Original Research Article

Electrocardiographic Changes in COVID-19 Pneumonia: A Cohort Study

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Abstract

Objective: To study electrocardiographic changes in COVID-19 pneumonia. **Methods:** ECG of 200 patients of COVID-19 pneumonitis admitted in Covid ward was studied. The collective data analysis was done using appropriate statistical test between the variables **Results:** Amongst various ECG manifestations, widespread new onset concave ST elevation followed by PR depression in almost every limb lead and precordial leads was most common suggesting acute pericarditis. **Conclusion:** The occurrence of ECG abnormalities in COVID-19 pneumonia is non dependant on severity of pulmonary tract infection. The ECG abnormalities are of past due onset, with various cardiovascular disease and regularly arise after non-significant nasopharyngeal swabs.

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

Introduction

COVID-19 infection manifests clinically as Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2)[1,2].The infection usually present with respiratory symptoms (including cough, fatigue and fever)) which may progress to pneumonia, acute respiratory distress syndrome (ARDS)and shock[1-3]. COVID-19 may adversely damage the heart and cardiovascular system. Some reviews additionally defined acute cardiovascular syndromes of SARS-CoV-2 which includes decompensated heart failure, acute coronary syndrome and myocarditis[4-7].Regarding this, standard electrocardiography (ECG) is an important test to rule out any injury to the myocardium and sinus abnormalities in SARS-CoV-2 patients. Nonetheless, research on ECG features especially during acute phase of SARS-CoV-2 is still in process, Thus, goal of this study is to investigate the ECG abnormalities associated with cardiac involvement during hospitalization for COVID-19 pneumonia.

Methods

In an ongoing registration of patients affected by COVID19, analysis of data from 200 patients consecutively hospitalized from September 15 to December 14,2020 in the COVID ward of the Maharishi Markandeshwar Medical College and Hospital, Solan (H.P).

All the sufferers with respiratory symptoms and signs and radiological findings suggesting COVID-19 pneumonia have been transferred medical and emergency departments of the hospital. The analysis of viral contamination become confirmed in all sufferers via way of means of nasopharyngeal swab[8].

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At admission, the initial evaluation included a detailed history and clinical examination, laboratory tests, 12-lead ECG, and arterial blood gas test. Additional comorbidities were also defined as per medical history by study-site level physician.

For protocol, Additional ECG was repeated at the time of discharge from medical institution and whilst clinical situations worsened or whilst there have been significant modifications in laboratory parameters. Standard techniques were used to assess laboratory parameters. PaO2/FIO2 ratio become used to analyse the severity of respiratory dysfunction[9]. Arterial blood gas was additionally analysed during significant ECG changes or any clinical worsening.

Recording of ECG was done with standard 25 mm/s and 1 mV/cm calibration, and 0.05–150 Hz filter setting. Coding of ECG tracings was done and were analysed off-line. ECG parameters measured were: Corrected QT interval (msec), Heart rate (HR), Cornell voltage (mm) and any ST-T abnormalities (Yes vs No). Cornell voltage was measured as the sum of the amplitudes of R wave in aVL and S wave in V3[10]. The corrected QT_c interval was measured as the interval between the origin of the Q wave and the termination of the T wave and correction was done by HR in accordance to the Bazett's formula. We also included measurement of PR interval (interval between the onset of the P wave and the end of the R wave) and QRS interval (interval from the beginning of the Q wave to the end of the S wave). Any arrhythmias, if present was also taken into consideration. Minnesota Coding was used for analysis of ST-T changes[11]

Criteria for ST-T changes as follows:

(A) coexistence, in any limb leads I, II, aVL or chest leads V3-V6, downward or horizontal sloping depression ≥ 0.05 mV of ST-segment (code 4–1 or 4 –2) plus asymmetric inversion of T-wave (code 5–1 or 5 –2);

