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Correlation between Serum Ntprobnp with Severity of Acute St Elevation Myocardial Infarction in Relation with Coronary Angiography.

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KEYWORDS

coronary artery, Myocardial Infarction, NT-proBNP levels,

ABSTRACT:

BACKGROUND: Acute Myocardial ST-Elevation Complete blockage of a coronary artery causes myocardial infarction (STEMI), a severe cardiovascular event that, if left untreated, can cause serious damage to the heart. Choosing treatment plans and forecasting results depend on timely risk categorization. Although the association between NT-proBNP levels and recognized risk scores such as TIMI, Aldrich, and SYNTAX in acute STEMI patients is still unclear, NT-proBNP may provide additional predictive information when paired with these scores. In patients with acute STEMI, the purpose of this study is to examine the association between NT-proBNP levels and the TIMI risk score, Aldrich score, and SYNTAX score.

METHODOLOGY: The purpose of this study is to determine the relationship between NT-proBNP levels at admission and the severity of coronary artery disease in acute STEMI patients as measured by the TIMI, Aldrich, and SYNTAX scores. The study was conducted at Kauvery Hospital in Chennai for 18 months (2023-2024) and comprised 48 patients with no comorbidities who received primary PCI within 48 hours of symptom onset. The association was analyzed using Pearson or Spearman correlation coefficients, depending on the data distribution.

RESULTS: The results show a high positive association between various scores and NT-proBNP levels. TIMI and SYNTAX scores have a substantial connection ($\rho=0.832$, $p<0.001$), suggesting that as TIMI values rise, so do SYNTAX ratings. greater TIMI scores correspond with greater NT-proBNP levels ($\rho=0.731$, $p<0.001$), as do higher SYNTAX scores ($\rho=0.722$, $p<0.001$). The median variations in NT-proBNP levels between Aldrich score groups are statistically significant ($p < 0.001$).

CONCLUSION: The study concluded that the high associations between NT-proBNP and the TIMI, SYNTAX, and Aldrich scores suggest that NT-proBNP could be beneficial in regular examinations of STEMI patients. This marker may aid in identifying high-risk patients who would benefit from more aggressive treatment techniques such as early revascularization or advanced medical therapy.

INTRODUCTION

Acute ST-Elevation Myocardial Infarction (STEMI) is a severe form of acute coronary syndrome (ACS) and a leading cause of global morbidity and mortality. It is marked by persistent ST-segment elevation on electrocardiography (ECG) due to complete thrombotic occlusion of a coronary artery, leading to myocardial ischemia and necrosis if not quickly treated. Despite advancements in reperfusion techniques like primary percutaneous coronary intervention (PCI), early risk

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stratification is crucial for guiding treatment decisions and predicting patient outcomes [1].

Several clinical and angiographic scoring systems exist to assess risk in STEMI patients, with the Thrombolysis in Myocardial Infarction (TIMI) risk score being particularly notable. This tool evaluates mortality risk based on factors like age, blood pressure, heart rate, Killip class, weight, anterior ST elevation or left bundle branch block, and treatment time [2]. Due to its simplicity and bedside applicability, the TIMI score remains integral to initial risk assessment.

In contrast, the SYNTAX (Synergy Between Percutaneous Coronary Intervention with TAXUS and Cardiac Surgery) score is an angiographic tool designed to quantify the anatomical complexity of coronary artery disease (CAD). It evaluates lesion characteristics, including bifurcations, total occlusions, calcification, vessel tortuosity, and lesion length. Higher SYNTAX scores are associated with increased procedural complexity and worse clinical outcomes following PCI [3]. Thus, while the TIMI score reflects clinical severity, the SYNTAX score provides an anatomical assessment of coronary disease burden.

The Aldrich score, another ECG-based risk stratification tool, estimates the percentage of myocardium at risk based on the extent of ST-segment elevation. Higher Aldrich scores correlate with larger infarct size and poorer prognosis. Aldrich et al. demonstrated a significant association between higher Aldrich scores and increased short-term mortality in STEMI patients [4].

Cardiac biomarkers, especially N-terminal pro-brain natriuretic peptide (NT-proBNP), are crucial for prognostication beyond clinical assessments. NT-proBNP is released from ventricular myocytes in response to wall stress, indicating ventricular dysfunction and hemodynamic stress. It offers important prognostic insights that traditional biomarkers like troponins do not provide. Large-scale studies have confirmed NT-proBNP's prognostic value in acute coronary syndromes (5-6).

