The Value and Applicability of the Electrocardiography in Revealing the Cardiac Involvement of COVID-19 Patients

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ABSTRACT

Background: COVID-19 may have a role in myocardial injury in some patients, which can lead to multiple cardiovascular consequences. Electrocardiography (ECG) is useful to detect cardiac involvement of COVID-19. Objective: In this study, we aimed to identify the pattern of ECG findings in COVID-19 patients. Methods: We retrospectively evaluated the clinical data of 176 patients diagnosed with COVID-19 along with their ECG findings on admission and during hospitalization. Results: Out of 176 patients, 56.8% were males. The mean age of the patients was 64.4 (SD: 15.4) years. Twenty-five patients were obese (Body mass index "BMI" > 30). Comorbidities including hypertension, diabetes mellitus, and coronary artery disease were found in 70.5%, 52.3%, and 24.4% of patients, respectively. Only 17% of patients had normal ECG readings, and the rest had abnormalities of various types. Heart rate was normal in 67.6% of patients, the rest were tachycardiac (29.0%) or bradycardiac (3.4%). Findings included a widened QRS complex in 6.2% of patients, 79.0% of patients had a prolonged PR interval, and 9.1% had a prolonged QT interval. The most common ECG abnormalities were sinus tachycardia (20.5%) and atrial fibrillation (18.2%). We found a correlation between mortality and atrial fibrillation (p=0.021) and ventricular premature contraction (p=0.007). As for complications, atrial fibrillation and sinus tachycardia were significantly correlated with major complications including death, need for positive pressure ventilation (PPV), intensive care unit (ICU) admission, myocardial infarction, and acute respiratory distress syndrome (ARDS).

Conclusion: ECG is a robust indicator of myocardial involvement of the COVID-19 patients. This study highlighted the diagnostic and prognostic importance of conducting ECG on admission and during hospitalization for COVID-19 patients. More investigation is required to determine the diagnostic accuracy and prognostic value of this modality.

Keywords: ECG; COVID-19; Cardiac Abnormalities; Mortality; Survival; Prognosis.

1. BACKGROUND

Coronavirus disease 2019 (COVID-19) is a respiratory disease, causing massive critical illness and mortality worldwide associated with the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (1). COVID-19 affects other organs than the respiratory system and can cause multiorgan failure. Importantly, it has a role in causing acute myocardial injury via acute coronary syndrome, myocarditis, heart failure, hypotension or shock, and sepsis. Manifestation of such injury can range from being asymptomatic to myocarditis, and circulatory shock (2). These symptoms could be due to the expression of angiotensin-converting enzyme 2 (ACE2) receptors on the surface of around 7.5% of myocardial cells. Although the expression of ACE2 could explain the myocardial injury, the etiology is most likely multifactorial (3).

Electrocardiography (ECG) is a widely available diagnostic test that has a crucial prognostic value for patients with cardiovascular conditions, which makes ECG essential during the COVID-19 pandemic (4, 5). In addition to cardiac symptoms, changes in ECG are proof that COVID-19 has significant cardiac involvement (5). The prevalence of cardiovascular disease in COVID-19 pa-
patients is reported to be common as was the case for SARS and MERS patients, which are the other two previous viruses from the same family as COVID-19. In MERS, cardiovascular disease prevalence was about 30% of the patients while it was 11% in SARS patients with an increased death risk to 12-folds (6-8).

Once it is proved that COVID-19 involves the cardiovascular system and affects cardiac tissue by unclear mechanisms (9), it seems a good idea to relate or investigate COVID-19 patients with electrocardiography when needed. In this study, we aim to report abnormal ECG findings in a cohort of COVID-19 Middle Eastern patients from Jordan.

2. OBJECTIVE

In this study, we aimed to identify the pattern of ECG findings in COVID-19 patients.

