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ORIGINAL RESEARCH

Electrocardiographic Manifestations in Patients of Covid-19 Pneumonia

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Abstract

Background: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is known to be associated with myocardial injury. Electrocardiographic (ECG) abnormalities could be a useful tool to identify the various forms of cardiac manifestations of SARS- CoV-2 infection. The aim of our study was to assess specific ECG patterns in COVID-19 patients admitted in New Covid ICU of KIMS Hubballi which could be related to in-hospital mortality. Cardiac involvement in patients with SARS-CoV-2 requires change in management as well carries poor prognostication.

Methods: We retrospectively analyzed the 12-lead ECG of 100 patients hospitalized in New Covid ICU of Karnataka Institute of Medical Sciences, Hubballi for respiratory distress in from 1StFebruary 2021 to May 31 2021(Second wave) who were diagnosed with covid-19 after naso-pharyngeal swab. Basic demographic data like name, age, sex co-morbities of patients were recorded. 12 lead ECG with normal standardization (speed of 25 mm/s and a voltage of 10 mm/mV) was taken for all study patients and following ECG features like rate, rhythm, axis abnormalities of p, QRS t waves, QTc interval were analyzed in each patient. This is an Observational non-randomized study.

Results: Among 100 patients included in the study, most common electrocardiographic feature was sinus tachycardia (n=48), ST elevation Myocardial infarction was observed in three patients (n=3), atrial fibrillation in 2 patients (n=2), one patient had svt (n=1), complete heart block in two patients (n=2) and S1Q3T3 was observed in three patients (n=3). Average QTc was 414msec, with maximum QTc observed was 566msec.

Conclusion: Cardiac manifestations play significant part in the treatment and overall prognosis of SARS-CoV-2 patients. Electrocardiography, a simple affordable tool helps in identifying such cardiac manifestations, hence aids in the management of patients.

Keywords: Electrocardiography, Severe acute respiratory syndrome coronavirus 2, QTc interval, prognostication.

Introduction

Coronavirus Disease 2019 (COVID-19) is the clinical manifestation of infection with virus called Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2). The clinical

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spectrum of the infection is characterized by respiratory symptoms (including fever, cough and fatigue) and may progress to pneumonia, acute respiratory distress syndrome (ARDS) and shock.

Severe acute respiratory syndrome coronavirus 2 (SARSCoV-2) can be associated cardiac involvement in the form of Myocarditis, acute coronary syndrome, decompensated heart failure rhythm abnormalities. QT interval prolongation, reported in patients with coronavirus disease 2019 (COVID-19), is of concern as it may lead to ventricular arrhythmias [(1)]. Infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) may itself directly and/or indirectly involve the heart. Viral particles have been identified in myocardial tissue. Early identification of cardiac involvement in COVID-19 in patients presenting to the Emergency Department (ED) is crucial. Electrocardiogram (ECG), widely performed in the ED and cost less, could be a very useful tool.

McCullough et al. performed a retrospective cohort study in patients with COVID-19 who had an ECG at or near hospital admission in a large New York City teaching hospital. Using a multivariable logistic regression model that included age, ECG, and clinical characteristics, they found that the presence of one or more atrial premature contractions, a right bundle branch block or intraventricular block, ischemic T-wave inversion and nonspecific repolarization increased the odds of death [(2)]. Early identification of these cardiac manifestations is crucial. Traditional 12-lead electrocardiogram (ECG) approach may play an important role for the screening of cardiac involvement because it is fast, widely accessible, low cost and remotely interpretable.

Thus we aimed to investigate Electrocardiographic manifestations in COVID 19 patients admitted in our center.

Objectives

1. To describe various Electrocardiographic features of patients of Covid 19 pneumonia
2. To study the extent of cardiac involvement in patients of Covid 19 pneumonia

Materials & methods

The present Retrospective Observational study was conducted on the patients admitted in Covid19 pneumonia in Covid19 Intensive Care Unit in KIMS, Hubballi during February 01 2021 to May 31 2021 (for a period of 4 months) Second wave of Covid19 pandemic.