Omland et al. found a positive correlation between NT-proBNP levels and the TIMI risk score in STEMI patients, suggesting that higher NT-proBNP indicates greater clinical risk. Becker et al. showed a strong correlation between NT-proBNP levels and SYNTAX scores, implying that elevated NT-proBNP may reflect more complex coronary artery disease (7-8). Indian studies have similarly supported these observations. Gupta et al. and Mohanty et al. reported significant associations between NT-proBNP levels and TIMI risk scores in Indian STEMI populations [9,10], while Nair et al. demonstrated a strong correlation between NT-proBNP levels and SYNTAX scores in patients undergoing primary PCI [11].

Although individual associations between NT-proBNP and specific risk scores have been described, limited data exist regarding its simultaneous correlation with clinical (TIMI), electrocardiographic (Aldrich), and angiographic (SYNTAX) scoring systems within a homogenous STEMI population devoid of major comorbidities.

Therefore, the present study aims to evaluate the correlation between serum NT-proBNP levels at admission and the severity of acute STEMI as assessed by the TIMI risk score, Aldrich score, and SYNTAX score derived from coronary angiography.

MATERIALS AND METHODS

Study Design and Setting

This was a hospital-based, cross-sectional observational study conducted in the Department of Cardiology at Kauvery Hospital, Alwarpet, Chennai, Tamil Nadu, India. The study was carried out over a period of 18 months from May 2023 to October 2024.

Study Population

The study included 48 patients presenting with acute ST-Elevation Myocardial Infarction (STEMI) who fulfilled the eligibility criteria and underwent primary percutaneous coronary intervention (PCI).

Inclusion Criteria

1. Patients aged between 30 and 65 years.
2. Patients presenting within 48 hours of the onset of chest pain suggestive of acute STEMI.
3. STEMI confirmed by electrocardiographic ST-segment elevation according to the universal definition of myocardial infarction, along with elevated cardiac biomarkers.

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4. Patients undergoing primary PCI.
5. Patients without known comorbidities such as diabetes mellitus, hypertension, chronic kidney disease, chronic heart failure, or previous coronary artery disease.
6. Patients who provided written informed consent.

Exclusion Criteria

1. Patients aged <30 years or >65 years.
2. Presentation after 48 hours of symptom onset.
3. History of prior myocardial infarction, coronary revascularization, or established coronary artery disease.
4. Presence of significant comorbid conditions (e.g., diabetes mellitus, hypertension, chronic kidney disease, heart failure, or other chronic systemic illness).
5. Patients not undergoing PCI.
6. Patients unwilling or unable to provide informed consent.

Data Collection

Demographic data, clinical history, and examination findings were recorded at admission using a predesigned structured proforma. The variables documented, such as Age and gender, Type of STEMI (Anterior wall, Inferior wall, Anteroseptal, Anterolateral, Extensive anterior wall, Inferoposterior), Hemodynamic parameters at admission, and Time from symptom onset to hospital presentation

NT-proBNP Measurement

Venous blood samples were collected at the time of admission before PCI. NT-proBNP levels were measured using an enzyme-linked immunosorbent assay (ELISA) or equivalent standardized laboratory method available in the hospital laboratory. The results were expressed in pg/mL. All samples were processed according to standard laboratory protocols to ensure accuracy and reliability.

Risk Score Assessment

1. TIMI Risk Score

The Thrombolysis in Myocardial Infarction (TIMI) risk score for STEMI was calculated for each patient based on established criteria, incorporating Age, Systolic blood pressure, Heart rate, Killip class, Weight, Anterior ST elevation or left bundle branch block, and Time to treatment. The total score ranged from 0 to 14.

2. Aldrich Score

The Aldrich score was calculated using electrocardiographic findings based on the extent and distribution of ST-segment elevation. The percentage of myocardium at risk was categorized according to standard scoring criteria into groups (A–D) reflecting increasing myocardial involvement.

3. SYNTAX Score

The SYNTAX score was calculated by an experienced interventional cardiologist based on coronary angiographic findings obtained during primary PCI. Lesion characteristics, including the number of diseased vessels, the presence of bifurcation/trifurcation lesions, total occlusion, Lesion length, Calcification and Vessel tortuosity, were incorporated to determine the final SYNTAX score.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) software (version XX). The Continuous variables were expressed as mean ±standard deviation (SD) or median with interquartile range (IQR), depending on distribution. The categorical variables were expressed as frequency and percentage.

