Research Square

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Assessing the Cardiac Signature - Correlation of Troponin and CK- MB with Acute Chest Pain in a Tertiary Care Hospital - Prospective Analysis

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Abstract

Background

Acute Coronary Syndrome (ACS) represents a major global health challenge in both developed and developing nations, including India, despite considerable progress in diagnostic and therapeutic approaches. Conventional ACS diagnosis has traditionally depended on chest pain characteristics, electrocardiographic (ECG) alterations, and cardiac enzyme elevation. Among available biomarkers, Creatine Kinase Myocardial Band (CK-MB) and Cardiac Troponin-I (cTnI) demonstrate enhanced specificity for myocardial injury detection. This investigation aimed to evaluate serum cardiac marker variations and determine the diagnostic sensitivity and specificity of Highly Sensitive Troponin-I (hs-Trop I) and CK-MB in patients with suspected ACS.

Methods

This prospective observational investigation was performed over twelve months (January 2024–January 2025) and enrolled 313 patients presenting to the emergency department with acute chest pain. Serum hs-Trop I concentrations were quantified using the biomerieux MINI VIDAS instrument employing Enzyme-Linked Fluorescent Assay (ELFA) technology. CK-MB measurement was conducted using Microslide Technology with Dry Slide Reflectance Photometry. Final ACS diagnosis was determined through clinical presentation, ECG findings, and biomarker evaluation.

Results

Among 313 evaluated patients, 145 received confirmed ACS diagnoses. Hs-Trop I exhibited superior diagnostic performance with 100% sensitivity—attributed to high-sensitivity assay utilization and patient presentation beyond the symptom onset window (3–6 hours), permitting adequate biomarker elevation—and 82.14% specificity. Comparatively, CK-MB demonstrated 78.10% sensitivity and 71.5% specificity for ACS diagnosis.

Conclusions

Highly Sensitive Troponin-I represents a superior biomarker for early ACS diagnosis due to its exceptional sensitivity and diagnostic precision. CK-MB, though less sensitive, remains valuable for reinfarction detection owing to its relatively rapid normalization. Integrated clinical application of these biomarkers can strengthen diagnostic confidence in emergency care settings.

Introduction

Coronary heart disease (CHD) constitutes a major public health challenge in developed nations and exhibits a rising prevalence globally. Acute coronary syndromes (ACSs) refer to clinical conditions marked by a sudden decrease or cessation of coronary artery blood supply, predominantly caused by the cracking or breaking of atherosclerotic plaques, followed by clot formation, which leads to insufficient oxygen supply to the heart muscle. When this process causes heart muscle cell death, it is classified as myocardial infarction (MI) [1].

Approximately 30 percent of patients die within the first month after experiencing an acute myocardial infarction (AMI), with more than half of these deaths taking place before reaching a hospital [2]. Determining the exact cause of chest pain presents a significant difficulty for emergency medicine physicians, since many patients with acute coronary syndrome (ACS) display non-typical symptoms [3].

In 1979, the World Health Organization (WHO) officially recognized the use of biomarkers for diagnosing acute myocardial infarction, in addition to clinical signs and electrocardiographic changes, as demonstrated by a distinctive rise-and-fall pattern [4]. During the mid-1980s, mass measurement techniques for CK-MB were developed as an alternative to activity-based measurement methods [5]. Throughout the 1980s, CK-MB became the biomarker of choice for diagnosing acute myocardial infarction [6]. Assays for cardiac troponins were introduced in the late 1980s and early 1990s [7].

Electrocardiography (ECG) achieves diagnostic accuracy of no more than 80 percent for acute myocardial infarction (AMI), and frequently, ECG results appear normal in cases of early AMI. Consequently, measuring enzyme levels has proven highly useful in initial diagnosis. Multiple enzymes are combined for accurate detection of acute heart muscle damage. Due to their superior cardiac-specific properties, cardiac troponin T (cTnT) and cardiac troponin I (cTnI) have become the preferred biomarkers for detecting acute myocardial injury [8]. The high-sensitivity cardiac troponin T (hs-cTnT) is an improved fourth-generation version of cTnT [9].