Method

We retrospectively analyzed the 12-lead ECG of 100 patients hospitalized in New Covid ICU of Karnataka Institute of Medical Sciences, Hubballi for respiratory distress in from 1St February 2021 to May 31 2021(Second wave) were diagnosed with covid-19 after naso-pharyngeal swab.

Basic demographic data like name, age, sex comorbidities of patients were recorded.

12 lead ECG with normal standardization (speed of 25 mm/s and a voltage of 10 mm/mV) was taken for all study patients and following ECG features like rate, rhythm, axis abnormalities of p, QRS t waves, QTc interval were analyzed in each patient.

This is an Observational non-randomized study.

Statistical Analysis

Data derived from the study was tabulated. Statistical analysis was performed using SPSS software.

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Results

Subjects (N=100)		Frequency (N)	Percentage (%)
Age group	<30 years	8	8.0%
	31 to 45 years	16	16.0%
	46 to 60 years	36	36.0%
	61 to 75 years	34	34.0%
	>75 years	6	6.0%
Gender	Male	75	75.0%
	Female	25	25.0%
Comorbidities*	Diabetes Mellitus	42	42.0%
	Hypertension	37	37.0%
	Ischemic Heart Disease	7	7.0%
	Peripheral Vascular Disease	1	1.0%
	Cerebrovascular Accidents	1	1.0%
	Chronic Kidney Disease	3	3.0%
	Immuno-Deficiency	1	1.0%

Table 1: Characteristics of the study subjects

* Multiple selections

In the study, the most common age group was 46 to 60 years (36.0%), majority were males (75.0%), and commonest co-morbidities were diabetes (42.0%), followed by hypertension (37.0%).

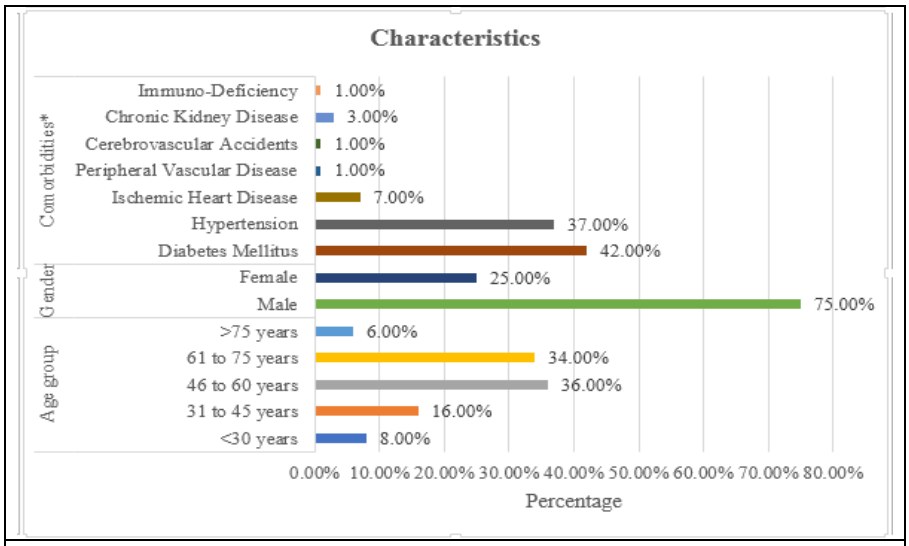

Figure 1: Bar diagram showing characteristics of the study subjects

Subjects (N=100)	Mean	SD	Minimum	Median	Maximum
SpO_2 (in %)	79.33	15.14	35.00	84.00	98.00
SBP (in mmHg)	120.30	22.09	50.00	120.00	170.00
DBP (in mmHg)	73.00	11.06	50.00	70.00	100.00
PR (in bpm)	100.13	25.51	42.00	100.00	170.00

Table 2: Vital measurements of the study subjects

In the study, the mean oxygen saturation was 79.33 ± 15.14%. The mean SBP and DBP were 120.30 ± 22.09 mmHg and 73.00 ± 11.06 mmHg respectively. The mean pulse rate was 100.13 ± 25.51 bpm.

