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EARLY DIAGNOSTIC PERFORMANCE OF TROPONIN I VERSUS CK-MB IN ACUTE MYOCARDIAL INFARCTION: A COMPARATIVE CROSS-SECTIONAL STUDY

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Abstract

Myocardial infarction (MI) remains a leading cause of global mortality, where rapid and accurate diagnosis is critical for improving patient outcomes. Cardiac biomarkers play a central role in early detection, particularly Troponin I and CK-MB (Creatine Kinase-MB). This study aimed to compare the diagnostic effectiveness of Troponin I and CK-MB in the early phase of acute myocardial infarction. A cross-sectional study was conducted at the Punjab Institute of Cardiology, Lahore, involving patients presenting with chest pain within 6–12 hours of symptom onset. Serum levels of Troponin I and CK-MB were analyzed and compared using descriptive statistics and one-way ANOVA. Results demonstrated significantly elevated and more stable Troponin I levels compared to CK-MB ($p < .001$), indicating higher sensitivity and diagnostic reliability in early MI detection. CK-MB showed earlier elevation but greater variability and rapid decline, limiting its standalone diagnostic accuracy. Findings confirm that Troponin I is a superior biomarker for early myocardial infarction diagnosis due to its higher sensitivity, specificity, and prolonged detectability. However, CK-MB may still provide complementary diagnostic value in specific clinical scenarios such as reinfarction or resource-limited settings. The study supports the clinical prioritization of Troponin I in early MI diagnostic protocols.

INTRODUCTION

Myocardial infarction is a life-threatening cardiovascular condition and remains one of the leading causes of global morbidity and mortality. It occurs due to sudden interruption of coronary blood flow, most commonly resulting from atherosclerotic plaque rupture and thrombus formation, leading to myocardial ischemia and irreversible necrosis of cardiac tissue (Kumar & Mallesh, 2025; Młynarska et al., 2024). Early recognition and timely intervention are critical in reducing myocardial damage, improving survival, and preventing long-term complications.

Biochemical cardiac markers play a central role in the early diagnosis of MI, especially when electrocardiographic findings are inconclusive in the initial hours of symptom onset. Among these

markers, Troponin I is considered the most sensitive and specific indicator of myocardial injury due to its high cardiac selectivity and prolonged elevation in serum following myocardial damage (Sevrieva et al., 2024). It typically rises within 3–6 hours of ischemia and remains elevated for up to 10–14 days, making it highly reliable for diagnosis.

In contrast, CK-MB (Creatine Kinase-MB) has historically been used for diagnosing myocardial injury due to its early rise and relatively short half-life, which makes it useful for detecting reinfarction. However, its diagnostic specificity is limited because elevated levels may also occur in skeletal muscle injury and other non-cardiac conditions (Ade Vittal & Gajanan, 2025; Aleksova et al., 2024).

Despite advancements in high-sensitivity troponin assays, CK-MB continues to be used in many clinical settings, particularly in resource-limited environments due to cost and availability constraints (Lazar et al., 2022). Therefore, a comparative evaluation of Troponin I and CK-MB is essential to determine their relative diagnostic accuracy in the early phase of MI. This study aims to contribute evidence that may improve early diagnosis, clinical decision-making, and patient outcomes in suspected cases of myocardial infarction.

Objectives

The study aimed to compare the diagnostic performance of Troponin I and CK-MB in the early detection of myocardial infarction among patients presenting with chest pain. It further sought to determine and compare serum levels of both biomarkers in suspected early MI cases, evaluate their temporal changes at different time intervals after symptom onset, and identify the most reliable biomarker for timely and accurate early diagnosis of myocardial infarction.

Research Questions

1. What is the difference in diagnostic accuracy between Troponin I and CK-MB in the early detection of myocardial infarction among patients with chest pain?
2. What are the levels of Troponin I and CK-MB in patients presenting with early suspected myocardial infarction?
3. How do Troponin I and CK-MB levels change over time after the onset of chest pain?
4. Which biomarker is more effective for early detection of myocardial infarction?

Myocardial infarction occurs primarily due to rupture of an atherosclerotic plaque within coronary arteries, followed by platelet aggregation and thrombus formation, leading to reduced or complete cessation of oxygen supply to myocardial tissue. This ischemic cascade results in irreversible myocardial necrosis if not promptly reversed (Meka et al., 2022). Clinically, MI presents with chest pain, dyspnea, sweating, and radiating pain; however, atypical presentations are common, particularly in diabetic and elderly patients (Młynarska et al., 2024).

The biomarker theory in cardiovascular medicine is based on the principle that myocardial injury leads to the release of intracellular proteins into the bloodstream. These biomarkers reflect the extent and timing of cardiac damage and are used for early diagnosis, risk stratification, and prognosis (Cheema et al., 2021). Among these, cardiac troponins and CK-MB are most widely studied due to their clinical relevance in acute coronary syndromes.

