ECG signal analysis used as confirmative tool in quick diagnosis of Myocardial Infarction

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Abstract— Apart from accidents, myocardial infarction is the most common reason of sudden deaths. As the time from the onset of myocardial infarction to the start of treatment is very crucial, quick diagnosis is essential. The paper proposes a novel, easily deployable, cheap and non-invasive technique for the quick confirmative diagnostic tool. The changes in the ECG signal of the patient suffering from myocardial infarction are different to that compared with the ECG of the normal patient. The degree of variation can be used as a diagnostic tool. With the advent of computer and signal processing technology, a confirmative diagnostic tool is developed and can be made deployable in the ambulatory services. This will help to reduce the time gap between the onset of symptoms and actual treatment for the disease. If the confirmatory test is positive, the paramedical personnel can begin with the preparatory treatment before the physician is available.

Index Terms— Ambulatory service, Autocorrelation, Cross correlation, ECG, Myocardial Infarction, Non invasive technique.

1 INTRODUCTION

Cardiovascular disease is the world's leading killer, accounting for 16.7 million or 29.2 per cent of total global deaths in 2003. The World Health Organization (WHO) estimates that 60 per cent of the world's cardiac patients will be Indian by 2010. Also it has been found out that India has more number of cardiovascular deaths claiming younger population than in America [1]. The major reasons contributing to sudden deaths are due to myocardial infarction (commonly known as heart attack). Apart from deaths due to accidents myocardial infarction is the most commonly found episode in sudden casualty. The time from the onset of myocardial infarction to the treatment for the same is very crucial. Therefore it is very essential that diagnosis of the clinical symptoms should be as fast as possible. The onset of myocardial infarction results in to the changes in ECG of the patient. These changes can be used as tools of diagnosis. Before the physician is available the paramedical staff can start the preparatory treatment if the myocardial infarction is confirmed. Such quick confirmation is possible by using signal processing techniques applied to a normal ECG and the ECG of the patient under diagnosis. The proposed paper discusses the confirmatory changes in ECG in case of different types of myocardial infarction and compares the patient's ECG with normal ECG. The ECG images available are converted in to signal so that the signal processing tools can be applied to it. The signal processing tool of cross correlation and auto correlation can confirmatively assess the degree of similarity/dissimilarity between the two signals.[2] This information can be used by the paramedical staff to assess whether the patient is suffering from myocardial infarction or a casual angina. Also the possibility of ectopic beats which can be falsely considered as a case of arrhythmia can be ruled out by the following test.

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The proposed paper uses the ECG of the patient and the normal ECG of the patient if available before onset of the disease. [3] If the normal ECG of the same patient is not available, then any other normal ECG can be used for tool for comparison.

2 Overview of Myocardial Infarction

Myocardial Infarction refers to damage or death (infarction) of heart muscle (myocardium). The damage results from the interruption of blood supply to part of the heart causing heart cells to die. This is most commonly due to occlusion (blockage) of a coronary artery following the rupture of a vulnerable atherosclerotic plaque, which is an unstable collection of lipids (cholesterol and fatty acids) and white blood cells in the wall of an artery. If left untreated for a sufficient period of time this leads to permanent death of heart wall muscle. Since heart wall expansion and contraction is essential for proper functioning of heart, the damage of the wall affects the functioning of the heart resulting into heart failure. The type of infarction depends upon which part of the heart wall is damaged. The heart wall is mainly divided in three zones as shown in figure-1.

The prominent types of infarction are –

1. Anterior infarction
2. Posterior infarction
3. Inferior infarction

ECG is non invasive, safe tool that gives instantaneous results. The ECG of an infracted heart is different than that of a normal heart. The change in ECG is the dependent upon the location of infarct.[4]

The anterior wall infarction can be properly represented by AVL and V5-V6 leads. (Refer figure 2a)

The inferior myocardial infarction will be properly represented by AVF and V2-V3 leads. (Refer figure 2b)

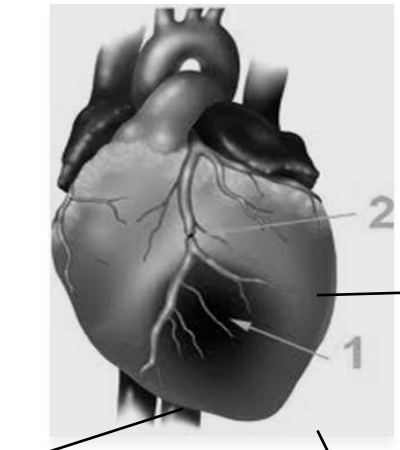

Figure-1

The posterior infarction is not clearly visible in the ECG. Over all changes in ST segment can be the confirmative indication. These changes in the ECG can be compared to that with the normal ECG. (Refer figure 2c).

The ECG is observed to be changing depending upon the duration of the infarct. By and large the confirmatory change in ECG is the ST segment depression and tall T wave with symmetrical taper.