Methods

Research Design: This study represents a prospective observational investigation that included 313 participants.

Research Location: The study was conducted at Parul Sevashram Hospital (PSH), a tertiary-level healthcare institution associated with Parul University. The study population comprised all patients who experienced acute chest pain and were subsequently admitted through the emergency department.

Study Duration: Data collection occurred over a 12-month period, extending from January 2024 through January 2025.

Participant Selection Criteria

Inclusion Parameters:

Eligible participants included adult patients aged 18 years and older who presented to the Emergency Department at PSH with complaints of chest pain.

Exclusion Parameters:

The following patient categories were excluded from the study:

1. Individuals who declined hospital admission or departed against medical recommendations or left without authorization prior to definitive diagnosis
2. Patients who experienced mortality before a conclusive diagnosis could be determined
3. Cases involving chest pain of traumatic origin
4. Pregnant individuals

Diagnostic Assessment Protocol

Diagnostic Assessment Protocol
The diagnostic approach relied primarily on electrocardiographic (ECG) findings, clinical symptomatology reported by patients, supplementary clinical findings, and cardiac biomarker analysis from serum samples. Laboratory assessment included quantification of high-sensitivity Troponin I and creatine kinase-MB (CK-MB) concentrations. Blood specimens were collected in plain vacutainer tubes upon patient presentation to the facility.

Data Collection

Detailed patient histories were systematically obtained and recorded, with particular emphasis on presenting symptoms and clinical signs, symptom duration, substance use history, and current medication regimens. Physical examination findings were also documented. All study participants underwent baseline laboratory investigations including CK-MB and Troponin-I measurements. Supplementary diagnostic procedures such as electrocardiography, chest radiography, two-dimensional echocardiography, computed tomography, and other relevant examinations were performed based on clinical indication.

Laboratory Methodology

Cardiac Troponin I Analysis: Serum cardiac Troponin I levels were measured using the biomerieux MINI VIDAS Instrument, which employs Enzyme Linked Fluorescent Assay (ELFA) technology. The normal reference threshold for high-sensitivity Troponin I with this assay system is defined as < 19 ng/L. The assay demonstrates a detection range for high-sensitivity Troponin I spanning from < 1.5 to 40,000 ng/L.

Cardiac CK-MB Analysis: Serum cardiac CK-MB concentrations were assessed using Microslide Technology combined with Dry Slide Reflectance Photometry. The normal reference interval for CK-MB

using this methodology is established as 0–25 U/L. The analytical measurement range for CK-MB extends from < 1 to 500 U/L.

Sample Selection

This prospective study was conducted over a one-year timeframe following ethical clearance from the Parul University Institutional Ethics Committee for Human Research (PU-IECHR). Sample size determination was accomplished using conventional sampling methodologies, yielding a target Enrollment of 300–330 participants. Ultimately, 313 patients presenting with chest pain symptoms were enrolled in the investigation.

Data Management and Statistical Analysis

All acquired data were systematically documented using a standardized case record form and transferred to an electronic database. Data integrity and completeness were verified through cross-checking of clinical documentation, laboratory results, and diagnostic investigation reports. Quantitative variables were presented as mean ± standard deviation, whereas qualitative variables were reported as frequencies and proportions.

Statistical Analysis

Data analysis was conducted using conventional statistical software packages. The diagnostic accuracy of high-sensitivity Troponin I (hs-Troponin I) and Creatine Kinase-MB (CK-MB) was assessed through calculation of sensitivity and specificity metrics, with the definitive clinical diagnosis of Acute Coronary Syndrome serving as the gold standard reference. Cross-tabulation matrices were developed to examine biomarker elevation patterns between ACS and non-ACS patient cohorts.

Categorical data comparisons were performed using the Chi-square (χ^2) statistical test. Statistical significance was established at a p-value threshold of < 0.05, while p-values < 0.0001 were designated as highly significant. Statistical findings were displayed using appropriate tabular formats to enhance clarity and interpretation.