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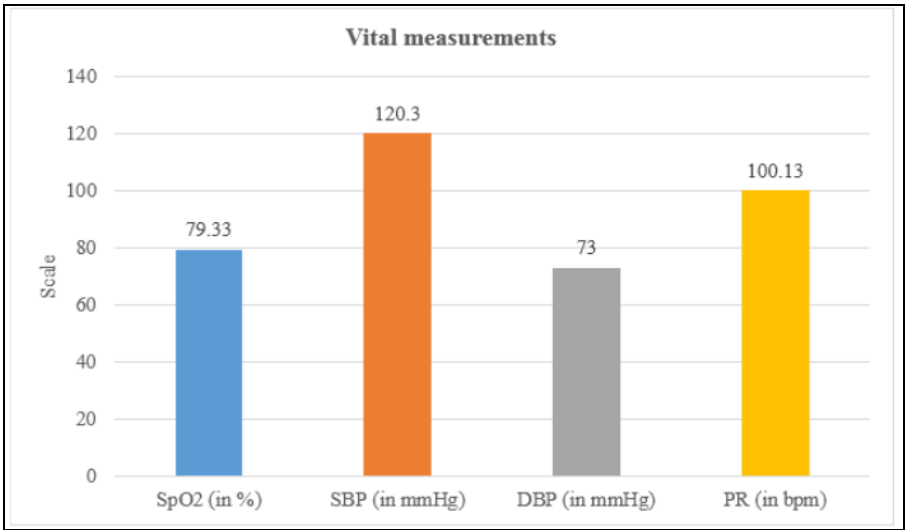

Figure 2: Bar diagram showing vital measurements of the study subjects

Subjects (N=100)	Mean	SD	Minimum	Median	Maximum
Rate	99.41	28.35	42.00	100.00	170.00
QTc	414.52	60.66	280.00	400.00	640.00

Table 3: ECG features among the study subjects

In the study, the mean heart rate was 99.41 ± 28.35 bpm, while the average QTc was 414.52 ± 60.66 msec.

Subjects (N=100)		Frequency (N)	Percentage (%)
Rhythm	Regular	98	98.0%
	Irregular	2	2.0%
Axis	Normal	88	88.0%
	Right Axis Deviation	3	3.0%
	Left Axis Deviation	9	9.0%
P-Wave	Normal	94	94.0%
	AV Dissociation	2	2.0%
	M Mitrale	2	2.0%
	P Mitrale	1	1.0%
	P Pulmonale	1	1.0%
QRS-Complex	Normal	89	89.9%
	Q-Wave	3	3.0%
	Narrow	1	1.0%
	Broad	1	1.0%
	Low Voltage	3	3.0%
	LVH	2	2.0%
ST-T Changes	Normal	75	75.0%
	Ectopics	1	1.0%
	LBBB	3	3.0%
	RBBB	2	2.0%
	ST Elevation	3	7.0%
	ST Depression	3	3.0%
	T Wave Inversion	12	12.0%
	Tall T Wave	1	1.0%

Table 4: ECG features of COVID patients in our study

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In the study, irregular rhythm was seen in 2.0% cases, while RAD and LAD were appreciated in 3.0% and 9.0% cases respectively. Abnormal P-wave was observed in 5.0% cases, whereas QRS complex was affected in 10.1% cases. ST-T changes were evident in 25.0% cases, which includes ectopics, LBBB, ST elevation and depression, T wave inversion and Tall T waves.

