International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 9, September 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.9.2024.89

ORIGINAL RESEARCH

Study to investigate the correlation between cardiac biomarkers and evaluate their use in risk assessment among myocardial infarction patients

[1]Dr. Hari Babu Poojari, [2]Dr. Metta Madhuri, [3]Dr. Geetika Sura, [4]Dr. Kirasani Sivaram Prasad

[1]Assistant Professor, Department of Cardiology, Government Medical College Srikakulam, Andhra Pradesh, India
[2]Assistant Professor, Department of Biochemistry, Government Medical College Srikakulam, Andhra Pradesh, India
[3]Indian Medical Graduate, Narayana Medical College, Andhra Pradesh, India
[4]Assistant Professor, Department of Community Medicine, Government Medical College, Srikakulam, Andhra Pradesh, India

Corresponding Author
Dr. Kirasani Sivaram Prasad
Assistant Professor, Department of Community Medicine, Andhra Pradesh, India

Received: 19July, 2024 Accepted: 20Aug, 2024

ABSTRACT

Objective: The objective of this research is to investigate the correlation between cardiac biomarkers and to evaluate their use in risk assessment.**Methods:** Hospital based prospective study which was undertaken by the cardiology department and biochemistry department of Government Medical college and Hospital Srikakulam, Andhra Pradesh on 40 patients who attended to the OPD. The patients were assessed for myocardial infarction biomarkers in conjunction with their clinical characteristics.**Results:** The study found that males predominantly had Myocardial Infarction than females. Hs-CRP, CKMB, TnT, and MPO levels were significantly higher (p<0.05) in the patients who were having MI. hs-CRP, CKMB, TnT, and MPO have a very strong connection with myocardial infarction, which is statistically significant. When cardiac muscle is injured, CKMB and TnT are released. Leukocytes generate myeloperoxidase (MPO), which causes inflammation. The association between age and myocardial infarction was weak and non-significant. Gender significantly affects myocardial infarction. hs-CRP, CKMB, TnT, and MPO are strong markers of myocardial infarction risk, whereas age and sex are not so significant. Infarction risk may be better predicted by biomarkers than age and sex, which has major implications for diagnosis and therapy.**Conclusion:** These cardiac biomarkers may indicate risk and prognosis for myocardial infarction in high-risk people. Further this study observations shows that age and gender are not a reliable risk factors for myocardial infarction.

Key words: Myocardial infarction, cardiac biomarkers, cardiovascular disease, troponin

INTRODUCTION

Notwithstanding the advancement of novel treatment approaches, coronary artery disease (CAD) continues to be a significant global health challenge. The incidence of ST-elevation myocardial infarction (STEMI) is particularly linked to considerable short- and long-term consequences. As a consequence, STEMI patients have an elevated chance of experiencing cardiovascular events (CVE), even throughout the extended post-myocardial infarction (MI) phase, leading to a subsequent decrease in long-term survival within this demographic[1].Consequently, the early identification of high-risk people is a primary therapeutic objective in the routine management of these patients.

The use of biological markers has shown an improvement in diagnostic accuracy for cardiovascular patients. This technique facilitates the classification of cardiovascular risk during hospitalization and throughout the long-term surveillance period. Concentrations of various biomarkers correspond with the severity of cardiovascular events, reflect disease dynamics, and improve the success of therapeutic regimens.

DOI: 10.69605/ijlbpr_13.9.2024.89

Traditional indicators such as the myoglobin fraction of creatine phosphokinase (CK-MB) and Troponins are associated with the long-term prognosis of STEMI patients and are incorporated into routine clinical practice.[1] Elevated levels of N-terminal pro brain natriuretic peptide (NT-proBNP) are indicative of an increased risk of sudden death, myocardial infarction recurrence, or the onset of chronic heart failure, applicable to both myocardial infarction patients and those with unstable angina[2].Nonetheless, except from Troponins, particularly high-sensitive Troponins (hs-Troponins), the sensitivity and specificity of these biomarkers for acute cardiac injury remain inadequate[3-6].Consequently, more methods are required to enhance the assessment of cardiovascular outcomes.