The Pearson's coefficient was used for normally distributed variables, while Spearman's was employed for non-normal data to assess relationships between NT-proBNP levels and TIMI, Aldrich, and SYNTAX scores. Independent t-tests or Mann–Whitney U tests compared NT-proBNP levels between risk groups, with Kruskal–Wallis tests for multiple Aldrich score categories. A p-value of less than 0.05 was considered statistically significant.

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Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of Kauvery Hospital, Chennai. Written informed consent was obtained from all participants before enrolment. The study was conducted in accordance with the Declaration of Helsinki principles. Patient confidentiality and data privacy were strictly maintained throughout the study.

Results

A total of 48 patients diagnosed with acute ST-elevation myocardial infarction (STEMI) were included in the study. The mean TIMI risk score was 5.33 ±2.23, ranging from 2 to 10. The mean SYNTAX score was 19.21 ±7.24, with values ranging between 7 and 35. The mean serum NT-proBNP level at admission was 339.94 ±137.33 pg/mL, with a range of 140–700 pg/mL. The descriptive statistics of the study variables are summarized in **Table 1**.

Table 1. Descriptive Statistics of TIMI Risk Score, SYNTAX Score, and NT-proBNP Levels

Variable	Minimum	Maximum		
TIMI Risk Score	2	10		
SYNTAX Score	7	35		
NT-proBNP (pg/mL)	140	700	339.94	137.33

Among the study population, Anteroseptal myocardial infarction (ASMI) was the most frequent presentation, accounting for 37.5% (n=18) of cases. Inferior Wall myocardial infarction (IWMI) was observed in 18.8% (n=9), followed by Anterior Wall myocardial infarction (AWMI) in 16.7% (n=8). Anterolateral MI (ALMI) and Extensive Anterior Wall MI (EAWMI) were present in 12.5% (n=6) and 10.4% (n=5) of patients, respectively, while Inferior Posterior MI (IPMI) was the least common (4.2%, n=2). The distribution of myocardial infarction types is shown in **Table 2** and illustrated in **Figure 1**.

Table 2. Distribution of Myocardial Infarction Types

MI Type	Frequency (n)	Percentage (%)
ASMI	18	37.5
IWMI	9	18.8
AWMI	8	16.7
ALMI	6	12.5
EAWMI	5	10.4
IPMI	2	4.2

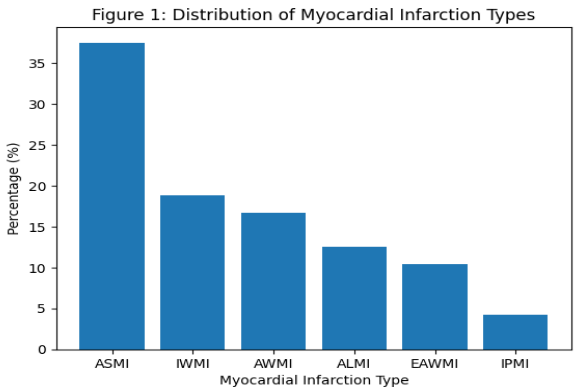

Figure 1. Distribution of Myocardial Infarction Types

The majority of patients were classified under Aldrich Score Category B (21–30% myocardium involvement), comprising 52.1% (n=25). Category C (31–40%) accounted for 25.0% (n=12), while Category D (>40%) included 12.5% (n=6). Category A (11–20%) was observed in 10.4% (n=5). The categorical distribution is presented in **Table 3** and depicted in **Figure 2**.

Table 3. Distribution of Aldrich Score Categories

Aldrich Category	Myocardial Involvement	N	Percentage (%)
A	11–20%	5	10.4
B	21–30%	25	52.1

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Aldrich Category	Myocardial Involvement	N	Percentage (%)
C	31–40%	12	25.0
D	>40%	6	12.5

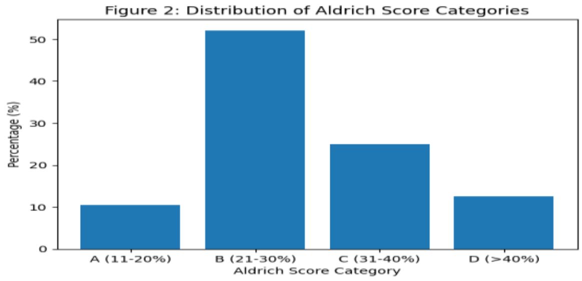

Figure 2. Distribution of Aldrich Score Categories

Spearman's rank correlation analysis revealed statistically significant, strong positive correlations between all three primary variables (Table 4). A strong positive correlation was observed between TIMI risk score and SYNTAX score ($\rho = 0.832$, $p < 0.001$), indicating that higher clinical risk scores were associated with increased anatomical complexity of coronary artery disease.