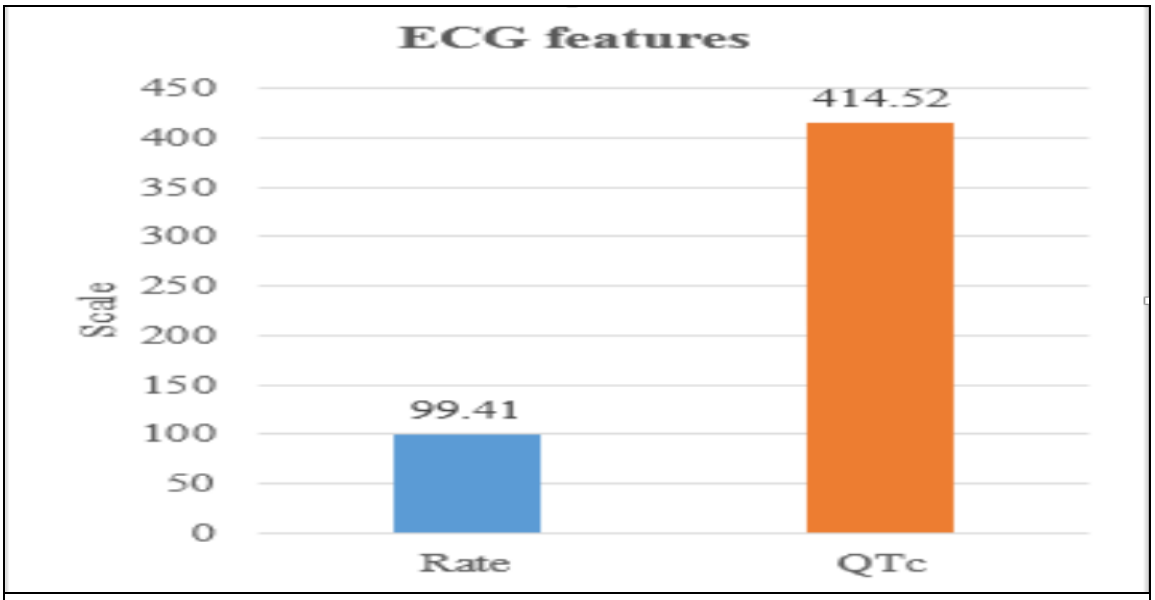

Figure3: Average Heart rate and QTc among patients enrolled in the study

Among 100 patients included in the study, most common Electrocardiographic feature was sinus tachycardia (n=48), ST elevation Myocardial infarction was observed in three patients (n=3), atrial fibrillation in 2 patients (n=2), one patient had Supraventricular Tachycardia (n=1), complete heart block in two patients (n=2) and S1Q3T3 was observed in three patients (n=3). Average QTc was 414msec, with maximum QTc observed was 566msec.

ECG Manifestations	Number Of Patients
SINUS TACHYCARDIA	48
BRADYCARDIA	2
STEMI AWMI	2
STEMI IWMI	1
NSTEMI	2
AF FVR	2
S1Q3T3	3
CHB	2
LBBB	3
RBBB	2
LVH	2

