Analysis of COVID-19 impact on Cardiovascular using ECG

Vani E S, Swarnalatha K S

Abstract: ***Electrocardiogram (ECG) is a real time signal which can be used to analyze the functioning of the cardiac muscles. These electrical signals help us in identifying the heart related issues. It gives lot of clinical information about heart. Corona virus disease (COVID-19) is a disease caused by Corona virus and it spreads through saliva droplets or nose discharge. A person with COVID-19 might suffer from heart related issues. To lower the risk of cardiovascular injury, monitoring of ECG is vital for a person identified with COVID-19. By analyzing QTc and ST prolongations, we can identify the complications in heart like Myocardial Infraction (MI), Cardiac Arrest, Myocarditis, Acute cardiac injury and Arrhythmia with COVID-19. And also change in QTc value is observed in a person before and after chloroquine treatement. This systematic review reveals that identifying ECG patterns which is related to COVID-19 is vital.***

Keywords: ECG, QTc, ST, COVID-19.

I. INTRODUCTION

Electrocardiogram (ECG) is one of the important tools used for cardiovascular diagnosis. The contraction of the heart muscles generates an electrical signal called ECG. This signal gives information about the activity of heart. This can be done by placing electrodes on the surface of human body. ECG is an effective method to detect heart diseases. The range of ECG signal is of 2mV and it needs a recording bandwidth of 0.1-120Hz. Figure 1 shows the important characteristic features of heart beat which consists of P-wave, T-wave, U-wave and QRS complex[11][12].

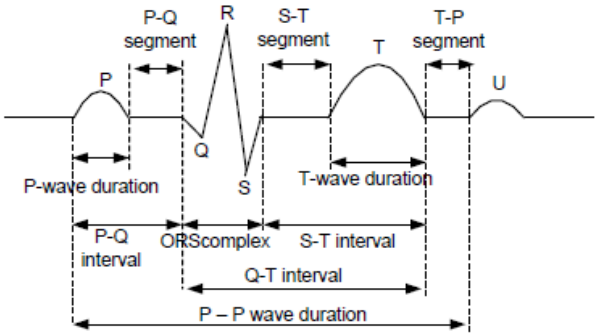

Figure 1: Typical ECG waveform

The raw ECG signals will be pre-processed for noise removal and it is subjected to feature extraction. Since the pandemic of COVID-19 pulled in the consideration, there were reports encompassing electrocardiographic changes in the tainted people. The Corona virus can cause inflammatory effects which results in atherosclerotic plaques rupture in coronary arteries which lead to heart attack. And the virus can cause cardiovascular injury to a person who is not having any history of heart related issues. A person having cardiovascular disease should avoid interaction with a person having COVID-19 to lower the risk of getting infected and death.

II. METHODOLOGY

The cardiac involvement may be observed by changes in the ECG signal of a patient having COVID-19. According to the information given by Cardiological Society of India (CSI), around 20-30% of patients who are admitted to hospitals because of COVID-19 are identified with cardiac injury which leads to increase in the levels of protein called cardiac troponin. This protein is released in the body due to the damage in the muscles of heart.[4] From the studies it is also found that the mortality rate of COVID-19 patients is 40% due to the complications in Cardiac muscles[4]. The abnormal increase in the level of troponin which is called as Accute cardiac injury happens in around 20% of COVID-19 patients. COVID-19 patients will get Myocardial injury because of coronary spasm, cytokine strom, microthrombi, vascular injury, hypoxy injury or plaque rupture. [1]

Corona Virus causes inflammation of heart muscles. And the virus causes two things i.e, damage to the heart muscle and Cytokine storm. Damage to the heart is because of Oxygen level in the blood which is low in COVID-19 patients, respiratory failure and hemodynamic stress. And Cytokine storm is caused due to the intense immune reaction where large number of cytokines are released in blood by the body[4]. Usually when the COVID-19 patient is in second week of illness, cardiac injury will be observed. This results in changes in ECG signal, increase in toponin level or arrhythmia[4]. The most complications heart related issues observed in COVID-19 patients are acute cardiac injury and Arrhytmia. The mortality rate of COVID-19 patients is moderately 2.3%[5]. It is inferred that, the corona virus can kill the person who is not having any history of heart disease. The Figure 2 shows various cardiovascular diseases which are associated with COVID-19. The diseases are ST segment elevation, Cardiogenic shock, Decompensated heart failure and heart transplant recipient.