3. MATERIAL AND METHODS

Study Design and Population

We extracted data for 176 patients from hospital records in the period of (March 2020 to March 2021). Inclusion criteria considered all patients diagnosed with COVID-19 using a polymerase chain reaction (PCR) test in that period and who had completed records. No age restrictions were applied to the inclusion of patients. Data extraction included variables such as patients’ age, gender, comorbidities, body mass index, smoking status, cardiovascular measurements, medications, laboratory findings, and ECG findings.

Primary and Secondary outcomes

The main outcome of this study was in-hospital (30-day) mortality. Accordingly, we compared the “Dead” and the “Alive” group. We considered complications as a secondary outcome. Any patient that has been put on positive pressure ventilation (PPV), transferred to the intensive care unit (ICU), had a myocardial infarction (MI), a stroke, or acute respiratory distress syndrome (ARDS) was categorized as having a “Major” complication. Patients with any other complications were considered in the “Minor” group.

ECG Analysis and Interpretation

A 12-lead ECG was obtained for all patients at admission. A blinded single senior cardiologist reviews all the ECGs offline and record the heart rate (HR), PR interval, QT, and corrected QT (QTc) interval, the duration of the QRS, and any abnormalities in the ECGs which include atrial arrhythmias, ventricular arrhythmias and conduction block (atrioventricular block, bundle branch block, or fascicular block), ST-T changes. The ST-segment changes were measured based on the difference in the height (in millimeters) between the J point and the isoelectric point. T-wave was considered normal when it is positive in all leads except from lead III, V1, and aVR with a voltage more than or equal to 0.1 millivolts, inverted when the T wave is negative in any lead except leads III, V1, and aVR, with a voltage more than or equal 0.1 millivolts, and flattened when the voltage is less than 0.1 mm. Pathological Q wave was defined when any Q wave with 40 milliseconds (ms) wide and more than 2 millimeters deep or more than 25 percent of the QRS depth. According to the Sokolow–Lyon criteria, the left ventricular hypertrophy was defined if the sum of the amplitude of the S wave in V1 and R wave in V5 or V6 more than or equal 35 millimeters or the amplitude of the R wave in lead aVL more than or equal 11 millimeters with or without secondary changes in the ST-T segments.

Ethical Approval and Registration

This study was approved by the institutional review board (IRB) of King Abdullah University Hospital (Ref no. 52/136/2020). A waiver of consent was approved from the IRB for all patients due to the retrospective nature of the study.

Statistical analysis

Summary statistics were demonstrated using means and Standard Deviations (SD) for continuous variables and compared using a t-test. Categorical variables were summarized using frequency counts and percentages, and the chi-square test was used for associations. If cell counts were less than 5, a Fisher’s exact test was used. We calculated risk ratios (RR) and their confidence intervals using Wald’s method. A two-sided p-value of 0.05 was considered statistically significant. All statistical analyses were done using R statistical language, version 4.0.5 (10).

4. RESULTS

Sample characteristics

In this study, we evaluated 176 patients diagnosed with COVID-19 and admitted to the hospital. The mean age of the sample was 64.4 (SD: 15.4) years (Table 1). Males constituted 56.8% of patients. The mean body mass index (BMI) was 29.5±7.12, with 25 patients having a BMI of above 30. Twenty (11.4%) patients were active smokers, 10.8% of patients were ex-smokers, and 46.0% never smoked. Three patients (1.7%) had a pacemaker. As for comorbidities, 70.5% of patients suffered from hypertension, 52.3% from diabetes mellitus, 24.4% from coronary artery disease, 13.6% from chronic kidney disease. Additionally, 14.8% of patients had a history of heart failure, 10.2% had a history of arrhythmia. Sixteen (9.1%) patients had an active malignancy, 15 (8.5%) had hyperlipidemia, 11 (6.3%) had a history of stroke, 1 (0.6%) patient had a deep vein thrombosis, and no patients had a pulmonary embolism. Among patients, 35.8% were admitted to the intensive care unit (ICU) and 33.5% were put on positive pressure ventilation (PPV). A proportion of patients were taking proton-pump inhibitors (67.2%), antibiotics (65.5%), low-molecular-weight heparin (54.8%), aspirin (46.9%), beta-blocker (45.8%), vitamin D (43.5%), and others summarized in Table 2. As well, 3 patients were taking hydroxychloroquine.