The corresponding ECGs are as shown in the figure.2 [5]

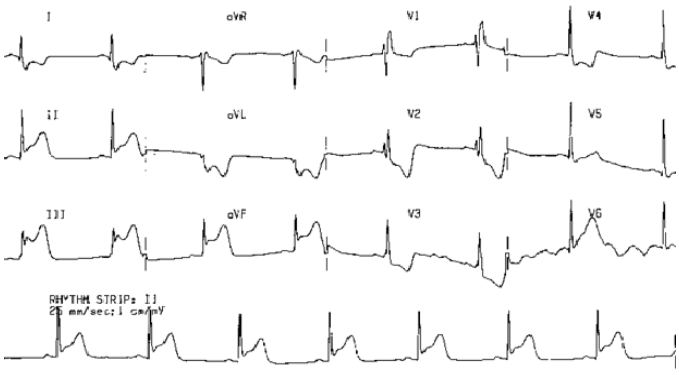

Figure 2a ECG of Posterior Infarction.

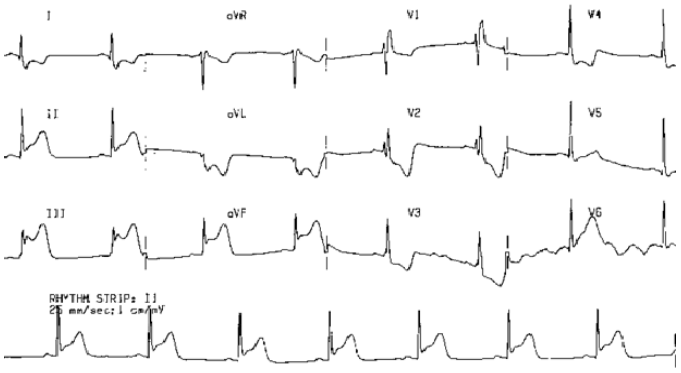

Figure 2b Required ECG leads representing Inferior Infarction

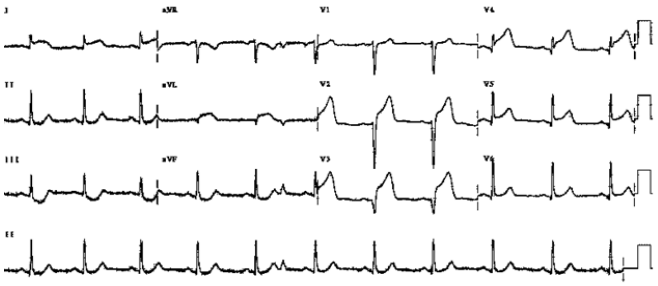

Figure 2c Required ECG leads representing Anterior Infarction

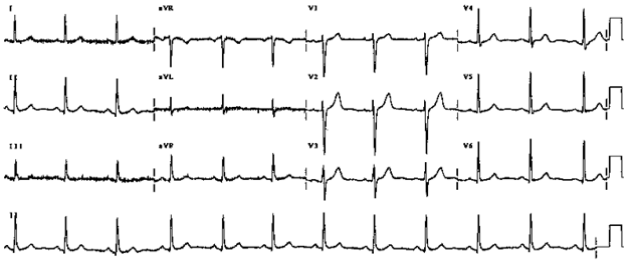

Figure 2c Normal ECG

3 Need to use cross correlation

Bio signals are highly subjective. Though there are some standard parameters of the ECG signals, the parameters tend to vary from person to person time to time. So it is not possible to build confirmative heuristic diagnostic algorithm to detect the abnormality. The suitable tool for the confirmative diagnosis is by using the cross correlation of the normal and abnormal signal. The accuracy of the diagnosis can be achieved by cross correlating the two signals over sufficiently long duration.

4 Material and methods used

ECG Images of normal and different types of infraction are used from standard MIT-BIH database. The duration of signals used is for 120 sec. which is sufficiently large to ensure accuracy of results.

It is essential to convert the images to signals to ascertain the accuracy of the result. [5] This can be done by the implementing gray level slicing and then boundary extraction algorithm. The

extracted boundary can be used as signal fit to use for applying further cross correlation and auto correlation techniques. [6]
The resulting summation values for autocorrelation and cross correlation can be used as confirmative parameters to diagnose the disease.

5 Results and Discussion

It is evident from table-1and also graph-1 that the cross correlation values are at least half that of the autocorrelation. It a confirmative positive diagnostic indication that proves the ECG change are prevalent over a sufficiently long period of time.
Also the autocorrelation values are found to be higher for the disease that is 15 days old compared to that if the disease is six months old. This proves the fact that longer the duration of myocardial infarction worse will be the situation.
It has also been evident from the table that values of anterior infarction are much higher than the other diseases. This is purely incidental as we have taken the specimen of one patient.

Type of specimen	Auto correlation	Cross correlation	Ratio of auto correlation to Cross correlation
Normal	1.4702e+10	-	-
Inferior Myocardial infarction (2 week old)	1.4310e+10	0.73774e+10	1.94
Inferior Myocardial infarction (12weekold)	1.3831e+10	0.66670e+10	2.07
Posterior Myocardial infarction (2week old)	1.3821e+10	0.6658e+10	2.08
Posterior Myocardial infarction (12weekold)	1.0188e+10	0.45242e+10	2.25
Anterior Myocardial infarction (2week old)	2.6013e+10	0.29013e+10	8.97
Anterior Myocardial infarction (12weekold)	2.2013e+10	0.24013e+10	9.17

Table 1

6 Further scope

More work can be done by taking more samples and results and discussion can be further more confirmative. Also it is possible
Also it is possible to explore more by taking different time interval windows of myocardial infarction. More work is also possible if one takes ECGs specific to one disease and actual patient data.

7 References

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