Frequency
Rate		
Bradycardia	32	3.21
Tachycardia	227	22.75
Sinus	876	87.78
Atrial fibrillation	110	11.02
Atrial flutter	2	0.20
Axis		
Left axis deviation	43	4.31
Right axis deviation	15	1.50
AV block		
1st degree	43	4.31
2nd degree type 1	2	0.20
2nd degree type 2	2	0.20
3rd degree	2	0.20
Bundle branch block		
Right bundle branch block	24	2.40
Left bundle branch block	4	0.40
Intraventricular conduction delay	14	1.40
Left ventricular hypertrophy	88	8.82
Right ventricular hypertrophy	11	1.10
Left atrial abnormality	65	6.51
Right atrial abnormality	11	1.10
ST segment elevation	27	2.71
ST segment depression	29	2.91
T wave inversion	17	1.70
Early repolarization changes	59	5.91
Non-specific ST-T changes	417	41.78
Premature atrial complex	30	3.01
Premature ventricular complex	43	4.31
Poor R wave progression	104	10.42
Low voltage complexes	72	7.21
QTc interval		
Shortened	6	0.60
Prolonged	17	1.70

Electrocardiographic Findings on Admission

The ECG findings of COVID-19 patients are shown in Table 2. Most of the ECGs were in normal sinus rhythm (88%); 11% of the patients had atrial fibrillation while 0.2% had atrial flutter. Abnormal axis was rare (5.8%), with 4.3% having left axis deviation and 1.5% having right axis deviation. Conduction abnormalities were also rare, with 4.9% having atrioventricular (AV) block, 2.8% having bundle branch block, and 1.4% having intraventricular conduction

Table 3. Comparison of ECG Findings Based on the Severity of COVID-19

ECG Finding, Frequency (%)	Non-severe	Severe	Critical
Sinus rhythm	238 (96.4)	189 (96.4)	83 (86.5)
Rate			
Normal	186 (75.3)	140 (71.4)	50 (52.1)
Bradycardia	13 (5.3)	9 (4.6)	4 (4.2)
Tachycardia	48 (19.4)	47 (24.0)	42 (43.8)
Atrial fibrillation	7 (2.8)	6 (3.1)	8 (8.3)
Atrial flutter	0 (0.0)	0 (0.0)	1 (1.0)
Axis			
Normal	233 (94.3)	181 (92.3)	84 (87.5)
Left	10 (4.0)	10 (5.1)	10 (10.4)
Right	4 (1.6)	5 (2.6)	2 (2.1)
Extreme	0 (0.0)	0 (0.0)	0 (0.0)
AV Block			
1st degree	7 (2.8)	3 (1.5)	4 (4.2)
2nd degree type 1	0 (0.0)	1 (0.5)	0 (0.0)
2nd degree type 2	1 (0.4)	0 (0.0)	0 (0.0)
3rd degree	1 (0.4)	0 (0.0)	0 (0.0)
Bundle Branch Block			
Right	9 (3.6)	5 (2.6)	4 (4.2)
Left	1 (0.5)	2 (1.0)	0 (0.0)
Intraventricular conduction delay	5 (2.0)	2 (1.0)	3 (3.1)
Left ventricular hypertrophy	11 (4.5)	15 (7.7)	8 (8.3)
Right ventricular hypertrophy	2 (0.8)	2 (1.0)	3 (3.1)
Left atrial abnormality	18 (7.3)	22 (11.2)	3 (3.1)
Right atrial abnormality	3 (1.2)	2 (1.0)	1 (1.0)
ST elevation myocardial infarction	3 (1.2)	0 (0.0)	2 (2.1)
ST depression	9 (3.6)	3 (1.5)	6 (6.3)
T wave inversion	1 (0.4)	2 (1.0)	6 (6.3)
Early repolarization changes	5 (2.0)	9 (4.6)	7 (7.3)
Nonspecific ST-T wave changes	107 (43.3)	73 (37.2)	42 (43.8)
Premature atrial complexes	9 (3.7)	2 (1.0)	4 (4.2)
Premature ventricular complexes	8 (3.2)	3 (1.5)	4 (4.2)
Poor R wave progression pattern	15 (6.1)	21 (10.7)	11 (11.5)
Low voltage complexes	18 (7.3)	18 (9.2)	7 (7.3)
Prolonged QT interval	7 (2.8)	3 (1.5)	3 (3.1)

delay. Left ventricular hypertrophy (8.8%) and left atrial abnormality (6.5%) were more common than right ventricular hypertrophy (1.1%) and right atrial abnormality (1.1%). Premature atrial complexes were seen in 3.0% and premature ventricular complexes in 4.3%. The most common significant ECG abnormalities were sinus tachycardia (22.7%) and atrial fibrillation (11%). Importantly, ST segment depression, ST segment elevation, and T wave inversion were also found to be present, which were seen in 2.9%, 2.7% and 1.7% of the ECGs, respectively. Other ECG findings included poor R wave progression (PRWP) and early repolarization changes.