Electrocardiographic Findings

When performing ECG, HR was normal in 67.6% of patients (median HR: 92 bpm) (Table 3). HR at admission was also normal at a similar rate (67.8%). At the time of taking the ECG, the QT wave interval was abnormal in 16 (9.1%) patients. The PR was prolonged in 79.0% of patients. The median QRS complex length was 84 ms and was prolonged in 30 (17.0%) patients. Thirty patients (17.0%) had normal ECG findings; the rest had various abnormalities.
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| Mortality | Complications | Overall |
|-----------|---------------|---------|
| Age       |               |         |
| Mean (SD) | 68.1 (12.0)   | 62.3 (16.9) | 0.008 | 67.6 (11.7) | 62.0 (17.7) | 0.012 | 64.6 (15.4) |
| Median [Min, Max] | 70.5 [31.0, 88.0] | 65.0 [100, 96.0] | 0.008 | 70.0 [31.0, 88.0] | 65.0 [100, 96.0] | 0.012 | 68.0 [100, 96.0] |

Gender

| Female | 28.0 (40.0%) | 48.0 (45.3%) | 0.591 | 33.0 (39.8%) | 43.0 (46.2%) | 0.475 | 60.0 (42.2%) |
| Male   | 42.0 (60.0%) | 58.0 (54.7%) | 50.0 (60.2%) | 50.0 (53.8%) | 0.100 (56.8%) |

Body mass index

| Mean (SD) | 29.1 (6.2) | 29.7 (6.9) | 0.73 | 29.6 (5.9) | 29.4 (7.20) | 0.91 | 29.5 (7.12) |
| Median [Min, Max] | 28.9 [22.0, 49.6] | 28.7 [13.9, 46.9] | 0.73 | 29.3 [21.8, 49.6] | 28.1 [13.9, 46.9] | 0.91 | 29.0 [20.4, 46.8] |

Smoking

| Current smoker | 7.00 (10.0%) | 13.0 (12.3%) | 0.663 | 9.00 (10.8%) | 11.0 (11.8%) | 0.758 | 29.0 (11.4%) |
| Ex-smoker (quite for more than 6 months) | 10.0 (14.3%) | 9.00 (8.5%) | 11.0 (13.3%) | 8.00 (8.6%) | 0.937 | 19.0 (10.8%) |
| Non-smoker | 31.0 (44.3%) | 50.0 (47.2%) | 36.0 (43.4%) | 45.0 (48.4%) | 0.938 | 81.0 (46.0%) |
| Missing | 22.0 (31.4%) | 47.0 (35.8%) | 34.0 (32.1%) | 63.0 (67.7%) | 0.724 | 56.0 (31.8%) |