(B) Depression ST-J segment ⟨0.05 mV with downward sloping ST-segment and segment or T-wave nadir⟩0.05 mV below P-R baseline, in any of leads I, II, aVL or V2–V6 (code 4–3);
(C) Depression of ST-J segment ≥ 0.10 mV and upward sloping of ST-segment or U-shaped, in any of limb leads I, II, aVL or V2-V6 (code 4–4);
(D) Flat(zero) T-wave amplitude, negative or diphasic (negative–positive type) with < 0.10 mV negative phase in limb lead I, II, V3–V6, or in lead aVL if R-wave amplitude is ≥ 0.5 mV (code 5–3):
(E) T-wave amplitude positive and T- to R-wave amplitude ratio < 1:20 in any limb leads I, II, aVL or V3-V6 when amplitude of R-wave in the corresponding leads is ≥ 1.0 mV (code 5–4).[11]
Left ventricular (LV) hypertrophy was detected at ECG by using body mass index (BMI)-corrected Perugia score [12]. LV hypertrophy on ECG was defined by a Cornell-BMI product ([R wave amplitude in lead aVL + S wave depth in lead V3] x BMI) > 604 mm·kg/m2 or typical strain pattern (as defined by a ≥ 0.5 mm depression of the J point, T-wave inversion with asymmetric branches and rapid return to baseline).[13] Main ECG changes related to cardiovascular (CV) complications were classified according to current Guidelines.[14-16]
For data analysis STATA 15 and R software version 3 was used.
Data is presented as mean ± standard deviation (SD) for continuous variables and proportions for categorical variables. For differences in proportions between groups $\chi 2$ test was used. Paired or independent sample t-test was used for comparison of mean values of variables. To test the relationship between the clinical, laboratory and demographic findings with the occurrence of ECG abnormalities, logistic regression model was used. In 2-tailed tests, p values <0.05 were considered statistically significant.

Table 1: Mean patient parameters

Variable	Overall(N=200)	New ECG changes NO (N=152)	YES(N=48)
Age	61 ± 15	61 ± 14	61 ± 16
Sex(male%)	70	66	82
BMI	26.6 ± 4.2	26.8 ± 4.0	26.4 ± 4.4
Systolic BP (mm hg)	128 ± 21	126 ±20	126 ± 22
Diastolic BP (mm hg)	82 ± 12	82 ± 14	80 ± 12
Hypertension (%)	52	44	64
Smoker (%)	20	10	18
Diabetes (%)	16	14	8
Coronary Artery disease (%)	10	9	16
COPD (%)	8	8	4
Antiretroviral (%)	56	70	16
HCQS (%)	84	90	60
Macrolides (%)	54	58	56
Enoxaparin (%)	72	80	70
RAS Blockers (%)	20	21	15
PaO2/FiO2 ratio (mm hg)	340 ± 10	349 ± 120	335 ± 80
pH	7.44 ± 0.03	7.45 ± 0.03	7.43 ± 004
Heart rate	76 ± 18	75 ± 15	74 ± 21
PR interval(msec)	164 ± 24	162 ± 19	176 ± 42
QRS duration(msec)	100 ± 12	96 ± 12	102 ± 18
QT_c(msec)	426 ± 26	428 ± 23	434 ± 38
ST-T abnormalities (%)	34	27	38
LV Hypertrophy (%)	32	31	40

Results
Overall, 200 patients were studied with complete clinical data, laboratory data and 12-lead ECGs. Table 1 shows the main characteristics of patients. Mean age of presentation was 61 years. The most prevalent comorbidity was hypertension (52%). Current smokers were 20%. Baseline BP was 128/82 mmHg. Overall, 152 patients showed sinus rhythm at presentation and mean HR was 76 ± 17 bpm. Most common ECG abnormalities were ST-T segment abnormalities (34%) and LV hypertrophy was prevalent in 32%. During hospitalization, P-pulmonale was observed in 2(1%) patients,48 patients (24%) documented new ECG changes including atrial fibrillation (8%), brady-tachy syndrome (2%), persistent ST-T changes probably due to acute pericarditis (10%). Eight patients (4%) developed right bundle branch block along with ST-T ischemic changes for non-ST elevated myocardial infarction. In the study, 168 patients (84%) were prescribed with HCQS, 112 (56%) with antiretrovirals, and 108 (54%) with macrolides. Patients without any new ECG changes during hospitalization received hydroxychloroquine and antiretrovirals in comparison to those who developed new ECG abnormalities and, more importantly, treating patients with these drugs was related with reduced ECG abnormalities during their hospital phase regardless of age, sex, and other comorbidities or risk factors.
The PR interval exhibited a prolongation when compared to admission. Mild decrease in the Cornell voltage (12±6 vs 11±5 mm, p = 0.0001) was also noted. While discharging the patient, only 4 patients developed QTc interval prolongation (≥ 500 msec with a QRS ≤120 milliseconds) and 12 patients (6%) had PR interval prolongation (> 200 msec, ranges from 200 to 215 msec). The extent of respiratory disease had no impact on developing ECG abnormalities.
The newly developed ECG abnormalities drastically affected duration of hospital stay. ECG abnormalities occurred after averages of 20 days after onset of COVID-19 symptoms (range 10–30days) and after 10 days from admission into hospital (range 2–22days), respectively.