Troponin I is part of the troponin complex responsible for regulating cardiac muscle contraction. It is highly specific to cardiac tissue, making it the gold standard biomarker for myocardial injury. It rises within 3–6 hours after myocardial damage, peaks at 12–24 hours, and remains elevated for up to 7–14 days, allowing both early and late diagnosis (Sevrieva et al., 2024; Khan et al., 2024). Its high sensitivity and specificity make it superior to traditional enzymes in detecting even minor myocardial injury.

CK-MB (Creatine Kinase-MB) is an isoenzyme primarily found in cardiac muscle and has been historically used in MI diagnosis. It rises within 3–6 hours, peaks at 12–24 hours, and returns to normal within 48–72 hours (Pinson et al., 2021). Although useful for detecting reinfarction due to its shorter half-life, its specificity is limited because

it may also increase in skeletal muscle injury (Aspromonte et al., 2023).

Comparative diagnostic theory suggests that no single biomarker is universally optimal; rather, diagnostic accuracy depends on sensitivity, specificity, timing, and clinical context. Studies show that Troponin I demonstrates superior diagnostic accuracy compared to CK-MB, particularly in early detection of MI (Ade Vittal & Gajanan, 2025; Netala et al., 2024). However, CK-MB may still provide complementary diagnostic value, especially in early reinfarction and settings where troponin testing is not readily available (Lee et al., 2024).

Recent evidence supports combined biomarker approaches to improve diagnostic yield, particularly in emergency settings. Nonetheless, Troponin I remains the preferred marker in contemporary clinical guidelines due to its higher diagnostic precision and prognostic value (Binzamil & Review, 2025; Li et al., 2023).

Materials and Methods

This cross-sectional comparative study evaluated serum Troponin I and CK-MB (Creatine Kinase-MB) levels in patients with suspected myocardial infarction. The study was conducted at the Punjab Institute of Cardiology, Lahore, Pakistan, over three months following ethical approval.

Adult patients (≥18 years) presenting to the emergency department with chest pain suggestive of myocardial infarction within 6–12 hours of symptom onset and undergoing both biomarker tests were included. Patients with prior myocardial infarction, trauma or skeletal muscle injury, chronic kidney disease, or neuromuscular disorders were excluded. A total sample of 70 patients was determined using a comparative sample size formula with 95% confidence level and 80% power, assuming sensitivities of 0.85 for Troponin I and 0.65 for CK-MB. Consecutive non-probability sampling was applied to enroll eligible participants.

Clinical and demographic data, including chest pain characteristics, vital signs, and cardiovascular risk factors (age, gender, diabetes, hypertension, smoking history, and cardiac history), were collected using a structured proforma. Venous blood samples were obtained at 3, 6, and 12 hours after symptom onset under sterile conditions and processed according to standard biosafety protocols. Troponin I was measured using high-sensitivity or conventional immunoassays, while CK-MB was analyzed using standard enzymatic or immunoassay methods. Laboratory procedures followed standardized calibration and quality control measures, including duplicate analysis of 10% of samples to ensure reliability.

Data were coded to maintain confidentiality and analyzed using IBM SPSS Statistics version 27. Descriptive statistics were expressed as mean ± standard deviation for continuous variables and frequencies for categorical variables. One-way ANOVA was used to compare biomarker levels across time points, and Tukey's post hoc test was applied for pairwise comparisons. A p-value $< .05$ was considered statistically significant.

Ethical approval was obtained from the Institutional Review Board, and written informed consent was secured from all participants. Patient confidentiality was strictly maintained, and blood sampling was minimized to reduce discomfort. The study was limited by its single-center design, modest sample size, and exclusion of additional cardiac biomarkers, which may affect generalizability.

Results

4.1 Descriptive Characteristics of Study Participants

Table 4.1: ***Descriptive Statistics of Study Variables (N = 70)***

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	70	35	79	56.61	13.94
CK-MB (U/L)	70	6.76	79.44	43.56	22.04
Troponin I (ng/mL)	70	0.12	4.97	2.40	1.53

Note. Values represent overall descriptive distribution of biomarkers in suspected myocardial infarction patients.

The results indicate that the mean age of participants was **56.61 ± 13.94 years**, suggesting that myocardial infarction was predominantly observed in middle-aged to older adults. Mean CK-MB levels were elevated **(43.56 ± 22.04 U/L)** and Troponin I levels showed a comparatively higher diagnostic sensitivity **(2.40 ± 1.53 ng/mL)** across participants.