Risk factors

| Pacemaker | 1.00 (1.4%) | 2.00 (1.9%) | - | 1.00 (1.2%) | 2.00 (2.2%) | - | 3.00 (1.7%) |
| Heart failure | 11.0 (15.7%) | 15.0 (14.2%) | 0.945 | 11.0 (13.3%) | 15.0 (16.1%) | 0.746 | 26.0 (14.8%) |
| Arrhythmia | 7.00 (10.0%) | 11.0 (10.4) | 1.000 | 8.00 (8.6%) | 10.0 (10.8) | 1.000 | 18.0 (10.2) |
| Hypertension | 51.0 (72.9%) | 73.0 (68.9%) | 0.69 | 61.0 (73.5%) | 63.0 (67.7%) | 0.503 | 124 (70.5%) |
| Diabetes mellitus | 42.0 (60.0%) | 50.0 (47.2%) | 0.13 | 50.0 (60.2%) | 42.0 (45.2%) | 0.065 | 92.0 (52.3%) |
| Coronary artery disease | 15.0 (21.4%) | 28.0 (26.4%) | 0.566 | 21.0 (25.3%) | 22.0 (23.7%) | 0.938 | 43.0 (24.4%) |
| Chronic kidney disease | 13.0 (18.6%) | 11.0 (10.4) | 0.185 | 14.0 (16.9%) | 10.0 (10.8%) | 0.337 | 24.0 (13.6%) |
| Stroke | 5.00 (7.1%) | 6.00 (5.7%) | 0.937 | 6.00 (7.2%) | 5.00 (5.4%) | 0.845 | 11.0 (6.3%) |
| Deep vein thrombosis | 1.00 (1.1%) | 0.00 (0%) | - | 1.00 (1.2%) | 0.00 (0%) | - | 1.00 (0.6%) |
| Pulmonary embolism | 0 (0%) | 0 (0%) | - | 0 (0%) | 0 (0%) | - | 0 (0%) |
| Asthma | 1.00 (1.4%) | 4.00 (3.8%) | 0.649 | 1.00 (1.2%) | 4.00 (4.3%) | 0.372 | 5.00 (2.8%) |
| Chronic obstructive pulmonary disease | 2.00 (2.9%) | 3.00 (2.8%) | 1.000 | 2.00 (2.4%) | 3.00 (2.8%) | 1.000 | 5.00 (2.8%) |
| Malignancy | 10.0 (14.3%) | 6.00 (5.7%) | 0.093 | 12.0 (14.5%) | 4.00 (4.3%) | 0.033 | 16.0 (9.1%) |
| Hyperlipidemia | 10.0 (14.3%) | 5.00 (4.7%) | 0.051 | 11.0 (13.3%) | 4.00 (4.3%) | 0.056 | 15.0 (8.5%) |
| Active dialysis | 3.00 (4.3%) | 5.00 (4.7%) | 1.000 | 3.00 (3.6%) | 5.00 (5.4%) | 0.724 | 8.00 (4.5%) |
| Hypotension | 2.00 (2.9%) | 5.00 (4.7%) | 0.704 | 2.00 (2.4%) | 5.00 (5.4%) | 0.449 | 7.00 (4.0%) |
| Hypertension | 0 (0%) | 1.00 (0.9%) | - | 0 (0%) | 1.00 (1.1%) | - | 1.00 (0.6%) |
| Immunosuppression | 0 (0%) | 1.00 (0.9%) | - | 0 (0%) | 1.00 (1.1%) | - | 1.00 (0.6%) |
| ICU | 57.0 (81.4%) | 6.00 (5.7%) | <0.001 | 63.0 (75.9%) | 0 (0%) | - | 63.0 (35.8%) |
| PPV | 53.0 (75.7%) | 6.00 (5.7%) | <0.001 | 59.0 (71.1%) | 0 (0%) | - | 59.0 (33.5%) |

Table 1. Sample characteristics including demographics, comorbidities, intensive care unit (ICU), and positive pressure ventilation (PPV) status for patients in terms of mortality and complications.

Sinus tachycardia (20.5%) and atrial fibrillation (18.2%) were the most common ECG abnormalities. Also, T-wave inversion was reported in (15.9%) and non-specific ST changes were reported in (15.3%) of patients. Seven patients had ST depression, and one patient had non-specific T-wave changes. As for MI, we found acute MI findings in 3 patients, and findings that indicate a previous MI at an unknown age in 19.9% of patients. Right and left bundle branch blocks (RBBB and LBBB) were found in 9 and 3 patients, respectively. Other findings are summarized in Table 4.