Table 5: Electrocardiographic patterns observed among patients

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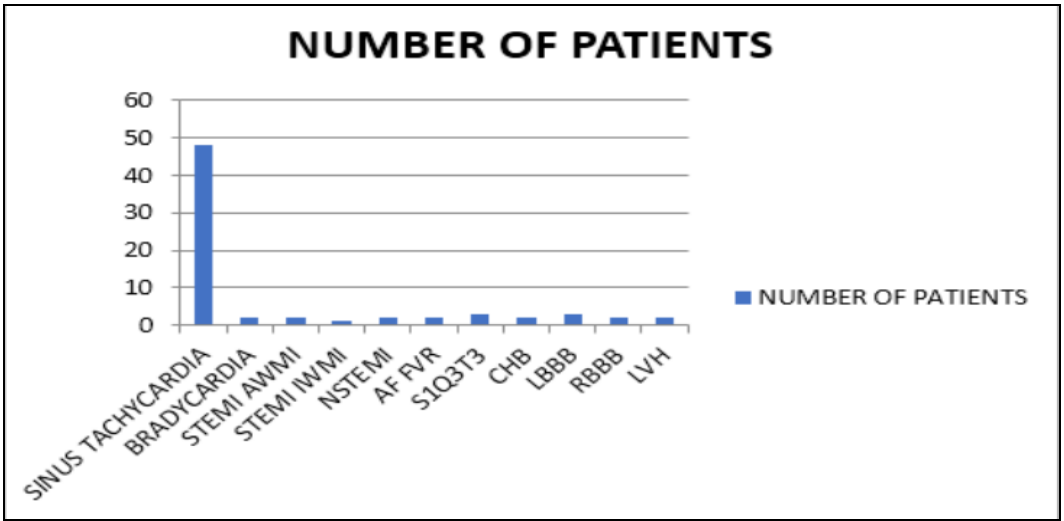

