Original Research

ASSOCIATION BETWEEN THROMBOLYSIS IN MYOCARDIAL INFARCTION (TIMI) RISK SCORE AND CORONARY VESSEL INVOLVEMENT IN PATIENTS WITH NON-ST-ELEVATION MYOCARDIAL INFARCTION AND UNSTABLE ANGINA – A RETROSPECTIVE OBSERVATIONAL RECORD-BASED STUDY

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ABSTRACT

Background: Most acute coronary presentations are caused by non-ST-elevation acute coronary syndromes (NSTE-ACS), which include non-ST-elevation myocardial infarction (NSTEMI) and unstable angina (UA). The severity of these conditions varies significantly. Although the Thrombolysis in Myocardial Infarction (TIMI) risk score is a validated bedside tool for risk stratification, its association with the angiographic severity of coronary artery disease (CAD) has not been sufficiently investigated in the Indian population. The purpose of this study was to ascertain whether the degree of coronary vascular involvement in individuals with NSTEMI and UA was correlated with the TIMI risk score.

Methods: This retrospective observational record-based study was conducted among 98 patients diagnosed with NSTEMI or UA who underwent coronary angiography at a tertiary care center in Puducherry, India, between January 2024 and June 2025. Patient data were extracted from medical records using ICD-10 codes and validated proformas. TIMI scores were calculated using seven clinical and laboratory parameters and categorized as <4 (low–moderate risk) or ≥4 (high risk). Coronary angiography findings were reviewed to classify vessel involvement as single-vessel (SVD) or multi-vessel disease (MVD). Statistical analysis included chi-square test, odds ratio (OR) estimation, and multivariate logistic regression to identify independent predictors of MVD.

Results: The patients were 69.4% male and had a mean age of 61.8 ± 9.3 years. The most prevalent risk factors were diabetes mellitus (55.1%) and hypertension (62.2%). Coronary angiography showed SVD in 36 patients (36.7%) and MVD in 59 patients (60.2%). Those with TIMI ≥4 had a considerably higher prevalence of MVD than those with TIMI <4 (78.7% vs. 45.1%, p = 0.001). A 4.59-fold higher risk of MVD was linked to a high TIMI score (95% CI: 1.84–11.43). The TIMI ≥4 category continued to be an independent predictor of MVD after controlling for age, diabetes, hypertension, and smoking (adjusted OR = 3.92, 95% CI: 1.42–10.83, p = 0.008).

Conclusion: A strong and independent association was observed between the TIMI risk score and the angiographic extent of coronary vessel involvement in NSTEMI and unstable angina. Patients with higher TIMI scores were significantly more likely to have multi-vessel coronary artery disease. The TIMI score, being simple and cost-effective, can be used as an effective triage tool for identifying high-risk patients who may benefit from early invasive management, particularly in resource-limited settings.

Keywords: TIMI Risk Score, Non–ST-Elevation Myocardial Infarction, Unstable Angina, Coronary Angiography, Multi-Vessel Disease, Risk Stratification.

INTRODUCTION

Cardiovascular diseases remain the leading cause of death worldwide, accounting for nearly one-third of all global mortalities.

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Among these, coronary artery disease (CAD) represents a significant proportion, imposing an immense public health and economic burden. Acute coronary syndrome (ACS) encompasses a continuum of clinical entities ranging from unstable angina (UA) and non–ST-elevation myocardial infarction (NSTEMI) to ST-elevation myocardial infarction (STEMI), all resulting from acute myocardial ischemia due to plaque rupture and thrombosis. Of these, non–ST-elevation acute

coronary syndromes (NSTE-ACS) constitute approximately 60–70% of all ACS presentations, frequently affecting older adults with multiple comorbidities and demonstrating considerable variability in outcomes and disease severity.

Early risk classification is essential for directing care methods, especially the time of invasive intervention, because of this clinical heterogeneity. One of the most extensively validated and therapeutically used instruments for this purpose is the Thrombolysis in Myocardial Infarction (TIMI) risk score, which was first introduced by Antman et al. (2000) [1]. To estimate the short-term risk of adverse cardiovascular events, the score is derived from seven easily accessible clinical and laboratory parameters: age ≥65 years, presence of ≥3 risk factors for CAD, known coronary stenosis ≥50%, ST-segment deviation, recent aspirin use, recurrent angina, and elevated cardiac markers (Antman et al., 2000) [1].

The predictive value of the TIMI score in predicting death, reinfarction, and the requirement for urgent revascularization in NSTE-ACS was given in the study by Morrow et al., 2002 [2]. Furthermore, there appears to be a relationship between the TIMI score and the angiographic severity of CAD; higher values are linked to left main or multi-vessel disease (Bashiruddin et al., 2019) [3]. According to research from a variety of populations, such as Iragavarapu et al. (2024) and Abbas et al. (2020), patients with TIMI scores ≥4 are up to 13 times more likely to develop multi-vessel coronary artery disease than patients with lower scores [4,5]. These results highlight the score's potential as a proxy indicator of the burden of underlying structural diseases as well as a prognostic diagnostic.

Despite these insights, regional data linking TIMI risk categories with coronary vessel involvement remain scarce, especially in South Indian tertiary care settings. Given that coronary angiography is the gold standard for assessing vessel disease but may not be universally available or feasible in all healthcare contexts, establishing a reliable non-invasive predictor of angiographic severity could be of substantial clinical value.