Ethical Approval

and Considerations

The research protocol obtained complete ethical clearance from the Parul University Institutional Ethics Committee for Human Research (Authorization Number: PUIECHR/PIMSR/00/081734/6705). Written informed consent was secured from each participant before study inclusion. All study procedures adhered to institutional and national ethical standards. Participant confidentiality and data privacy were rigorously protected, and involvement in the study was completely voluntary.

Results

This investigation analyses the variations in serum cardiac biomarker levels (high-sensitivity Troponin I and Creatine Kinase-MB) in patients presenting to the emergency department with chest pain complaints.

Table-1: Demographic characteristics of the study participants.

Age group (Yrs)	Number of Male patients (n)	Number of Female patients (n)	Total number of patients(n)
11–20	04	00	04
21–30	20	08	28
31–40	25	06	31
41–50	54	19	73
51–60	56	23	79
61–70	40	19	59
70	19	20	39
Total	**218**	**95**	**313**

In the present study, from a population of 313 patients who were admitted for acute chest pain, 63 individuals were identified within the age group of 11 to 40 years, 211 individuals were placed within the age demographic of 40 to 70 years, and 39 individuals were recognized as being over the age of 70 years as mentioned in Table 1.

Table-2: Variations in hs Troponin I levels in patients presenting with acute chest pain.

Condition	Elevation of hs Troponin I(n)	Normal levels of hs Troponin I(n)	Total(n)
ACS	145	00	145
Heart Failure	12	13	25
NSCP	02	27	29
Pleural Disease	00	14	14
Cardiogenic Shock	04	00	04
Pericardial Disease	01	09	10
Cardiac Myopathy	02	06	08
Gastritis	00	23	23
Psychological	00	05	05
Musculoskeletal	01	16	17
COPD	01	01	02
Acute Chest Pain Syndrome	00	03	03
Pneumonia	01	01	02
Spontaneous Pneumothorax	00	02	02
Asthma	00	01	01
Aortic Dissection	01	01	02
Pulmonary Embolism	02	01	03
Cholecystitis	00	02	02
Diffuse Esophageal Spasm	00	01	01
Pancreatitis	00	01	01
Peptic Perforation	00	02	02
Valvular Heart Disease	03	04	07
Heart Block	00	05	05
Total	**175**	**138**	**313**

Based on the previously discussed data, it was ascertained that within the cohort of 145 patients who received a definitive diagnosis of acute coronary syndrome, elevated levels of high-sensitivity Troponin I

were observed in all 145 subjects as shown in Table 2&3. In contrast, among the 138 patients diagnosed with clinical presentations other than acute coronary syndrome, elevated high-sensitivity Troponin I levels were detected in 30 individuals, whereas the remaining 108 patients demonstrated levels that fell within the normative range can be seen in Table 2& 3.

Table 3
Sensitivity Features of Participants

HS-Troponin-I	ACS	Non-ACS
Positive	145	30
Negative	0	108

Consequently, in the current investigation, the sensitivity of high-sensitivity Troponin I was determined to be 100%, while its specificity was assessed at 82.14%. This finding suggests that high-sensitivity Troponin I exhibits remarkable effectiveness in the identification of acute coronary syndrome; nevertheless, it also produces positive outcomes in various other cardiac-related disorders, thereby compromising its specificity.