ST segment elevation: The ST segment is a span between ventricular depolarization and repolarization and it causes myocardial ischaemia.

Cardiogenic shock: It is the circumstance where the heart is unable to pump sufficient blood to the body. Decompensated heart failure: With the change in ability of heart pumping, heart works well without noticing any symptoms in the body. Heart Transplant Recipient: Heart transplant recipients show symptoms similar to the symptoms of COVID-19 infection.

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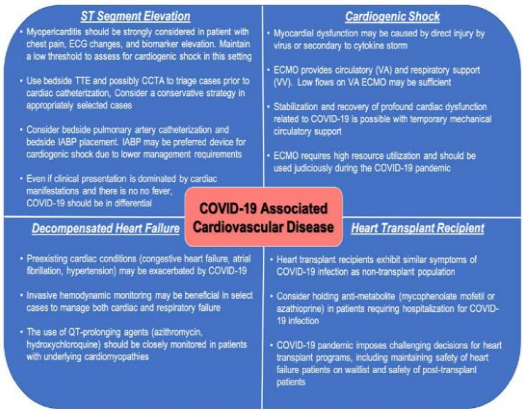

Figure 2: Cardiovasular diseases associated with COVID-19

In case of drug induced group, Increase in the QTc interval which is caused by Azithromycin, Chloroquine and HydroxyChloroquine results in increased risk but still arrhythmia related deaths are not induced by this. In non-drug induced group, ECG signal of a COVID-19 patients are observed with elevation in ST interval and also ST-T abnormalities [3][7].

Table 1 summarizes the main attributes of COVID-19 patients.

Table 1: Baseline characteristics [10]

Characteristic	Median (min-max) or number (%)
Age (years)	65 (18–91)
Gender (male)	63 (66%)
Intensive care unit	21 (22%)
Concurrent use of antiarrhythmic drugs	4 (4%)
Known prior cardiovascular disease	
– Atrial fibrillation	13 (14%)
– Coronary artery disease	11 (12%)
– Congestive heart failure	9 (9%)
– Other	9 (9%)

Baseline characteristic table provides clinical data collected for patient at the beginning of a clinical trial. It shows average number or percentage of each characteristics considered like age, gender, ICU, use of antiarrhythmic drugs and cardiovascular disease of a COVID-19 patients.

Table 2: Effect of chloroquine on QTc interval [10]

	Mean QTc before chloroquine treatment (ms) (95% CI)	Mean QTc during chloroquine treatment (ms) (95% CI)	Mean difference (ms) (95% CI)
Computer interpreted	444 (373–515)	479 (394–564)	35 (28–43)
Manually interpreted	432 (360–505)	466 (383–549)	34 (25–43)

CI confidence interval

Table 2 shows mean QTc of pre- chloroquine treatement and when a patient is under chloroquine treatement. It is evident that computerizes interpreted value is 35ms and manual interpreted value is 34ms.

Figure 3 shows the distributation of PR interval, QRS interval and QTc interval of pre- chloroquine treatement and ongoing chloroquine treatement after computerised ECG interpretation. The first box represents before chloroquine treatement and second box represents during chloroquine treatement [10].

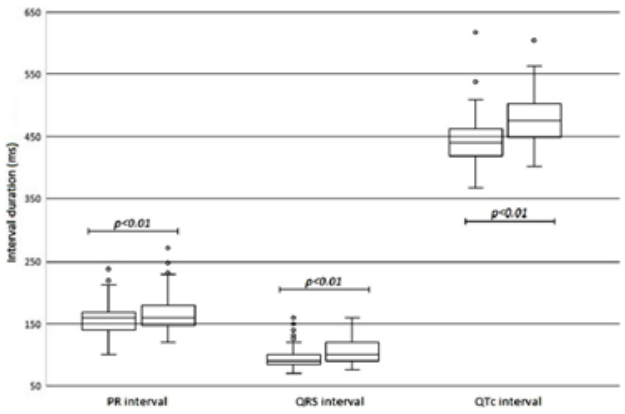

Figure 3: Distribution of PR, QRS and QTc intervals.