Multimarker analytical methods have shown an improvement in the sensitivity and specificity of prognostic evaluations. Therefore, they may serve as a more efficacious instrument for forecasting cardiovascular death in myocardial infarction patients. Recent advancements in serum biomarkers, such as ST2 and Pentraxin-3 (Ptx-3), have shown promise in enhancing the evaluation of cardiovascular disease[7-11].Ptx-3 denotes the class of pentraxins synthesized locally by stromal and myeloid cells in response to proinflammatory stimuli. Ptx-3, being a multifunctional protein, is significant in vascular inflammatory processes. As a result, it was shown to have a significant role in the pathogenesis of atherosclerosis and myocardial infarction. Moreover, it seems to be implicated in the pathogenesis of heart failure and cardiac arrest[8].Elevated Ptx-3 levels are correlated with coronary artery disease, especially acute coronary syndrome[7, 9, 12, 13].In patients with acute coronary syndrome, elevated Ptx-3 levels were significantly correlated with an increased death rate, even in long-term observational investigations[14-16].

The objective of this research is to identify the correlation between cardiac biomarkers and the incidence of myocardial infarction (MI), as well as to use them for risk assessment and prognostic evaluation.

MATERIALS AND METHODS

This is a hospital based prospective study, conducted by the department of cardiology and biochemistry at Government Medical College Srikakulam, Andhra Pradesh, India for a period of six months in the year 2024.Forty patients were randomly selected for this study and prior consent was taken from the patients who participated in this study by the cardiology department. In addition to their clinical characteristics, the patients were tested for MI biomarkers.

The criteria for diagnosing MI was as per the definition given by the World Health Organization [17,18]. To determine the risk of myocardial infarction (MI), the analysis of laboratory markers such as high-sensitivity C-reactive proteins (CRP), creatine kinase-MB (CKMB) troponin T (TnT), and myeloperoxidase (MPO) were carried out on all the forty patients who were included in the study based on the inclusion criteria as below.

INCLUSION AND EXCLUSION CRITERIA

This research only included individuals who presented to the hospital with chest pain and other symptoms consistent with MI according to the World Health Organization's criteria,non-diabetic,non-smoker and non-hypertensive.

Exclusion criteria is that the patients who are not cooperative, presence of chronic diseases (particularly pulmonary illness), and noncompliance with the inclusion criteria of this study.

SAMPLE SIZE ESTIMATION

$$n = \left(\frac{(Z_{\alpha/2} + Z_{\beta})^2 \cdot (2\sigma^2)}{\Delta^2} \right)$$

Where:

- n is the sample size per group,
- $Z_{\alpha/2}$ is the Z-score for the significance level (for $\alpha = 0.05$, $Z_{\alpha/2} \approx 1.96$),
- Z_{β} is the Z-score for the desired power (for 80% power, $Z_{\beta} \approx 0.84$),

USING A POWER ANALYSIS CALCULATOR

- Effect Size (Cohen's d): 1.27.
- Significance Level (α): 0.05.
- Sample Size:40.

STATISTICAL ANALYSIS

For efficient statistical analysis, the research used SPSS 22. The mean±sd was used to represent continuous data, whereas frequency and its corresponding percentage were used to represent discrete data. The research used Pearson's correlation coefficient and a chi-square test. Significant at the $p<0.05$ level.

RESULTS

In this study males were 30 and females were only 10.hsCRP, CKMB, TnT, and MPO, were all significantly ($p<0.05$) elevated among all those diagnosed with MI.

Table 1: Pearson's Chi-Square Test between each variable

Parameters	F-value	p-value
hs-CRP	931.59	.000
CKMB	674.746	.000
TnT	1936.324	.000

DOI: 10.69605/ijlbpr_13.9.2024.89

MPO	1336.084	.000
Age	3.247	0.72
Sex	4.028	0.043

The very low p-values (all at 0.00) of the first four variables (hs-CRP, CKMB, TnT, and MPO) show a strong association with myocardial infarction. When cardiac muscle is injured, CKMB and TnT are released. Leukocytes generate myeloperoxidase (MPO), which causes inflammation. The association between age and myocardial infarction was weak and non-significant. Gender significantly affects myocardial infarction.