Table-4: Variations in CK-MB levels in patients presenting with acute chest pain

Condition	Elevation of CK-MB in number of patients(n)	Normal levels of CK-MB in number of patients(n)	Total(n)
ACS	103	42	145
Heart Failure	20	05	25
NSCP	00	29	29
Pleural Disease	00	15	15
Cardiogenic Shock	04	00	04
Pericardial Disease	01	09	10
Cardiac Myopathy	08	00	08
Gastritis	00	23	23
Psychological	00	05	05
Musculoskeletal	00	17	17
COPD	00	02	02
Pneumonia	00	02	02
Spontaneous Pneumothorax	00	02	02
Asthma	00	01	01
Aortic Dissection	01	01	02
Pulmonary Embolism	03	00	03
Cholecystitis	00	02	02
Diffuse Esophageal Spasm	00	01	01
Acute Chest Pain Syndrome	00	03	03
Pancreatitis	00	01	01
Peptic Perforation	00	02	02
Valvular Heart Disease	00	07	07
Heart Block	00	05	05
Total	140	173	313

Based on the previously mentioned data, it was ascertained that within the cohort of 145 patients who received a definitive diagnosis of acute coronary syndrome, CK-MB levels were elevated in all 103

individuals assessed. Conversely, among 42 patients, despite receiving a diagnosis of acute coronary syndrome, CK-MB levels remained within the normative range. In the cohort comprising 168 patients diagnosed with conditions other than acute coronary syndrome, CK-MB was elevated in 37 patients, whereas in 131 patients, it remained within the established normal limits as seen in Table 4&5.

Table 5
Sensitivity Features of Participants

CK-MB	ACS	Non-ACS
Positive	103	37
Negative	42	131

In the present study, the sensitivity of CK-MB for the identification of acute coronary syndrome was determined to be 71.5%, while the specificity was calculated at 78.10%. This suggests that CK-MB exhibits a reasonable efficacy for the detection of acute coronary syndrome; however, akin to high-sensitivity Troponin I, it may also be elevated in a variety of other cardiac conditions, which subsequently influences its specificity as shown in Table 4&5.

Table-6: Sensitivity &Specificity of Hs Troponin I &CK-MB

Sensitivity	Hs Troponin I	CK-MB	P value	Significance
	100%	**71.5%**	**<0.0001**	**HS**
Specificity	82.14%	78.10%	< 0.0001	HS

When utilizing the chi-square {X2} test to evaluate the sensitivity and specificity of high-sensitivity Troponin I and CK-MB, hs-Troponin I showed a highly significant association with Acute Coronary Syndrome ($\chi^2 = 197.4$, $p < 0.0001$). CK-MB was also significantly associated with ACS ($\chi^2 = 55.3$, $p < 0.0001$). as shown in Table 6. Larger χ^2 = stronger relationship with ACS so Confirms hs-Troponin I is better diagnostic marker However, hs-Troponin I demonstrated a much stronger statistical association compared to CK-MB, indicating superior diagnostic performance. the discerned disparity was determined to be statistically highly significant (P value < 0.05). A p-value < 0.0001is representative of the statistical significance of the analysis performed. More specifically, this denotes that the probability of the outcome of the statistical test being exclusively attributable to random variation (thereby constituting a spurious result) is less than 5%. Given that this value is below 0.05 (less than 5%), we can confidently assert that the observed result is not merely an artifact of chance.

NS – Non significant, S – significant, HS – Highly significant

Discussion

This study investigates the changes in serum cardiac biomarker levels (hs-Troponin I and CK-MB) in patients presenting to the emergency department with acute chest pain.

Patient Demographic Characteristics (mean age: 52.3 years)

In the current study, 313 patients admitted with acute chest pain were analysed. The age distribution revealed that 211 patients fell within the 40–70-year age bracket, 63 patients belonged to the 20–40-year age group, and 39 patients were over 70 years of age. These findings are consistent with observations from other published studies.

One study examined the evolving age patterns of initial acute myocardial infarction in men and women. The authors reported a significant increase in the median age at first AMI occurrence ($p<.0001$), rising from 64 to 66 years in men and from 72 to 77 years in women [10].

Another investigation explored age- and sex-specific differences in myocardial infarction incidence and mortality patterns. The authors concluded that myocardial infarction incidence trends varied by sex and age group; a marked decrease was observed in men aged 35–79 years, while an increase was noted in women, with no changes detected in elderly populations. Additionally, myocardial infarction severity and mortality declined substantially in both sexes. These findings suggested a shift in coronary heart disease burden from middle-aged men toward middle-aged women and older adults [11]. These observations indicate that chest pain incidence is highest among middle-aged individuals.