The complications which occurs in ECG are, Myocardial Infraction(MI), Cardiac Arrest, Myocarditis, Acute cardiac injury and Arrhythmia[5].

Arrhythmia: It is the problem with heart beat. The heart beat can be very slow or very fast or it may be irregular. The condition of very fast heart beat is known as Tachycardia and the condition of very slow heart beat is known as Bradycardia. Following observations can be seen in COVID-19 patients. Heart rate is around 350 to 650 beats /minute, Irregular rhythm, absent F wave , QRS is less than 0.12.

Arrhythmia is diagnized by review of ECG but rhythm strip can also be used.

- Tachycardias- If the pulse is >100 beats/minute.
- Bradyarrhythmias- If the pulse is < 50-60 beats/minute.

The mostly caused arrhythmias are monomorphic or polymorphic VT, atrial flutter or atrial fibrillation. If Bradyarrhythmias and tachycardias are present they can be noticed by using just the surface of ECG. COVID-19 causes Hypoxemia which may damage the myocardial cells.

Acute cardiac injury: It is the condition increase in the levels of cardiac troponin will occur and it is the mostly observed abnormality which occur in COVID-19. The patient is Evident with abnormal heart activity, ST segment depression, inversion and depression of Q wave and T wave.

Myocarditis: It affects the heart muscle and its electrical system and also it reduces heart pumping ability which results in abnormal heart beat. It is indicated by Sinus tachycardia and conduction defects and in COVID-19 patient.

Sinus Tachycardia: irregular rhythm with heart rate of 100 beats/minute, PR interval is from 0.12 to 0.20 seconds, QRS is less than 0.12 and identical P waves occur before QRS.

Conduction Defects: It is a disturbance in heart rhythm which leads to 3rd degree heart block.

It results in Branch blocks and PR interval is from 0.12 to 0.20 seconds, QRS is less than 0.12 and identical P waves occur before QRS. And it has unique characteristics like elevation in ST or RSR' in V1.

Cardiac Arrest: Due to the failure in heart pumping sudden loss of blood flow will occur which causes abnormal breathing loss of consciousness. ECG signal represents RSR' patterns and pathologic Q waves.

Myocardial Infraction(MI): It occurs when there is a decrease in blood flow which will damage the heart muscle. Essential pattern indicative of MI- posterior/anterior/interior STEMI and STEMI with right and left bundle branch blocks.

The Figure 4 shows various cardiovascular involvement associated with COVID-19. It conveys, how a person gets cardiac issues Acute coronary syndrome, heart failure, myocarditis and arrhythmia when he/she is identified with COVID-19.

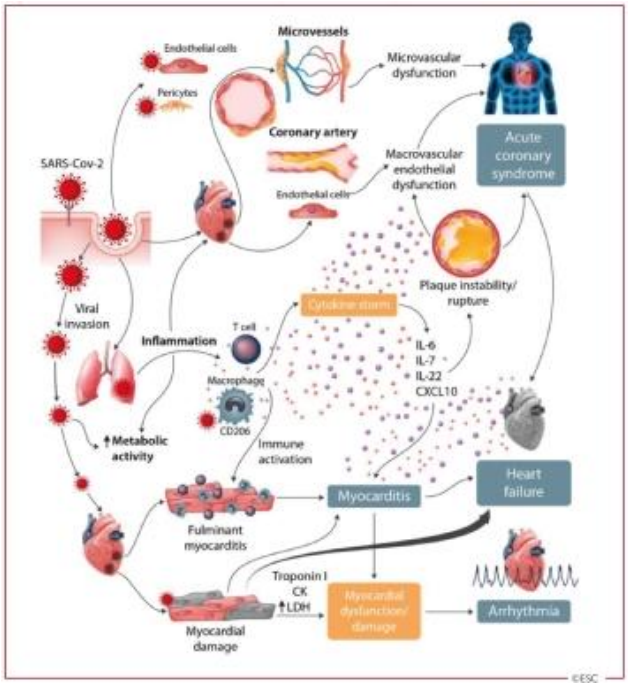

Figure 4: Cardiovascular involvemement in COVID-19. Key manifestations and hypothetical mechanisms.[6]