Similarly, the TIMI risk score showed a strong positive correlation with NT-proBNP levels ($\rho = 0.731$, $p < 0.001$), suggesting that higher NT-proBNP levels are associated with greater clinical severity.

Furthermore, the SYNTAX score demonstrated a strong positive correlation with NT-proBNP levels ($\rho = 0.722$, $p < 0.001$), indicating that greater angiographic complexity was associated with higher myocardial wall stress.

The correlation matrix is summarized in **Table 4**, and the relationships are illustrated in the scatter plots shown in **Figure 3**.

Table 4. Spearman's Correlation Between TIMI Risk Score, SYNTAX Score, and NT-proBNP

Variables Compared	Correlation Coefficient (ρ)	p-value
TIMI vs SYNTAX	0.832	<0.001
TIMI vs NT-proBNP	0.731	<0.001
SYNTAX vs NT-proBNP	0.722	<0.001

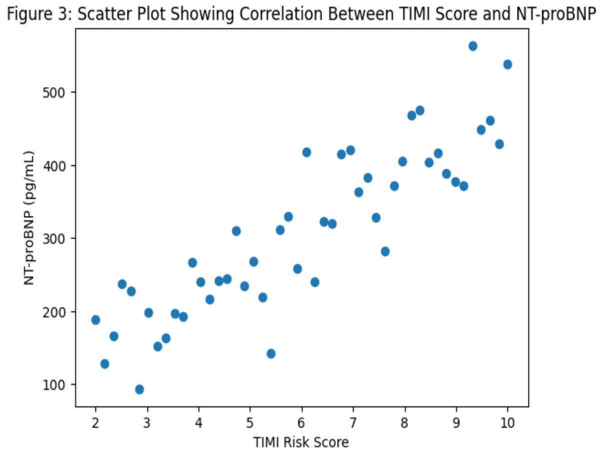

Figure 3. Scatter Plot Showing Correlation Between TIMI Risk Score, SYNTAX Score, and NT-proBNP

NT-proBNP Levels Across Aldrich Score Categories

A progressive increase in median NT-proBNP levels was observed with increasing Aldrich score category. Median NT-proBNP levels were:

- Category A: 200 pg/mL (IQR: 145–206)
- Category B: 300 pg/mL (IQR: 208–333)
- Category C: 400 pg/mL (IQR: 305.75–440.5)
- Category D: 492.5 pg/mL (IQR: 466.25–691)

The Kruskal–Wallis test demonstrated a statistically significant difference across the four categories ($p < 0.001$). Pairwise comparisons revealed significant differences between Categories A vs C (adjusted $p < 0.01$) and A vs D (adjusted $p = 0.002$), and between B vs D (adjusted $p = 0.002$). These findings are summarized in **Table 5**.

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Table 5. Median NT-proBNP Levels Across Aldrich Score Categories

Aldrich Category	N	Median (IQR) pg/mL	p-value*
A	5	200 (145–206)	
B	25	300 (208–333)	
C	12	400 (305.75–440.5)	<0.001
D	6	492.5 (466.25–691)	

*Kruskal–Walli's test

Overall, NT-proBNP levels demonstrated strong positive correlations with both TIMI and SYNTAX scores, as well as significant differences across Aldrich score categories. Additionally, TIMI and SYNTAX scores showed a very strong correlation, reflecting concordance between clinical severity and angiographic complexity in acute STEMI.

Discussion

The present study evaluated the correlation between serum NT-proBNP levels and established risk stratification tools—TIMI risk score, SYNTAX score, and Aldrich score—in patients presenting with acute ST-elevation myocardial infarction (STEMI).

Our findings demonstrate strong and statistically significant positive correlations between NT-proBNP levels and both clinical and angiographic indices of disease severity. Additionally, a very strong correlation was observed between TIMI and SYNTAX scores, highlighting the concordance between clinical presentation and anatomical coronary complexity.

In our study, NT-proBNP levels showed a strong positive correlation with the TIMI risk score ($\rho = 0.731$, $p < 0.001$). This suggests that increasing NT-proBNP concentrations are associated with greater clinical severity and higher predicted mortality risk in STEMI patients. These findings are consistent with prior international studies. **Omland et al.** reported a significant correlation between NT-proBNP levels and TIMI risk scores, demonstrating that elevated NT-proBNP values corresponded with increasing short-term mortality risk in acute myocardial infarction patients (7). Similarly, **Sabatine et al.** showed that higher NT-proBNP levels were independently associated with adverse cardiovascular outcomes in STEMI cohorts (6).