Table 2: Pearson Correlation Coefficient among Myocardial Infarction case

Correlations						
		Age	**HsCRP**	**CKMB**	**TnT**	**MPO**
AGE	Pearson Correlation	1	-0.067	-.170*	-0.131	-0.098
	Sig. (2-tailed)		0.325	0.011	0.052	0.147
	N	80	80	80	80	80
HsCRP	Pearson Correlation		1	.755	.822	.80
	Sig. (2-tailed)			0.000	0.000	0.000
	N		80	80	80	80
aa	**Sig. (2-tailed)**				0.000	0.000
	N			80	80	80
TnT	**Pearson Correlation**				1	.912
	Sig. (2-tailed)					0.000
	N				200	200
MPO	**Pearson Correlation**					1
	Sig. (2-tailed)					
	N					200

Hs-CRP, CKMB, TnT, and MPO are robust indicators of myocardial infarction risk, but age and sex exhibit lesser correlations with myocardial infarction risk. The results have significant implications for the diagnosis and treatment of myocardial infarction, indicating that biomarkers may be more effective in predicting MI risk than age and sex alone.

DISCUSSION

Cardiovascular disease (CVD) is the leading cause of death and disability globally. Traditional cardiovascular disease risk factors such as smoking, hypertension, diabetes mellitus, and hypercholesterolemia have catalyzed substantial progress in both treatment and risk assessment models. However, 40.2% of individuals with cardiovascular issues possess just one conventional risk factor, while as many as 20.4% exhibit none.[19] Biomarkers include a broad spectrum of quantitative and reproducible biological indicators. They are characterized as "a trait that is objectively quantified and examined as an indicator of normal biological mechanisms, pathogenic processes, or pharmacological responses to a therapeutic approach" in its most comprehensive description. Effective biomarkers must fulfill the following criteria:

1. Accuracy, defined as the ability to identify individuals at risk.
2. Reliability, referring to the consistency of results upon retesting.
3. Therapeutic Impact associated with Primary Prevention[20, 21].

The cardiac isoforms of troponin T and I are only expressed in cardiac myocytes, and their presence in the bloodstream is indicative of myocardial injury.[22] Following myocardial infarction, troponin levels in peripheral blood increase within 3-4 hours and remain elevated for up to 2 weeks. The significant increase in troponin levels, indicative of low plasma concentrations in healthy individuals, enables the identification of myocardial injury in about one-third of patients with unstable angina, even when small CK-MB elevations are absent[23].This present study revealed that hsCRP, CKMB, TnT, and MPO levels were substantially elevated (p<0.05) in the MI group relatively.The first four variables (hs-CRP, CKMB, TnT, and MPO) demonstrate a very significant correlation with the occurrence of myocardial infarction, as seen by the exceedingly low p-values (all at 0.00). CKMB (creatine kinase MB) and TnT (troponin T) are enzymes secreted upon injury to cardiac muscle. Myeloperoxidase (MPO) is an enzyme produced by leukocytes that contributes to the inflammatory response. Numerous clinically significant cardiac biomarkers have shown efficacy in prognostic prediction for persons with acute coronary syndromes[25].Age exhibits a slight correlation with the occurrence of myocardial infarction, which was not statistically significant. Gender has a significant correlation with the occurrence of myocardial infarction. hs-CRP, CKMB, TnT, and MPO are robust

DOI: 10.69605/ijlbpr_13.9.2024.89

indicators of myocardial infarction risk, but age and sex exhibit lesser correlations with myocardial infarction risk. These results have significant implications for the diagnosis and treatment of myocardial infarction, indicating that biomarkers may be more effective in predicting myocardial infarction risk than age and sex alone. The risk of coronary artery disease is rising. Traditional biomarkers such as troponins and creatine kinase, while essential for diagnosing, assessing susceptibility, and treating cardiovascular illness, are incapable of identifying myocardial ischemia in the absence of necrosis[26].

Troponins and CK, two prevalent conventional biomarkers, have proved essential in the diagnosis, risk evaluation, and management of ACS. Potential new biomarkers, such as MPO and H-FABP, have been established via considerable research and are now undergoing active validation trials. The use of a multi-marker approach for complementary analysis is an effective instrument in risk categorization with the introduction of supplementary markers[27].