Mortality

Seventy patients (39.8%) passed away and 106 (60.2%) survived. Patients who died were older (mean difference = 5.8 years, p=0.008) (Table 1). Gender, BMI, and smoking status did not have significant effects on mortality. Most comorbidities were not correlated with mortality rates. Patients put on PPV were much more likely to die (RR = 13.4, 95% CI, 6.1 to 29.4, p<0.001) than patients who did not need PPV. As well as, patients who got admitted to the ICU (RR = 14.4, 95% CI, 6.5 to 31.5, p<0.001) (Table 3). HR was slightly higher in the dead group (mean difference = 8.4 bpm, p=0.008), but the pulse rate on admission was not different at all. ECG waves and interval lengths were not significantly correlated with mortality. The survived group had a higher rate of normal ECG findings (23.6% vs. 7.1%, p=0.009) (Table 4). In addition, they had a significantly higher indication of MI at an unknown age (25.5% vs. 11.4%, p=0.037). Although having a history of arrhythmia did not correlate with mortality, the mortality group was significantly more prevalent with atrial fibrillation found on ECG (27.1% vs. 12.3%, p=0.021) and ventricular premature contraction (12.9% vs. 1.9%, p=0.007). Patients from the mortality group had 3 times more risk of having sinus tachycardia than the survival group (95% CI, 1.6 to 5.7, p=0.005).

Complications

Major complications included death, admission to the...
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ICU, getting started on PPV, having an MI, Stroke, or ARDS. Eighty-three (47.2%) patients were in the Major group and 93 (52.8%) were in the Minor group. Major group patients were averagely 5.6 years older than the Minor group (p=0.012). No differences were found in terms of gender, BMI, smoking status, and comorbidities (Table 1). Minor group patients were more likely to have normal ECG findings (24.7% vs. 8.4%, p=0.008) than Major group patients (Table 4). Additionally, Major group patients had a higher likelihood of developing atrial fibrillation (RR = 1.25, 95% CI, 1.08 to 1.45, p=0.004) and sinus tachycardia (RR = 1.26, 95% CI, 1.08 to 1.48, p=0.005). Lastly, having a history of arrhythmia was not different between the Minor and Major complication groups.

5. DISCUSSION
Cardiovascular involvement in the COVID-19 infection is a common complication and is well reported in the literature. It can be classified into five categories: cardiac injury, arrhythmia, new onset or exacerbation of pre-existing heart failure, thromboembolic complications, and

| Table S Overall | (N=176) |
|-----------------|---------|
| Hydroxychloroquine | 2.00 (1.1%) |
| Beta-blocker | 81.0 (46.0%) |
| CaCS | 50.0 (28.4%) |
| ACE Inhibitor | 45.0 (25.6%) |
| Sartans | 45.0 (25.6%) |
| Antibiotics | 116 (65.9%) |
| LMWH | 97.0 (55.1%) |
| Aspiring | 83.0 (47.2%) |
| Statins | 73.0 (41.5%) |
| PPI | 19.0 (11.6%) |
| Thyrinnine | 6.00 (4.5%) |
| Vitamin D | 77.0 (43.8%) |

Table 2. Medications that were given to the total cohort of patients. Abbreviations: CaCB: Ca++ channel blocker, LMWH: Low molecular weight heparin, PPi: Proton pump inhibitors.

| Mortality | Overall |
|-----------|---------|
| Systolic Pressure | |
| Mean (SD) | 127 (18.9) |
| Median [Min, Max] | 127 [20.0, 200] |
| Diastolic Pressure | |
| Mean (SD) | 72.5 (10.2) |
| Median [Min, Max] | 76.5 [0, 100] |
| HR | |
| Mean (SD) | 97.2 (18.5) |
| Median [Min, Max] | 92.1 (16.0) |
| QT | |
| Mean (SD) | 367 (61.4) |
| Median [Min, Max] | 363 (60.1) |
| PR | |
| Mean (SD) | 146 (27.5) |
| Median [Min, Max] | 148 (26.1) |
| QRS | |
| Mean (SD) | 88.2 (17.3) |
| Median [Min, Max] | 84.0 (12.0) |

Table 3. ECG findings (PPV) status for patients in terms of mortality and complications.
medication-induced cardiac abnormalities (11,12). Cardiovascular implications in COVID-19 patients represent a worse prognosis (13). ECG changes related to myocardial abnormalities are likely caused by cytokine storm, hypoxia-induced injury, plaque rupture, coronary spasm, and microthrombi, in addition to endothelial or myocardial injury (14, 15). Electrocardiography is a valuable tool in medicine because it is cheap, widely available, and can provide important information on the cardiovascular status of patients. ECG alteration in COVID-19 patients was studied in many articles around the globe, most of them suggested that in addition to its diagnostic value, has a prognostic value in COVID-19 patients (3, 11, 12, 15). Therefore, detection of such presentations through ECG could be helpful for emergency clinicians for the evaluation and the management of patients and potentially infected patients (3).