On the other hand, the comparison of ECG findings based on the severity of COVID-19 is shown on Table 3. Remarkably, the percentage of atrial fibrillation is significantly higher among patients who had severe (3.1%) and critical (8.3%) COVID-19. On the contrary, patients with non-severe cases already had baseline ischemic ECG findings, namely ST elevation MI (1.2 %), ST depression (3.6%), and T wave inversion (0.4%).

DISCUSSION

Previous studies have reported that SARS-CoV-2 can cause ECG abnormalities, and studies on the ECG characteristics of patients with COVID-19 are still underway. This study of more than 900 hospitalized COVID-19 patients with ECGs is the largest study of ECG testing in patients with confirmed COVID-19 in the Philippines to date. Compared to the local study conducted by Ozaeta and colleagues[5], only a small percentage of the population (1.7%) in this study exhibited a baseline prolonged QTc interval, which is expected given that these individuals had not received any form of treatment at the onset. Similarly, both studies highlighted a significant proportion of the population with ischemic electrocardiographic findings at baseline, aligning with the known direct toxic effects of SARS-CoV-2 on the myocardium. Furthermore, compared to the study of Li and colleagues[6] done also in an Asian population in 2020, our cohort was younger and had higher prevalence of cardiovascular comorbidities. Hypertension and diabetes were also the most common comorbidities of hospitalized COVID-19 patients. Angiotensin II receptor blockers and calcium channel blockers were also the most common cardiovascular drugs prescribed on these patients on admission. Our study found similarities with the findings of McCullough and colleagues[7] in 2020 on the ECG findings among hospitalized COVID-19 patients: (1) majority of patients had normal sinus rhythm, (2) signs of ischemia including ST segment elevation, ST segment depression, and T wave inversions were found to be frequent, together with non-specific ST-T wave changes, (3) AV blocks were rare, (4) left ventricular hypertrophy was more common than right ventricular hypertrophy, and (5) premature ventricular complex was more common than premature atrial complex. Our study was different from McCullough and colleagues[7] in that in our cohort, there were lower frequency of atrial fibrillation, abnormal axis, bundle branch blocks and intraventricular conduction delay, and early repolarization changes. Since the incidence of atrial fibrillation increases with age, the lower frequency of atrial fibrillation observed can be explained by the younger population included in our cohort. Given these differences, overall, the ECG findings among COVID-19 patients during the surge of Delta and Omicron variants do not significantly differ from the ECGs of patients infected by previous COVID-19 variants.

Although the study results indicate that the majority of ECGs were normal, the identification of baseline electrocardiographic abnormalities, including atrial fibrillation (11%) and ischemic findings (7%), is clinically significant.

These abnormalities may influence patient management, as they have the potential to contribute to clinical deterioration if left undetected. Therefore, this study recommends performing baseline ECG in confirmed COVID-19 patients to detect these significant findings. Additionally, serial ECG evaluations are warranted to monitor the progression of abnormalities during hospitalization. Further research is warranted to explore this aspect in greater detail.

Our study has some limitations. The analyzed population consisted of individuals with COVID-19 infection who required hospital admission. As a result, the true prevalence of electrocardiographic abnormalities in the population may be underestimated. Furthermore, when the ECG was abnormal on admission, it was not possible to determine if those abnormalities were related to COVID-19 infection or to a previous unknown heart disease, and this factor should be studied further.

CONCLUSION

Majority of patients with COVID-19 in our sample population presented with normal 12L-ECGs. Nevertheless, it still noteworthy that cardiovascular comorbidities and ECG abnormalities were not uncommon. Most were hypertensives and diabetics, and had moderate to severe COVID-19 infection. The significant electrocardiographic abnormalities most commonly observed were sinus tachycardia, atrial fibrillation, and signs relating to ischemia.

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Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

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