CONCLUSION

In individuals who were clinically diagnosed with myocardial infarction, elevated levels of cardiac biomarkers may serve as indicators of risk and prognostic markers for myocardial infarction. The research has clearly shown a male predominance in myocardial infarction patients and indicates that age is not a dependable risk factor or parameter. This research has emphasized a significant clinical facet of myocardial infarction that might aid in early identification, therapy, and prognosis.

REFERENCES

1. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, Caforio ALP, Crea F, Goudevenos JA, Halvorsen S, Hindricks G, Kastrati A, Lenzen MJ, Prescott E, Roffi M, Valgimigli M, Varenhorst C, Vranckx P, Widimský P; ESC Scientific Document Group. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018 Jan 7;39(2):119-177.
2. Magnussen C, Blankenberg S. Biomarkers for heart failure: small molecules with high clinical relevance. J Intern Med. 2018 Jun;283(6):530-543.
3. Sarko J, Pollack CV Jr. Cardiac troponins. J Emerg Med. 2002 Jul;23(1):57-65.
4. Müller-Bardorff M, Hallermayer K, Schröder A, Ebert C, Borgya A, Gerhardt W, Remppis A, Zehelein J, Katus HA. Improved troponin T ELISA specific for cardiac troponin T isoform: assay development and analytical and clinical validation. Clin Chem. 1997 Mar;43(3):458-66.
5. Garg P, Morris P, Fazlanie AL, Vijayan S, Dancso B, Dastidar AG, Plein S, Mueller C, Haaf P. Cardiac biomarkers of acute coronary syndrome: from history to high-sensitivity cardiac troponin. Intern Emerg Med. 2017 Mar;12(2):147-155.
6. James SK, Lindbäck J, Tilly J, Siegbahn A, Venge P, Armstrong P, Califf R, Simoons ML, Wallentin L, Lindahl B. Troponin-T and N-terminal pro-B-type natriuretic peptide predict mortality benefit from coronary revascularization in acute coronary syndromes: a GUSTO-IV substudy. J Am Coll Cardiol. 2006 Sep 19;48(6):1146-54.
7. Casula M, Montecucco F, Bonaventura A, Liberale L, Vecchié A, Dallegri F, Carbone F. Update on the role of Pentraxin 3 in atherosclerosis and cardiovascular diseases. Vascul Pharmacol. 2017 Dec;99:1-12.
8. Ristagno G, Fumagalli F, Bottazzi B, Mantovani A, Olivari D, Novelli D, Latini R. Pentraxin 3 in Cardiovascular Disease. Front Immunol. 2019 Apr 17;10:823.
9. Fornai F, Carrizzo A, Forte M, Ambrosio M, Damato A, Ferrucci M, Biagioni F, Busceti C, Puca AA, Vecchione C. The inflammatory protein Pentraxin 3 in cardiovascular disease. Immun Ageing. 2016 Aug 24;13(1):25.
10. Ciccone MM, Cortese F, Gesualdo M, Riccardi R, Di Nunzio D, Moncelli M, Iacoviello M, Scicchitano P. A novel cardiac bio-marker: ST2: a review. Molecules. 2013 Dec 11;18(12):15314-28.
11. Aydin S, Ugur K, Aydin S, Sahin İ, Yardim M. Biomarkers in acute myocardial infarction: current perspectives. Vasc Health Risk Manag. 2019 Jan 17;15:1-10.
12. Helseth R, Solheim S, Opstad T, Hoffmann P, Arnesen H, Seljeflot I. The time profile of Pentraxin 3 in patients with acute ST-elevation myocardial infarction and stable angina pectoris undergoing percutaneous coronary intervention. Mediators Inflamm. 2014;2014:608414.
13. Morishita T, Uzui H, Nakano A, Fukuoka Y, Ikeda H, Amaya N, Kaseno K, Ishida K, Lee JD, Tada H. Association of plasma pentraxin-3 levels with coronary risk factors and the lipid profile: a cross-sectional study in Japanese patients with stable angina pectoris. Heart Vessels. 2018 Nov;33(11):1301-1310.
14. Akgul O, Baycan OF, Bulut U, Somuncu MU, Pusuroglu H, Ozyilmaz S, Gul M, Demir AR, Yılmaz E, Yazan S, Kokturk U, Cetin I, Uyarel H. Long-term prognostic value of elevated pentraxin 3 in patients undergoing primary angioplasty for ST-elevation myocardial infarction. Coron Artery Dis. 2015 Nov;26(7):592-7.
15. Mjelva ØR, Pönitz V, Brügger-Andersen T, Grundt H, Staines H, Nilsen DW. Long-term