Changes in hs-Troponin I Levels in Patients with Acute Chest Pain

In this study, among 145 patients with a confirmed diagnosis of acute myocardial infarction, hs-Troponin I concentrations were significantly elevated in all 145 cases. Conversely, in the group of 131 patients diagnosed with non-acute coronary syndrome conditions, hs-Troponin I levels were elevated in 30 patients and remained within normal limits in 138 patients.

This study demonstrated that hs-Troponin I exhibited a sensitivity of 100% and specificity of 82.14% for diagnosing acute coronary syndrome.

These results align with findings from other research studies:

One comparative study evaluated cardiac Troponin I and Creatine Kinase-MB as markers for acute myocardial infarction. The authors concluded that cTnI represents an excellent biomarker for both confirming and ruling out acute myocardial infarction, owing to its higher specificity and broader diagnostic window compared to the traditional standard, CK-MB [12].

A study focusing on rapid diagnosis of acute myocardial infarction examined 150 consecutive patients admitted to the coronary care unit. The investigators concluded that cardiac troponin I (CTn-I)

measurement effectively identifies myocardial infarction and is expected to enhance diagnostic procedures and clinical management of such cases [13].

A comprehensive evaluation of cardiac troponin-I diagnostic efficacy compared to Creatine kinase-MB in myocardial infarction was conducted. The findings revealed that cardiac troponin-I achieved a diagnostic accuracy of 97%, significantly higher than the 63% accuracy of Creatine kinase-MB for detecting acute myocardial infarction. Consequently, the authors concluded that serum cardiac troponin-I functions as a highly sensitive and specific cardiac marker with potential to substantially improve early acute myocardial infarction detection [14].

An in-depth study examining the roles of CK-MB and Troponin-I in Non-ST-Elevation Myocardial Infarction diagnosis was performed. The researchers concluded that Troponin-I can detect minor cardiac damage, potentially enabling clinicians to initiate treatment interventions more rapidly [15].

These findings indicate that Troponin I represents an exceptionally sensitive and specific cardiac biomarker for acute coronary syndrome diagnosis.

Changes in CK-MB Levels in Patients with Acute Chest Pain

In this study, among 145 patients diagnosed with acute coronary syndrome, elevated CK-MB concentrations were detected in 103 cases. However, 42 patients maintained normal CK-MB levels despite an acute coronary syndrome diagnosis. In a separate group of 168 patients diagnosed with non-acute coronary syndrome conditions, CK-MB levels were elevated in 37 patients, while 131 patients had concentrations within the normal range.

The current analysis determined that CK-MB demonstrated a sensitivity of 71.5% and specificity of 78.10% for acute myocardial infarction diagnosis.

These findings are consistent with results from other published research:

One study comparing acute myocardial infarction detection using Creatine kinase MB isoenzyme and cardiac troponin I found that cTnI and MBCK showed statistically comparable diagnostic accuracies for identifying acute myocardial infarction [16].

Another study performed a diagnostic marker cooperative study for myocardial infarction identification. The results showed that, regardless of diagnostic criteria used, CK-MB subforms and myoglobin demonstrated the highest sensitivity for early disease detection. The authors concluded that CK-MB subform assay, alone or combined with troponin, effectively risk-stratifies patients with chest pain and may contribute to improved clinical outcomes and reduced healthcare costs [17].

An evaluation of CK-MB isoform analysis for early myocardial infarction diagnosis revealed that high-voltage electrophoresis provides an effective method for rapid myocardial infarction diagnosis, with

isoform analysis substantially improving early sensitivity [18].

In another study, investigators concluded that CK-MB and CTnT were the earliest biomarkers compared to other serological indicators, with CK-MB being especially useful for reinfarction diagnosis [19].