Figure 3: Bar diagram showing ECG features among the study subjects

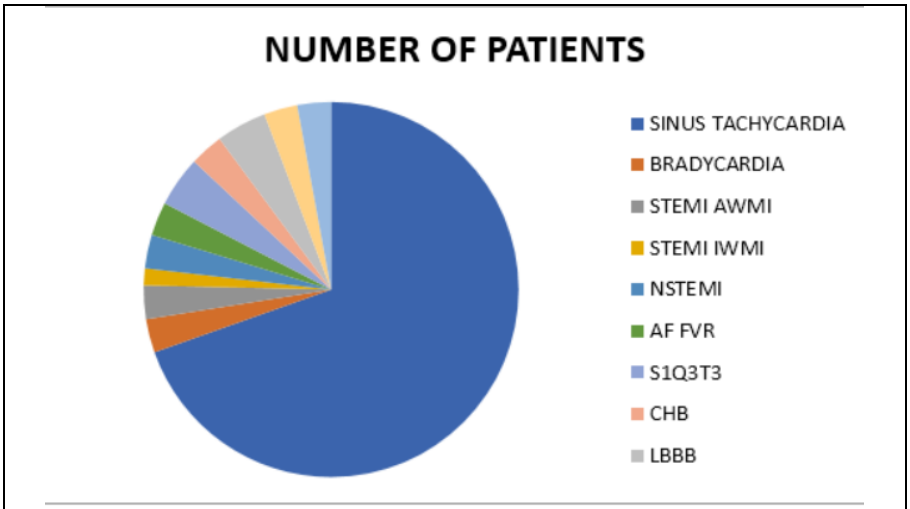

Figure 5: Pie diagram showing ECG features among the study subjects

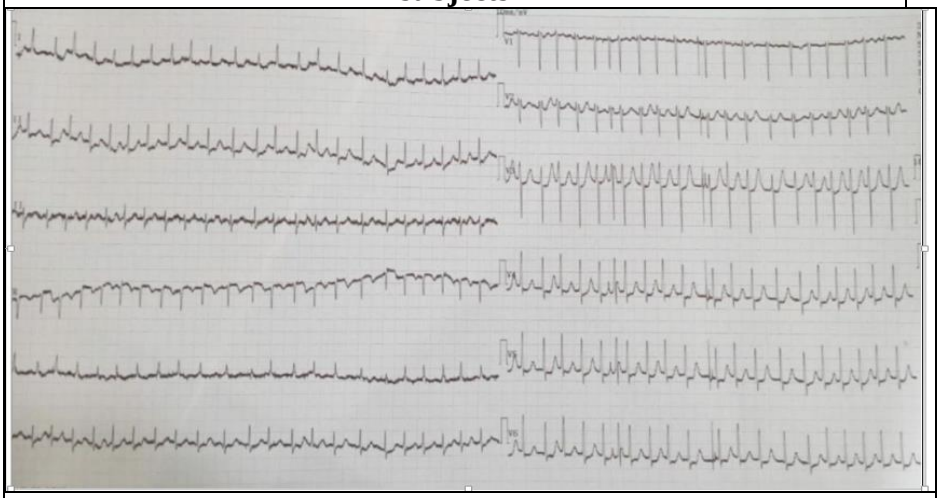

Figure 6: ECG of Supraventricular Tachycardia

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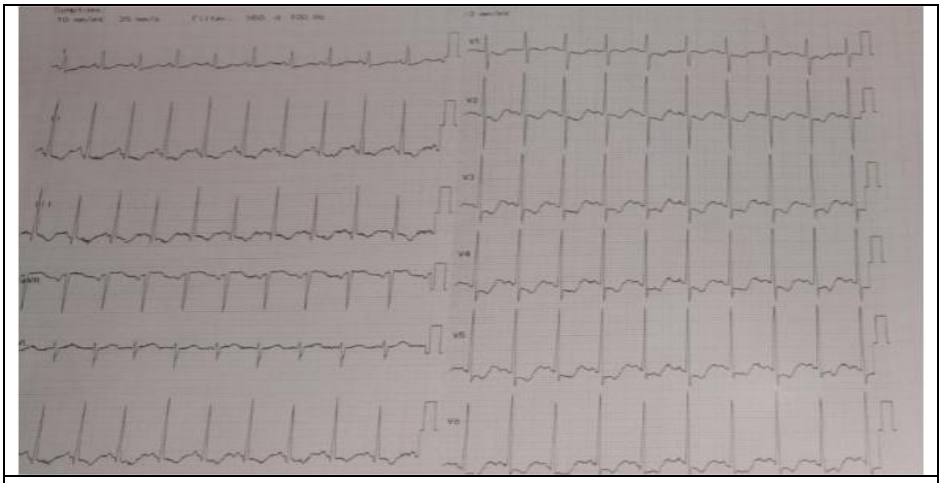