DOI: 10.69605/ijlbpr_13.9.2024.89

prognostic utility of pentraxin 3 and D-dimer as compared to high-sensitivity C-reactive protein and B-type natriuretic peptide in suspected acute coronary syndrome. Eur J Prev Cardiol. 2016 Jul;23(11):1130-40.
16. Altay S, Çakmak HA, Kemaloğlu Öz T, Özpamuk Karadeniz F, Türer A, Erer HB, Kılıç GF, Keleş İ, Can G, Eren M. Long-term prognostic significance of pentraxin-3 in patients with acute myocardial infarction: 5-year prospective cohort study. Anatol J Cardiol. 2017 Mar;17(3):202-209.
17. Roffi M, Patrono C, Collet JP, Mueller C, Valgimigli M, Andreotti F, Bax JJ, Borger MA, Brotons C, Chew DP, Gencer B. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. Polish Heart Journal (Kardiologia Polska). 2015;73(12):1207-94.
18. Haaf P, Drexler B, Reichlin T, Twerenbold R, Reiter M, Meissner J, Schaub N, Stelzig C, Freese M, Heinzelmann A, Meune C. High-sensitivity cardiac troponin in the distinction of acute myocardial infarction from acute cardiac noncoronary artery disease. Circulation. 2012 Jul 3;126(1):31-40.
19. Wang J, Tan GJ, Han LN, Bai YY, He M, Liu HB. Novel biomarkers for cardiovascular risk prediction. Journal of geriatric cardiology: JGC. 2017 Feb;14(2):135.
20. Forouzanfar MH, Afshin A, Alexander LT, Anderson HR, Bhutta ZA, Biryukov S, Brauer M, Burnett R, Cercy K, Charlson FJ, Cohen AJ. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. The lancet. 2016 Oct 8;388(10053):1659-724.
21. Hozawa A, Folsom AR, Sharrett AR, Chambless LE. Absolute and attributable risks of cardiovascular disease incidence in relation to optimal and borderline risk factors: comparison of African American with white subjects—Atherosclerosis Risk in Communities Study. Archives of internal medicine. 2007 Mar 26;167(6):573-9.
22. Adams 3rd JE, Abendschein DR, Jaffe AS. Biochemical markers of myocardial injury. Is MB creatine kinase the choice for the 1990s?. Circulation. 1993 Aug;88(2):750-63.
23. Galvani M, Ottani F, Ferrini D, Ladenson JH, Destro A, Baccos D, Rusticali F, Jaffe AS. Prognostic influence of elevated values of cardiac troponin I in patients with unstable angina. Circulation. 1997 Apr 15;95(8):2053-9.
24. Gami BN, Patel DS, Haridas N, Chauhan KP, Shah H, Trivedi A. Utility of heart-type fatty acid binding protein as a new biochemical marker for the early diagnosis of acute coronary syndrome. Journal of clinical and diagnostic research: JCDR. 2015 Jan;9(1):BC22.
25. Kabekkodu SP, Mananje SR, Saya RP. A study on the role of heart type fatty acid binding protein in the diagnosis of acute myocardial infarction. Journal of clinical and diagnostic research: JCDR. 2016 Jan;10(1):OC07.
26. Tawiah K, Jackson L, Omosule C, Ballman C, Shahideh B, Scott MG, Murtagh G, Farnsworth CW. Serial cardiac biomarkers for risk stratification of patients with COVID-19. Clinical biochemistry. 2022 Sep 1;107:24-32.
27. Chacko S, Haseeb S, Glover BM, Wallbridge D, Harper A. The role of biomarkers in the diagnosis and risk stratification of acute coronary syndrome. Future science OA. 2017 Oct 27;4(1):FSO251.