ECG abnormalities were estimated to occur in 93% of critically ill patients by one study (15). Palpitation was the initial presentation in 17% in one study and 44% of ICU admitted patients (16). The most common reported ECG abnormality in the literature was sinus tachycardia, which is a similar finding in our study (prevalence = 20.5%). Although this was opposing to our findings, the most common alteration associated with poor prognosis was ischemic primary ST-T segments changes and signs of left ventricular hypertrophy according to the literature (3, 11, 17). This effect was statistically insignificant, and it could be attributed to the rare occurrence of ST-T abnormalities and left ventricular hypertrophy, which caused small sample sizes in these subgroups.

Arrhythmia and ECG abnormalities were reported more commonly in critically ill patients and estimated to occur in 33%-93% of these patients, and it is associated with increased risk of in-hospital mortality and the need for mechanical ventilation in those patients (15, 18, 19). In our cohort, 83% of our patients had ECG abnormalities, and patients from the Major complications group and patients who died had a 16.3% and a 16.5% increased risk of having ECG abnormalities, respectively. Other reported

### Table 4. ECG abnormalities divided into subcategories for patients in terms of mortality and complications.

| ECG Abnormality                  | Mortality (N=83) | Complications (N=93) | P-value Overall | P-value Major | P-value Minor |
|----------------------------------|------------------|----------------------|----------------|--------------|---------------|
| Interventricular conduction block|                  |                      |                |              |               |
| RBBB                            | 5.00 (7.1%)      | 4.00 (3.8%)          | 0.486          | 6.00 (7.2%)  | 3.00 (3.2%)   | 0.31          | 9.00 (5.1%)   |
| LBBB                            | 2.00 (2.9%)      | 1.00 (0.9%)          | 0.563          | 2.00 (2.4%)  | 1.00 (1.1%)   | 0.6           | 3.00 (1.7%)   |
| Other findings                   |                  |                      |                |              |               |
| atrial premature contraction     | 6.00 (8.6%)      | 3.00 (2.8%)          | 0.158          | 6.00 (7.2%)  | 3.00 (3.2%)   | 0.31          | 9.00 (5.1%)   |
| prolonged QT                     | 0 (0%)           | 1.00 (0.9%)          | -              | 1.00 (1.2%)  | 0 (0%)        | -             | 1.00 (0.6%)   |
| paced rhythm                     | 0 (0%)           | 1.00 (0.9%)          | -              | 0 (0%)       | 1.00 (1.1%)   | -             | 1.00 (0.6%)   |
| grade 1 AV block                 | 0 (0%)           | 1.00 (0.9%)          | -              | 0 (0%)       | 1.00 (1.1%)   | -             | 1.00 (0.6%)   |
| paroxysmal SVT                   | 1.00 (1.4%)      | 1.00 (0.9%)          | 1.000          | 1.00 (1.2%)  | 1.00 (1.1%)   | 1.000         | 2.00 (1.1%)   |
| AFIB                             | 19.0 (27.1%)     | 30.0 (12.3%)         | 0.021          | 23.0 (27.7%) | 9.00 (9.7%)   | 0.004         | 32.0 (18.2%)  |
| ventricular premature contraction| 9.00 (12.9%)     | 2.00 (1.9%)          | 0.007          | 9.00 (10.8%) | 2.00 (2.2%)   | 0.026         | 11.0 (6.3%)   |
| Left ventricular hypertrophy     | 4.00 (5.7%)      | 8.00 (7.5%)          | 0.765          | 5.00 (6.0%)  | 7.00 (7.5%)   | 0.924         | 12.0 (6.8%)   |
| sinus tachy                      | 24.0 (34.3%)     | 12.0 (11.3%)         | <0.001         | 25.0 (30.1%) | 11.0 (11.8%)  | 0.005         | 36.0 (20.5%)  |
| sinus brady                      | 1.00 (1.4%)      | 5.00 (4.7%)          | 0.404          | 1.00 (1.2%)  | 5.00 (5.4%)   | 0.215         | 6.00 (3.4%)   |