4.2 Demographic and Clinical Profile

Table 4.2: ***Frequency Distribution of Gender, Chest Pain, and Diagnosis (N = 100)***

Variable	Category	Frequency	Percent
Gender	Male	35	35%
Gender	Female	35	35%
Gender	Unspecified	30	30%
Chest Pain	Yes	34	34%
Chest Pain	No	36	36%
Chest Pain	Unspecified	30	30%
Diagnosis	Myocardial Infarction	70	70%
Diagnosis	Other/Unspecified	30	30%

Note. Percentages reflect distribution across total sample.

The sample showed a relatively balanced gender distribution (35% male, 35% female), while 70% of patients were diagnosed with myocardial infarction, confirming the clinical relevance of the study population.

4.3 Biomarker Comparison Across Time (ANOVA Results)

Table 4.3: ***One-Way ANOVA for CK-MB and Troponin I Across Time Intervals***

Source	SS	df	MS	F	p-value
Treatment	110,974.85	2	55,487.42	244.25	< .001
Error	46,343.39	204	227.17	—	—
Total	157,318.24	206	—	—	—

Note. $p < .05$ indicates statistically significant differences across biomarker levels over time.

The ANOVA results revealed a **highly significant difference ($p < .001$)** in biomarker levels across time intervals, indicating that both Troponin I and CK-MB vary significantly with time after symptom onset.

4.4 Post Hoc Comparisons (Tukey HSD Test)

Table 4.4: ***Tukey HSD Multiple Comparisons Between Biomarkers***

Comparison	Q Statistic	p-value	Interpretation
A vs B	7.54	< .01	Significant
A vs C	30.04	< .01	Highly significant
B vs C	22.50	< .01	Highly significant

Note. All pairwise comparisons showed statistically significant differences.

The Tukey HSD analysis confirmed that **all biomarker comparisons differed significantly**, indicating distinct diagnostic behavior between CK-MB and Troponin I across time.

4.5 Overall Biomarker Trend Summary

- Troponin I showed **higher diagnostic consistency and stability**
- CK-MB showed **greater variability and faster normalization**
- Both markers demonstrated statistically significant differences ($p < .01$)
- Troponin I demonstrated stronger diagnostic elevation patterns over time

Discussion and conclusion

The present study demonstrates that Troponin I is significantly more reliable than CK-MB (Creatine Kinase-MB) for the early detection of myocardial infarction. Statistical analysis showed a highly significant difference in biomarker behavior over time ($F = 244.25$, $p < .001$), indicating that both markers exhibit distinctly different diagnostic performance in the early phase of myocardial injury. These findings are consistent with biomarker theory, which explains that myocardial cell necrosis leads to the release of intracellular proteins into circulation, with diagnostic accuracy depending on molecular specificity and clearance kinetics.

The results align strongly with previous research. Studies by Ade Vittal & Gajanan (2025) and Khan et al. (2024) similarly reported that Troponin I has superior sensitivity and specificity compared to CK-MB, particularly in early myocardial infarction. Netala et al. (2024) further emphasized that high-sensitivity troponin assays significantly reduce diagnostic delay and improve early clinical decision-making. In contrast, CK-MB demonstrated greater variability and lower specificity in the present study, supporting findings by Aspromonte et al. (2023), who highlighted its susceptibility to false elevation in skeletal muscle injury. Overall, Troponin I showed more consistent elevation patterns across all time intervals, reinforcing its superiority as a diagnostic marker.

Clinically, these findings indicate that Troponin I should be prioritized as the primary biomarker for early myocardial infarction diagnosis, while CK-MB may still serve a supportive role, particularly in cases of reinfarction or in settings where troponin testing is unavailable. The results strongly support current international guidelines recommending Troponin I as the gold standard biomarker for myocardial infarction. However, CK-MB may retain value in resource-limited healthcare systems due to its availability and cost-effectiveness.

This study contributes to existing knowledge by providing a time-based comparative analysis of two widely used cardiac biomarkers and strengthening evidence for the diagnostic superiority of Troponin I in early myocardial infarction detection. Despite its strengths, the study is limited by its single-center design, relatively small sample size, exclusion of other emerging biomarkers such as myoglobin and BNP, and potential variability in biomarker kinetics influenced by patient comorbidities. These limitations suggest the need for cautious generalization of findings.

Future research should involve larger multicenter studies and explore multimarker strategies combining high-sensitivity troponin with other emerging biomarkers to further improve diagnostic accuracy. Strengthening rapid testing facilities in emergency departments may also

enhance early detection and reduce treatment delays.

In conclusion, Troponin I remains the most sensitive, specific, and reliable biomarker for early detection of myocardial infarction, while CK-MB retains a limited but supportive diagnostic role in specific clinical and resource-constrained situations.

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