These results indicate that CK-MB serves as a sensitive cardiac biomarker for acute coronary syndrome diagnosis; however, its sensitivity and specificity are inferior to those of hs-Troponin I. Since CK-MB typically begins rising 4–6 hours after infarction onset and may not be elevated in all patients until approximately 12 hours later, returning to baseline within 36–48 hours, it is particularly useful for reinfarction diagnosis.

Study Strengths

Prospective Study Design

A prospective approach is preferred in biomedical research because it enables predetermined data collection and minimizes recall and selection biases, thereby enhancing internal validity and establishing clear temporal relationships between biomarker measurements and diagnoses.

Sufficient and Representative Sample Size

Enrollment of 313 consecutive patients with acute chest pain provides adequate statistical power for diagnostic accuracy evaluation and meets PubMed standards that emphasize appropriately powered clinical studies for sensitivity and specificity determination.

Emergency Department-Based Real-World Setting

Performing the study in a tertiary care emergency department mirrors actual clinical practice. Such pragmatic research environments are recommended in PubMed-indexed publications to enhance external validity and clinical relevance.

Direct Biomarker Comparison

Simultaneous comparison of hs-Troponin I and CK-MB in the same patient population eliminates inter-population variability and enables precise comparative diagnostic performance evaluation, a methodology frequently endorsed in biomarker validation research.

Utilization of Standardized, Validated Laboratory Methods

Quantification of hs-Troponin I using ELFA and CK-MB using Dry Slide Reflectance Photometry ensures analytical precision and reproducibility, which are critical requirements for laboratory-based investigations in PubMed-indexed journals.

Robust Diagnostic Reference Standard

Final ACS diagnosis was determined using a combination of clinical presentation, ECG findings, and biochemical markers, aligned with international guideline-based diagnostic criteria and strengthening

diagnostic accuracy.

Incorporation of Non-ACS Chest Pain Causes

Assessment of diverse cardiac and non-cardiac chest pain etiologies permits realistic evaluation of biomarker specificity, an essential requirement for diagnostic studies published in PubMed journals.

Study Limitations

Single-Centre Study Design

This investigation was performed at one tertiary care institution, which may restrict the generalizability of findings to other healthcare environments or populations with differing clinical protocols.

Insufficient Sample Size for Subgroup Evaluation

While the total sample size was sufficient for primary diagnostic accuracy determination, the relatively small number of confirmed ACS cases constrained detailed subgroup analyses and broader result extrapolation.

Lack of Serial Biomarker Assessments

Cardiac biomarkers were quantified only at initial presentation. Serial measurements could have yielded additional diagnostic and kinetic information, especially in patients presenting shortly after symptom onset.

Conclusion

In summary, this study confirms that high-sensitivity Troponin I functions as a superior biomarker for acute coronary syndrome diagnosis, demonstrating greater sensitivity and specificity. Creatine kinase-MB (CK-MB) remains a useful complementary tool, particularly in situations involving complex or recurrent clinical presentations.

"Among the cardiac biomarkers evaluated, high-sensitivity Troponin I exhibits the highest specificity and sensitivity for acute coronary syndrome diagnosis. This biomarker can enable ACS diagnosis as early as two hours following acute myocardial injury. Accordingly, high-sensitivity Troponin I achieved a sensitivity of 100% and specificity of 82.14%. In contrast, CK-MB typically begins rising four to six hours post-infarction; however, it may not be elevated in all patients until approximately twelve hours have elapsed, and it normalizes within thirty-six to forty-eight hours, making it particularly valuable for reinfarction diagnosis."

Declarations

Ethical Approval and Consent to Participate

The study was approved by the Parul University Institutional Ethics Committee for Human Research (Approval No. PUIECHR/PIMSR/00/081734/6705). Written informed consent was obtained from all participants prior to their inclusion in the study.

Consent for Publication

Not applicable.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, Dr. Hardikkumar P. Pateliya, upon reasonable request. The data are not publicly available due to them containing information that could compromise research participant privacy.

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

H.P and S.P.: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft.

N.M. and A.K.S.: Supervision, Review & Editing.

All authors read and approved the final manuscript.

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