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Research Article

Comparative Analysis of Abnormal Troponin and ST Deviations in Diagnosis of Myochardia Infarction

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ABSTRACT

Introduction: Cardiac Troponin (cTn) represents a pivotal protein complex involved in the contraction of the myocardium, the heart's muscular wall. The measurement and interpretation of troponin levels play a significant role in diagnosing Acute Myocardial Infarction (AMI) and evaluating cases of potential cardiac chest pain. Troponin testing (assay) has always been used to diagnose MI but the presence of elevated troponin levels does not state one has MI, this study aims to determine if MI or other cardiac problems may be detected just by troponin testing and it also compares the results with the ECG to see if all patients with increased troponin levels were also diagnosed with MI.

Method: The study population consisted of 47 patients with elevated troponin levels at the GoodHeart Medical Consultants Hospital; the ECG data of the population were evaluated. ST elevation and depression was judged to be present if there was an upward or downward sloping ST-segment for atleast 0.08 s respectively in one or more of the 12 leads except aVR.

Results: The frequency of ECG recordings and troponin measurements for each patient, was at 100% for all included in the study. The mean ± standard deviation age of the patients was 61 ± 16.58 years and 25 (53%) were males while 22 (47%) were females. 28% of the study population had hypertensive heart disease, 19% had heart failure while 13% had Atrioventricular (AV) block. 49% of the study group had myocardial infarction while 17% had ischemic heart disease (myocardial ischemia), only 1 patient (2%) had stable angina. 78.26% who had myocardial infarction has ST elevation while 39.13% had depression.

Conclusion: This study shows that Cardiac Troponin (cTn) status and quantitative ST deviation (elevation and depression) are complementary in evaluating risk among patients with ACS and both should be used to establish prognosis and support medical decision making. Although cTn and ST deviation are both useful risk indicators, cTn seems to be more helpful than ST elevation in diagnosing NSTEMI.

Keywords: Myocardial infarction; Elevated troponin; Electrocardiogram; ST elevation

INTRODUCTION

Troponin is a crucial complex made up of three essential regulatory proteins and its significance in the orchestration of muscle contraction has been well-documented in the research of Li and Hwang. It's important to note that these muscles under the influence of troponin encompass both skeletal and cardiac muscle. However, notably absent from this group is smooth muscle, which operates differently in terms of its regulation and contraction mechanisms [1].

Cardiac Troponin (cTn) represents a pivotal protein complex involved in the contraction of the myocardium, the heart's muscular wall. Detectable levels of cTn in the bloodstream serve as a critical marker for assessing damage to the heart muscle. The measurement and interpretation of troponin levels play a significant role in diagnosing Acute Myocardial Infarction (AMI)

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and evaluating cases of potential cardiac chest pain, as highlighted by Roffi et al., in their 2015 study.

It's important to note that while the presence of troponin in the bloodstream is not exclusive to myocardial infarction, it demonstrates an exceptional level of sensitivity in the diagnosis of AMI. According to Reichlin, et al., the high-sensitive troponin tests have demonstrated their significant utility in accelerating the diagnosis of AMI and forecasting the occurrence of Cardiovascular Disease (CVD) in individuals who may lack symptoms or any prior record of CVD.

These assessments hold the promise of improving the speed at which AMI can be diagnosed and offer valuable information about the risk of developing cardiovascular disease, often before any symptoms becomes apparent.

Measurable levels using modern or high-sensitive troponin tests serve as a clear indicator of cardiac injury in Acute Coronary Syndrome (ACS) and various other pathological conditions, encompassing Heart Failure (HF), pulmonary embolism and arrhythmias.

Acute Coronary Syndrome (ACS) is a group of clinical disorders caused by a limited coronary blood supply, which reduces blood flow to the heart muscle. An imbalance between the oxygen supply and demand in the heart causes acute myocardial ischemia and/or Myocardial Infarction (MI), which is caused by the blockage of coronary blood flow.