Figure 7: NSTEMI

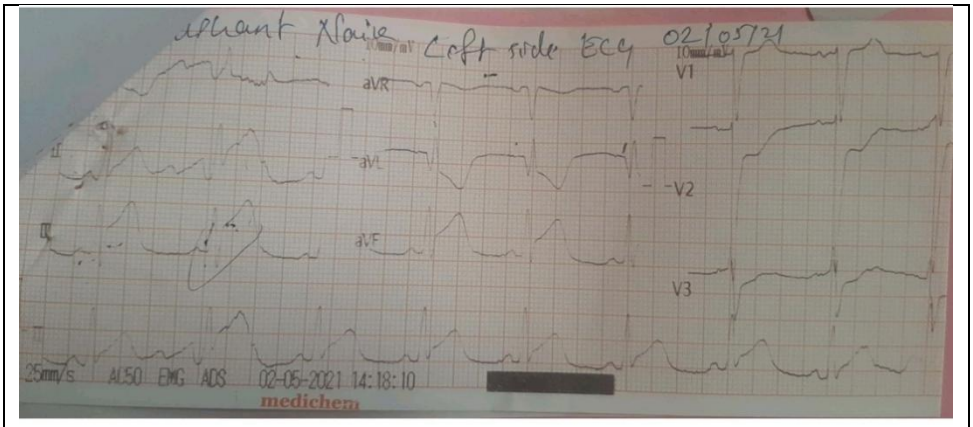

Figure 8: IWMI

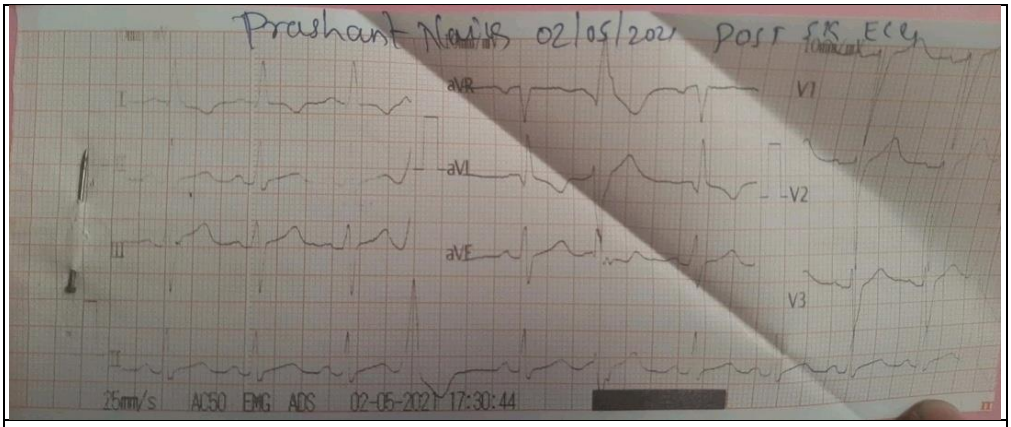

Figure 9: IWMI post Streptokinase therapy

Discussion

Sinus tachycardia was the most common ECG feature observed in our study because only ICU patients were included in study who are dependent on more than 8L of oxygen requirement. Sinus tachycardia was probably secondary to hypoxia. Three patients of STEMI (two Inferior wall Myocardial Infarction and one Anterior wall Myocardial Infarction) were thrombolysed with streptokinase. Three patients with S1Q3T3 pattern, two patients with sinus tachycardia presenting with rapidly worsening hypoxia were suspected for acute pulmonary thromboembolism. One Complete Heart block patient with IWMI reverted to

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sinus rhythm following thrombolysis. One patient of Supraventricular Tachycardia was given intravenous adenosine, following which it reverted back to sinus rhythm.

The mechanism of the ECG changes is unknown. Basic cellular repolarization may be affected by direct and indirect effects of COVID-19 on the heart. Direct cardiac infiltration of the virus may disrupt the cardiomyocyte membrane potential and gap junctions and lead to dysfunction in the conduction system. Cytokines have a direct effect on action potential duration by inducing changes in expression and function of calcium and potassium channels [3,4], and are hallmarks of COVID-19. Myocardial strain (as indexed by abnormal BNP/ NT pro-BNP levels) due to heart failure or resulting from pulmonary and vascular abnormalities caused by COVID-19 may also play a role. Lengthening of action potential duration caused by myocardial cell stretch has been demonstrated in experimental studies, but only with decreased myocardial contractility, possibly lengthening in some patients with COVID-19 who have LV or RV dysfunction. Whatever the mechanism, it remains that myocardial activation and repolarization are prolonged in patients with COVID19, and only rarely reported in other cases of fulminant myocarditis

SARS-CoV-2 infection is associated with prolongation in activation (QRS) and repolarization (QTc). The severity of infection (indexed by triage of patients and mortality) is associated with prolongation in activation and repolarization. Prolonged QRS and QTc intervals are also associated with cardiac involvement, indicated by troponin release or abnormal BNP/NT pro-BNP. Finally, changes in activation and repolarization are independent predictors of disease severity and mortality. Taken together with cardiac biomarkers and other demographics, cardiac electrophysiologic changes seen in COVID-19 provide an early marker for subsequent clinical course and death and may help in initial triage of infected patients.

Pulmonary embolism has been recognized as a presenting issue and/or complication of COVID-19, particularly in patients with severe illness [5-7]. This COVID-19-related predisposition to venous thromboembolism likely occurs via several different mechanisms, including increased angiotensin II activity and related thrombogenic effects via enhanced coagulation system and platelet function, cytokine-mediated activation of the coagulation cascade, and a potential direct effect of the viral infection, causing localized inflammatory process and enhanced focal thrombosis. Sinus tachycardia and/or atrial fibrillation with rapid ventricular response are commonly encountered in the setting of critical illness, including PE and COVID-19. Electrocardiographic findings of right ventricular strain, as discussed previously, are also frequently encountered. In a recent review of PE in patients with COVID-19 infection, ECG findings most often involved non-specific abnormalities, including sinus tachycardia and minimal ST segment or T wave changes. More specific findings, suggestive of right ventricular strain, were encountered in only one-third of patients. The classic S1Q3T3 pattern was seen in less than 10% of COVID-19-related Pulmonary Embolism. Other electrocardiographic presentations typical of pulmonary embolism include anterior T wave inversion and right bundle branch block.