When the COVID-19 patients are admitted, very firstly their ECG should be monitored to know the condition of heart. The ECG used may be 12 leads or single-or multi lead ECG. This helps to identify the baseline QRS-T morphology and helps to identify that whether the patient got any symptoms of acute coronary syndrome or Myocardial injury[8].

By considering the manifestation in ECG signal of two particular cases with COVID-19, one of the cases showed complete artrioventricular block with temporary SIQIIITII morphology and in the second case, the elevation in ST segment is observed along with multifocal ventricular tachycardia. These abnormalities may lead to hypoxia and inflammatory damage [9].

If it is noticed that the patient got symptoms of Myocardial injury or acute coronary syndrome, then continuous monitoring of patient's ECG is required. If the symptoms are not evident then continuous monitoring is not required which helps the health care workers to reduce their interaction with COVID-19 infected persons and they can lower the chance of getting infected [8].

Figure 5 shows the ECG signal of a person identified with COVID-19. From the figure following observations can be noticed. (**A**) Sinus rhythm with first-degree atrioventricular block (AVB); (**B**) sinus tachycardia, first AVB with SITIIIQIII; (**C**) Mobitz type 1 second-degree AVB and atrioventricular junctional escape beat; (**D**) high-grade AVB or nearly complete AVB with junctional escape rhythm; (**E**) first-degree AVB and recovery of SITIIIQIII.

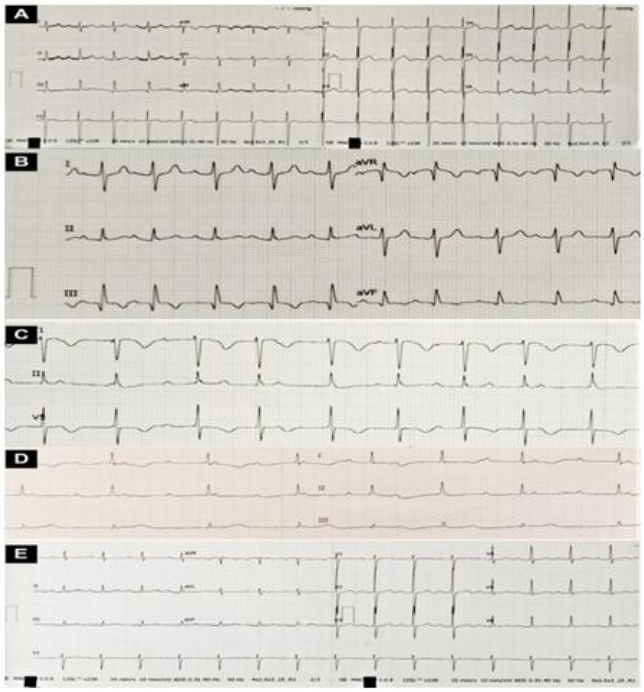

Figure 5: Electrocardiography series of COVID-19 patient. [9]

III. RESULT AND CONCLUSION

The cardiac complications like Arrhythmia, Myocardial Infraction (MI), Cardiac arrest, Myocarditis, Sinus rhythm with first-degree atrioventricular block (AVB), sinus tachycardia, first AVB with SITIIIQIII, Mobitz type 1 second-degree AVB and atrioventricular junctional escape beat and high-grade AVB or nearly complete AVB with junctional escape rhythm are observed in a person having COVID-19. Constant changes in ECG signal is a sign of cardiovascular injury, which usually denotes critical status in COVID-19 patients. And also drugs like chloroquine used to treat COVID-19 patients affects ECG parameters and hence should take preventive measures while using the medicines.

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