Three different clinical presentations-unstable angina, Non ST-Segment Elevation MI (NSTEMI), and ST-Segment Elevation MI (STEMI)-are indicative of acute coronary syndrome. The existence of myocardial infarction symptoms, abnormalities in the Electrocardiogram (ECG) and cardiac biomarkers, especially cardiac troponins, are used to differentiate between these subtypes.

When deciding whether patients need higher-level monitoring-such as telemetry or the cardiac care unit-troponin can be a helpful metric.

Troponin testing (assay) has always been used to diagnose MI but the presence of elevated troponin levels does not really mean one has MI, so this study is to examine or find out if everyone who did troponin testing with elevated troponin level result at GoodHeart medical hospital was diagnosed of MI or other heart conditions and also to compare with their ECG to know if troponin alone can be used to diagnose MI [2].

MATERIALS AND METHODS

Study design/population

The medical records of forty seven patients with abnormal troponin T and I level over a five year period at GoodHeart medical consultant's hospital laboratory information system were retrieved for analysis [3].

The information extracted included factors such as age, gender, height, blood pressure, pulse, TnT, TnI, S-T elevation, S-T depression, rhythm, ECG indication and mortality.

Troponin measurement

All troponin measurement done in the Goodheart medical consultants were done using Point of Care Test (POCT) machine. The 'Cobas' machine measured Troponin T (TnT) while the 'Ichromax' machine measured for Troponin I (TnI). The normal range for TnI<0.10 ng/mL and that of TnT is <50 ng/mL [4].

ECG parameters

All ECG data were evaluated from the electronic database at the ECG room of Goodheart medical consultants and also from the ECG printouts in the patients' folders.

The ECGs were recorded in 12-lead format at a paper speed of 25 mm/s. The ST elevation and depression was judged to be present if there was an upward or downward sloping ST-segment for at least 0.08 s respectively in one or more of the 12 leads except aVR [5].

Statistical analysis

Statistical analysis was undertaken using Excel 2016 and SPSS V15. Descriptive analysis and cross tabulation were used for the results in forms of tables and bar chat approval for this study was acquired from GoodHeart medical consultant's research department [6].

RESULTS

Patients

A total of 47 patients with elevated troponin levels were screened in GoodHeart medical consultants hospital during the study period. The frequency of ECG recordings and troponin measurements for each patient, was at 100% for all included in the study [7].

Figure 1 shows the year distribution. This study analyzed abnormal troponin level between year 2018 and 2022. The highest number of abnormal troponin was recorded in year 2020. The second highest was in year 2019, then 2018. The lowest number of abnormal troponin was recorded in year 2021.

Patient characteristics according to ST segment deviation (elevation and depression) are summarized in Table 1. The mean ± standard deviation age of the patients was 61 ± 16.58 years and 25 (53%) were males while 22 (47%) were females [8].

Patients with ST depression was older, more of female as compared to male and less likely to have undergone prior percutaneous coronary intervention. These patients had higher heart rates and diastolic Blood Pressure (BP). Patients with ST elevation most likely had Hypertensive Heart Disease (HHDX), heart failure, myocardial ischemia and myocardial infarction.

28% of the study population had hypertensive heart disease, 19% had heart failure while 13% had Atrioventricular (AV) block. 49% of the study group had myocardial infarction while 17% had ischemic heart disease (myocardial ischemia), only 1 patient (2%) had stable angina [9].

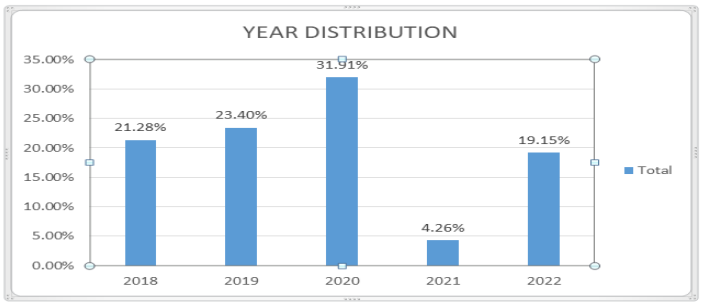

Figure 1: Bar chart showing the distribution of number of patients with abnormal toponin across the years.