Indian data also align with our results. **Mohanty et al**. demonstrated significantly elevated NT-proBNP levels in patients with higher TIMI scores, reinforcing the biomarker's role in risk stratification within the Indian population (10). **Srikanth et al.** reported a comparable moderate-to-strong correlation between NT-proBNP and TIMI score in acute coronary syndrome patients. Our correlation coefficient (0.731) is consistent with these observations, supporting NT-proBNP as a reliable adjunct to clinical scoring systems (12).

A strong positive correlation was also observed between NT-proBNP levels and SYNTAX score ($\rho = 0.722$, $p < 0.001$). This indicates that patients with more complex and extensive coronary artery disease exhibited higher NT-proBNP levels.

Becker et al. demonstrated a similar association between NT-proBNP and angiographic complexity, suggesting that elevated NT-proBNP may reflect not only myocardial dysfunction but also the anatomical burden of coronary disease (8). **Nair et al.** observed a strong correlation ($r = 0.72$) between NT-proBNP levels and SYNTAX scores in STEMI patients undergoing primary PCI (11). **Kumar et al.** similarly demonstrated that higher NT-proBNP levels were associated with greater angiographic severity (13).

The association between NT-proBNP and SYNTAX score may be explained by the fact that extensive coronary artery disease leads to larger ischemic territories, increased myocardial strain, and consequent elevation in natriuretic peptide levels.

A particularly notable finding of our study was the very strong positive correlation between TIMI and SYNTAX scores ($\rho = 0.832$, $p < 0.001$). This suggests a substantial overlap between clinical risk and angiographic severity in acute STEMI. In a similar study, **Aslan et al.** demonstrated a strong correlation between TIMI and SYNTAX scores in STEMI patients undergoing PCI, indicating that higher clinical risk scores often parallel increased coronary complexity (14). **Rajagopal et al.** reported comparable correlations, reinforcing the

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consistency of this relationship across different populations (15).

This strong association implies that while the TIMI score provides rapid bedside risk assessment, it also indirectly reflects underlying anatomical severity, which is formally quantified by the SYNTAX score.

Our study demonstrated statistically significant differences in NT-proBNP levels across Aldrich score categories ($p < 0.001$), with progressive increases observed from Category A to Category D. Patients with greater myocardial involvement exhibited markedly higher NT-proBNP levels. Our findings support the concept that NT-proBNP may serve as a biochemical reflection of myocardial area at risk.

Clinical Implications

The strong correlations observed in this study suggest that NT-proBNP may function as an integrated prognostic biomarker in STEMI. Unlike risk scores that require multiple variables or angiographic assessment, NT-proBNP is a single laboratory parameter that can be measured rapidly at admission. Its ability to correlate with clinical severity (TIMI), anatomical complexity (SYNTAX), and myocardial involvement (Aldrich) underscores its comprehensive prognostic value.

In resource-constrained settings, where immediate angiographic evaluation may not always be feasible, NT-proBNP could assist in early identification of high-risk patients who may benefit from urgent revascularization or more aggressive medical therapy.

Limitations of the study

Several limitations must be acknowledged. First, the study was conducted at a single center with a relatively small sample size (n=48), which may limit generalizability. Second, patients with comorbidities were excluded, potentially restricting applicability to real-world STEMI populations. Third, long-term outcomes were not assessed; therefore, the prognostic implications beyond the acute phase remain uncertain. Finally, comparison with other biomarkers, such as high-sensitivity troponin or CRP, was not performed.

Future multicentre studies with larger cohorts and long-term follow-up are warranted to further validate these findings and explore whether NT-proBNP–guided risk stratification improves clinical outcomes.

Conclusion:

This study demonstrates that serum NT-proBNP levels have a strong positive correlation with TIMI ($r = 0.731$) and SYNTAX ($r = 0.722$) scores, and a statistically significant association with the Aldrich score ($p < 0.001$) in STEMI patients. These results indicate that NT-proBNP is a reliable biomarker for assessing both clinical risk and anatomical complexity. Integrating NT-proBNP into routine clinical practice can enhance early risk stratification, guide more aggressive treatment strategies, and improve overall prognostic evaluation in diverse populations.

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