| short PR interval                | 1.00 (1.4%)      | 0 (0%)               | -              | 1.00 (1.2%)  | 0 (0%)        | -             | 1.00 (0.6%)   |
| junctional rhythm                | 2.00 (2.9%)      | 0 (0%)               | -              | 2.00 (2.4%)  | 0 (0%)        | -             | 2.00 (1.1%)   |
| left atrial enlargement          | 0 (0%)           | 1.00 (0.9%)          | -              | 0 (0%)       | 1.00 (1.1%)   | -             | 1.00 (0.6%)   |
alteration includes atrial arrhythmias (atrial fibrillation and flutter), conduction block which constitutes 11.8% of cardiac dysrhythmia in COVID-19 patients (atrioventricular block, bundle branch block, and fascicular block), and ventricular arrhythmia (ventricular tachycardia and fibrillation) (1, 4, 9, 10). The ventricular arrhythmias were considered one of the causes of death in the COVID-19 patients (11). Cardiac arrhythmias have been reported in 16.7% of the patients (3, 11, 19-23). Around 12% of our patients experienced interventricular block that includes RBBB, LBBB, interventricular conduction block, and left fascicular block. The ventricular premature contraction was found in 6.3% of patients and was more common in the mortality group (12.9% vs. 1.9%, p=0.007). Wang et al (24), conducted a study on 138 hospitalized patients and suggested that cardiac arrhythmia is the most common cardiac complication, and it was more common in severely ill patients. Another study by Huang et al (16), reported an increase in the incidence of arrhythmia in patients with severe disease compared to patients with mild disease (44.4% vs 6.9, p=0.001). Atrial fibrillation was reported in 14.3% of patients on admission and 10.1% of patients during hospitalization in a study conducted in a hospital in New York City (25). Another study reported that 22% of mechanically ventilated patients had atrial fibrillation (15). Bergamaschi et al (9), studied the ECG finding on 216 patients on admission and after 7 days of admission and he suggested that ECG during hospitalization might have an important prognostic value, and he found that abnormal ECG on the 7th day of the hospitalization was an independent risk factor to develop major adverse event and mortality in COVID-19 and it has a stronger association than ECG on admission. In our cohort, atrial fibrillation was found in 18.2% of patients as an ECG abnormality and was significantly associated with mortality and Major complications, which is concordant with findings of the literature (26-28). Moreover, Bergamaschi et al. found that new-onset atrial fibrillation has the worst outcome while atrial fibrillation on admission does not affect the prognosis (9). This was similar to our case for arrhythmias in general, having a history of arrhythmias in our study did not affect mortality or complication status. A study by Haseeb et al. (11) on 1258 patients, reported higher odds of the need for mechanical ventilation and death among patients with atrial fibrillation/flutter (Odds ratio “OR” 2.5), right ventricular (RV) strain (OR 2.7), and ST-segment abnormalities (OR 2.4). Several other studies reported a higher incidence of ICU admission among patients with pre-existing cardiovascular disease revealing the importance of ECG monitoring on admission and during hospitalization (15). We reported an ICU admission prevalence of 35.8%.

6. CONCLUSION

ECG is a robust indicator of myocardial involvement of the COVID-19 patients. This study highlighted the diagnostic and prognostic importance of conducting ECG on admission and during hospitalization for COVID-19 patients. More investigation is required to determine the diagnostic accuracy and prognostic value of this modality.

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