Table 1: Patient clinical characteristics.

Baselines	Total	ST elevation	ST depression
Age (years; mean ± SD)	61 ± 16.58	61 ± 16.52	68 ± 16.48
Male (n; %)	25 (53)	19 (63)	7 (41)
Female (n; %)	22 (47)	9 (30)	8 (47)
Heart rate (bpm; mean ± SD)	86.55 ± 21.62	87 ± 20.6	89.4 ± 23.48
Systolic (mmHg; mean ± SD)	128 ± 22.13	129.43 ± 22.75	132.4 ± 17.38
Diastolic (mmHg; mean ± SD)	74.15 ± 23	61.11 ± 20.21	67.6 ± 20.68
Diagnosis (n; %)			
HHDX	13 (28)	8 (27)	4 (24)
Heart failure	9 (19)	5 (17)	3 (18)
AV block	6 (13)	4 (13)	2 (12)
Stable angina	1 (2)	0 (0)	1 (6)
Myocardial ischemia	8 (17)	4 (13)	5 (29)
Myocardial infarction	23 (49)	18 (60)	7 (41)

Note: HHDX: Hypertensive Heart Disease; AV Block; SD: Standard Deviation

Table 2 shows a cross tabulation of ST segment elevation, depression and some cardiovascular diagnosis. 78.26% who had myocardial infarction has ST elevation while 39.13% had depression.

Table 2: Cross tabulation of ST deviations and some cardiovascular diagnosis.

Diastolic parameters	ST elevation (%)	ST depression (%)	ST elevation and depression (%)
Myocardial infarction	78.26	39.13	17.39
Myocardial ischemia	75	62.5	50
Heart failure	55.56	44.44	11.11
Hypertensive heart disease	69.23	30.77	15.38

DISCUSSION

The fourth universal definition of myocardial infarction states that acute myocardial injury identified by aberrant cardiac biomarkers along with acute myocardial ischemia is the clinical criteria for the diagnosis of MI. In this single center study of patients with abnormal troponin levels in a 5-year period, 49% of the total population had myocardial infarction and of this population 60% had ST elevation while 53% had ST depression. These individuals with ST elevation met the diagnostic criteria for MI based on a typical rise or fall in elevated troponin measurements and ischemic changes on a 12-lead ECG, with ECGs performed as clinically indicated. Those who had MI with no diagnostic ST-elevation ECG abnormalities fell on category of Non-ST Elevation MI (NSTEMI). Mechanic et al. also reported that the patients may have presented with typical chest pain which led to investigation for NSTEMI with subtle abnormalities on ECG, including ST-depressions and T wave changes [10].

Some ECG when critically observed may present with both ST elevation and ST depression for patients with AMI as seen in Figure 2.

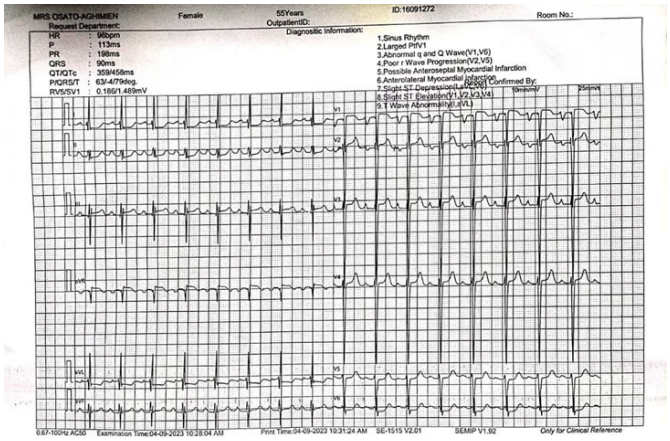

Figure 2: Patient's ECG showing slight ST-Elevation on V1, V2, V3, V4 and ST-depression on I, aVL, V6. Diagnostic information shows anterolateral myocardia infarction.