In addition to bedside evidence for a hypercoagulable state in COVID-19, laboratory tests have also been consistent with a prothrombotic milieu such as increased D-dimer, fibrinogen, factor VIII (FVIII), von Willebrand factor (vWF), decreased antithrombin, and TEG results . While critical illness is known to cause a hypercoagulable state due to immobilization, mechanical ventilation, central venous access devices, and nutritional deficiencies, COVID-19 appears to cause a hypercoagulable state through mechanisms unique to SARS-CoV-2 and centers around the cross-talk between thrombosis and inflammation [8-9].

According to Avni Thakur et al[10] QRS and Qtc intervals are early markers for covid-19 disease progression and mortality. ECG, a readily accessible tool, identifies cardiac involvement and may be used to predict disease course. This is a retrospective study between march 15th, 2020 and may 30th, 2020 of 828 patients with covid-19 and baseline ECG.

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Corrected Qt (QTc) and QRS intervals were measured from ECGs performed prior to intervention or administration of qt prolonging drugs. QTc and QRS intervals were evaluated as a function of disease severity.
In our study as patients follow was not done , significance of prolonged QTc on prognosis couldn't be studied.
According to Marco Mele et al [(11)] ECG differences at admission can be found in Covid-19 patients according to different clinical settings and intensity of care. A simplified score derived from few clinical and ECG variables may be helpful in stratifying the risk of in-hospital mortality.12-lead ECG of 1124 consecutive patients hospitalized for respiratory distress in the Policlinico Riuniti University Hospital from the 1st of October 2020 to the 28th of February 2021 was retrospectively analyzed.
According to Hugo De Carvalho et al[(12)] ECG performed at ED admission may be useful to predict death in COVID-19 patients. Ecg was performed on 275 patients who presented to the ed. Most of the ECGs were in normal sinus rhythm (87%), and 26 (10%) patients had atrial fibrillation/flutter on ECG at admission. Repolarization abnormalities represented the most common findings reported in the population (40%), with negative t waves representing 21% of all .
According to Fabio Angeli et al[(13)] ECG abnormalities during hospitalization for COVID-19 pneumonia reflect a wide spectrum of cardiovascular complications, exhibit a late onset, do not progress in parallel with pulmonary abnormalities and may occur after negative nasopharyngeal swabs. 50 patients admitted to hospital with proven COVID-19 pneumonia were examined. At baseline, 30% of patients had ST-T abnormalities, and 33% had left ventricular hypertrophy. During hospitalization, 26% of patients developed new ECG abnormalities which included atrial fibrillation, ST-T changes, tachy-brady syndrome, and changes consistent with acute pericarditis.
According to Brit Long et al [(14)] ECG abnormalities in COVID-19 may be due to cytokine storm, hypoxic injury, electrolyte abnormalities, plaque rupture, coronary spasm, microthrombi, or direct endothelial or myocardial injury. While sinus tachycardia is the most common abnormality, others include supraventricular tachycardias such as atrial fibrillation or flutter, ventricular arrhythmias such as ventricular tachycardia or fibrillation, various bradycardias, interval and axis changes, and ST segment and T wave changes.

Limitations

1. Limited sample size
2. Echocardiographic correlation couldn't be done

Conclusion

Cardiac manifestations play significant part in the treatment and overall prognosis of SARS-CoV-2 patients. Electrocardiography, a simple affordable tool helps in identifying such cardiac manifestations, hence helping in the management of patients.

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