Table 2: Summary of ECG changes in our study

ECG abnormalities	n=200
Sinus rhythm (%)	76%
P pulmonale (%)	1%
PR Prolongation (%)	6%

LV Hypertrophy (%)	32%
RBBB (%)	4%
ST-T abnormalities (%)	34%
Atrial Fibrillation (%)	8%
Brady-Tachycardia syndrome (%)	2%
QT_c prolongation (%)	2%

Table 3: Comparison of ECG changes

Feature	Admission	Pre-discharge
HR(/min)	76 ± 17	72 ± 12
PR interval(msec)	160 ± 19	166 ± 20
QRS duration(msec)	99 ± 12	97 ± 11
QT_c (msec)	424 ± 24	418 ± 36
ST-T abnormalities (%)	30	17
Cornell voltage(mm)	12 ± 6	11 ± 5

Discussion

In most of cases COVID 19 pneumonia presents as flu-like symptoms with mild severity, but in about 10-15% of cases it may present as interstitial pneumonia with varying degree of respiratory failure[17]. Nonetheless, some case reports and systematic reviews associated COVID-19 with cardiovascular adverse effects[4-7,20-23]. Also, COVID-19 has been associated with various cardiovascular complications including acute coronary syndromes, decompensated heart failure, complete hart block, acute pericarditis, myocarditis, and pulmonary embolisms.[5,6,19,21,22] All these findings suggest and supports that development of ECG abnormalities during the hospital stay may be relevant to the clinical impact on the course of the disease and that COVID-19 infection may also be linked with an increased long-term cardiovascular risk[14].Regarding this, data from 200 patients who were admitted to hospital with definitive COVID-19 pneumonia was analysed. our analysis offer some key findings which needs to be mentioned. COVID-19 provoked pericarditis might occur due to expression of ACE2 receptors in epicardial adipocytes, facilitating the entry of SARS-CoV-2 into the cell[23-25]., and possibly triggering local inflammation. In this context, it's important to mention that epicardial fat has been linked previously to atrial electrical remodelling and the progression The commonest ECG manifestation was signs of acute pericarditis as diagnosed by new widespread concave ST elevation and PR depression throughout the limb (I, II, III, aVL, aVF) and precordial (V2-V6) leads, reciprocal ST depression and PR elevation in aVR, and a ST segment/T wave ratio> 0.25 of atrial fibrillation[26,27]. Although it's very likely that atrial fibrillation may be associated with COVID-19 infection (systemic hyperinflammation, fever, hypoxia, adrenergic tone), the involvement of epicardial adipocytes during SARS-CoV-2 infection could predispose to the development of atrial fibrillation. Altogether, these findings do reinforce the recommendation to carefully choose the therapeutic choices of anticoagulation, balancing thromboembolic and bleeding risk. In this study, 4 patients also developed QT interval prolongation or a delayed sinoatrial nodal conduction to the ventricle. The prolongation of PR interval observed in 12 patients did not exert a clinically significant effect because of a PR interval at discharge not exceeding 210 msec. The observation at discharge of a prolonged QTc (>500 msec) in only 4 patients may suggest that current therapeutic approaches for COVID-19[18] may exert minimal effects on ventricular depolarization and repolarization[28]. This also suggests that treatment with hydroxychloroquine, which have QT-prolonging effects by blocking activation of the potassium channel IKr[29] does not adversely affect QTc in COVID-19. Another observation which is more complex to understand is the of the reduction from baseline to discharge in Cornell voltages (12±6 vs 11±5 mm, p = 0.0001) which might reflect the presence of pleural or pericardial effusions [30,31] epicardial oedema[32] or electric or conduction alternans associated with tachyarrhythmias.

Patients with past vascular events, comorbidities and baseline ECG features had an insufficient discriminatory power to identify subjects at increased risk for the development of new ECG changes(including ST-T abnormalities,clinically significant atrioventricular and inter-ventricular delays, cardiac rhythm disturbances, and ventricular depolarization and repolarization prolongations). However, patients receiving treatment with antiretrovirals and hydroxychloroquine were related with a significant reduction in the risk of developing new ECG abnormalities during the hospital phase. Finally, onset of ECG abnormalities from hospitalization and initiation of COVID-19 symptoms was late. In this study, the ECG abnormalities developed after an average 20 days post admission and 30 days post symptoms. Notably, about 56% of patients developed ECG abnormalities just prior to discharge from hospital and after one negative nasopharyngeal swab. The present study should be interpreted along with its limitations. The study duration is limited to hospital stay. In conclusion, this study suggests that ECG abnormalities seen in COVID-19 patients were independent of severity of respiratory symptoms. The ECG abnormalities which evolved during COVID-19 infection were of late onset, with a broad range of cardiovascular complications and regularly occur after negative nasopharyngeal swab.

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