28% of the study population had Hypertensive Heart Disease (HHDX), with 30% having ST elevation on their ECG and 24% having ST depression. ST elevation is an indication of myocardial infarction while ST depression indicates myocardial ischemia (ischemic heart disease). This means that high Blood Pressure (BP) is a well-known risk factor for Cardiovascular (CV) diseases and interventions that lower BP have generally reduced CV events. Individuals with elevated levels of cTnT (high-sensitivity troponin-T) face a significantly higher risk of experiencing new Cardiovascular (CV) events even when they fall within specific narrow categories of Systolic Blood Pressure (SBP). The risk is most pronounced in individuals with the highest cTnT levels within each SBP category and this association is particularly robust in the context of Heart Failure (HF). While previous studies, including the ARIC study, have examined the relationship between cTnT and various CV events, the significance of measuring high-sensitivity troponin-T as an indicator of the impact of blood pressure on the development of new CV outcomes had not been previously reported. The magnitude and rate of change of troponin can help differentiate type 1 from type 2 myocardial infarction and acute or chronic myocardial injury [11].

Heart failure was diagnosed in 19% of the study population; 17% of these patients with heart failure had ST segment elevation while 24% had ST segment depression. The remaining patient with heart failure neither had ST elevation nor depression. High-sensitivity troponin was independently linked to cardiovascular mortality and the development of CHF, but not MI, in a sizable observational cohort of patients with known Coronary Artery Disease (CAD) who did not have acute coronary syndrome or Congestive Heart Failure (CHF)(Prevention of Events with Angiotensin Converting Enzyme Inhibition (PEACE) trial population). The patients were followed for a median of 5.2 years. The composite outcome of cardiovascular death and future MI over a mean follow-up of 4.5 years was found to be independently correlated with high-sensitivity troponin levels in comparable research of patients at high risk for CAD events (Heart Outcomes Prevention Evaluation (HOPE) study population [12].

17% of the study population had ischemic heart disease. 13% of them had ST elevation while 29% had ST depression. As part of the Thrombin Inhibition in Myocardial Ischemia (TRIM) substudy, Kaul et al., investigated the combined utility of ECG and biochemical testing for very early risk classification among patients with unstable coronary artery disease. 64 (14%) of the 470 patients whose ECGs could be read showed a ST depression of at least 1 mm in any lead. Both ST depression and cTnT 0.1 ng/ml were highly predictive of mortality or recurrent MI within 30 days in univariate analysis [13].

In a study by Meyers et al., ST-Segment Depression (STD) was present in triage ECG of some of the study population. Some of the leads exhibited mild elevation of the ST-segment along with reciprocal STD in aVL. Angiography was delayed for some hours after presentation since none of their ECGs fit the criteria for ST-segment elevation myocardial infarction. Upon completion, a complete (Thrombolysis in Myocardial Infarction (TIMI) 0) left circumflex artery blockage was discovered and stented. These patients also had elevated cardiac troponin T levels [14,15].

CONCLUSION

This study shows that cardiac Troponin (cTn) status and quantitative ST deviation (elevation and depression) are complementary in evaluating risk among patients with ACS and both should be used to establish prognosis and support medical decision making. Although cTn and ST deviation are both useful risk indicators, cTn seems to be more helpful than ST elevation in diagnosing NSTEMI. Furthermore, risk assessment analysis should take into account values of cTnT less than 0.1 ng/ml, as they contain significant prognostic information. Further research is needed to understand how the different values of abnormal cTn can be compared to ST deviation on ECG within different time range.

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