Therefore, the study was designed to investigate the relationship between coronary vessel involvement and TIMI risk score in patients with NSTEMI and unstable angina in a South Indian population. The purpose of the study was to verify the use of TIMI scoring as a quick, low-cost bedside tool for triaging patients for early invasive therapy, particularly in settings with limited resources, by assessing whether higher TIMI scores indicate multi-vessel CAD. Additionally, the 2025 AHA/ACC Guidelines for non-ST-elevation ACS, which stress tailored, risk-driven treatment decision-making, are in line with current evidence-based frameworks (Rao et al., 2025) [6].

MATERIALS AND METHODS

Study Design and Setting

This study was designed as a retrospective observational record-based study conducted in the Department of General Medicine at a tertiary care hospital, Ariyur, Puducherry. The study covered an 18-month period from January 1, 2024, to June 30, 2025, during which medical records of patients admitted with non–ST-elevation acute coronary syndromes (NSTE-ACS) were reviewed. Institutional Ethical Committee approval was obtained prior to data collection, and the study adhered to the ethical standards of the Declaration of Helsinki (2013) [7].

Study Population

In the present study, 30-80 years adults diagnosed with non–ST-elevation myocardial infarction (NSTEMI) or unstable angina (UA) based on clinical presentation, electrocardiogram (ECG) findings, and elevated cardiac biomarkers. Patients who had undergone coronary angiography during the same admission were eligible for inclusion. Exclusion criteria were a history of percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG), congenital heart disease, myocarditis, pericarditis, hemodynamic instability due to mechanical complications (such as acute mitral regurgitation or ventricular septal defect), and unstable ventricular arrhythmias. Patients younger than 30 years were excluded to avoid non-atherosclerotic causes of chest pain, while those older than 80 years were excluded due to the higher likelihood of comorbidities and incomplete records.

Sampling Frame and Data Source

Data were retrieved from the Medical Records Department (MRD) using the following ICD-10 codes: I21.4 (NSTEMI), I20.0 (Unstable Angina), and I24.x (Acute ischemic heart diseases). To ensure completeness, keyword filters such as *"NSTEMI," "UA," "ACS," "Non-ST elevation MI,"* and *"Troponin positive"* were applied. A two-stage identification process was followed initial electronic screening, followed by manual verification of eligibility by two independent reviewers. Any discrepancies were resolved through consensus or adjudication by a cardiologist.

Sample Size Determination

The sample size was calculated to detect a 30% difference in the prevalence of multi-vessel coronary involvement between patients with TIMI score ≥4 (expected 65%) and those with TIMI score <4 (expected 35%), using a two-proportion formula at 95% confidence and 80% power. The minimum required sample size was 84, which was increased to 98 patient records after adjusting for 10% anticipated data loss due to missing or incomplete

records.

Data Extraction and Variables

Data were extracted retrospectively using a standardized data collection proforma. Extracted variables included demographic data (age, sex), cardiovascular risk factors (hypertension, diabetes mellitus, dyslipidemia, smoking, and family history of CAD), clinical presentation, ECG changes, and serum troponin levels. The Thrombolysis in Myocardial Infarction (TIMI) risk score was calculated for each patient using seven clinical and laboratory parameters: age ≥65 years, ≥3 CAD risk factors, prior aspirin use within seven days, known CAD with ≥50% stenosis, ≥2 episodes of angina within 24 hours, ST-segment deviation ≥0.5 mm, and elevated cardiac markers. Each variable contributed one point to the total score, and patients were categorized into low–moderate risk (TIMI <4) and high risk (TIMI ≥4) groups.

Coronary Angiography and Vessel Classification

All included patients underwent diagnostic coronary angiography during hospitalization. Angiographic data were verified by a consultant cardiologist. Single-vessel disease (SVD) was defined as ≥70% stenosis in one major epicardial coronary artery, whereas multi-vessel disease (MVD) was defined as ≥70% stenosis in two or more major coronary arteries. Left main coronary artery disease (LMD) with ≥50% stenosis was classified under MVD. These classifications were used for the primary analysis of association with the TIMI score.

Data Quality and Management

Data extraction was performed independently by two reviewers to minimize bias and transcription errors. Ten percent of records were randomly cross-verified with the original MRD files for accuracy. Inter-observer reliability was assessed using Cohen's kappa statistic. Missing data were handled by listwise deletion, and only complete cases were included in the analysis. All data were anonymized and stored in a password-protected, encrypted database accessible only to the principal investigator and guide. Data will be retained for five years as per ICMR (2017) guidelines and permanently deleted thereafter [8].

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 28.0. Continuous variables were summarized as mean ± standard deviation (SD) and categorical variables as frequencies and percentages. Associations between TIMI risk category (<4 vs ≥4) and coronary vessel involvement (SVD vs MVD) were analyzed using the Chi-square test or Fisher's exact test where appropriate. Odds ratios (ORs) with 95% confidence intervals (CIs) were computed to quantify the strength of association. Multivariate logistic regression was performed to adjust for confounding variables such as age, diabetes, hypertension, and smoking. A p-value <0.05 was considered statistically significant.

Ethical Considerations

This study posed minimal risk to participants as it involved retrospective review of hospital records with no direct patient contact. A waiver of informed consent was approved by the Institutional Ethics Committee, as the study met all ICMR 2017 criteria for waiver—specifically, data anonymization, non-identifiability, and no impact on patient rights or welfare [8]. Confidentiality of patient information was maintained throughout the research process.

RESULTS

Baseline Characteristics

A total of 98 patients diagnosed with non–ST-elevation myocardial infarction (NSTEMI) or unstable angina (UA) were included in the final analysis. The mean age of the study population was 61.8 ± 9.3 years, with 68 males (69.4%) and 30 females (30.6%). Hypertension was present in 61 patients (62.2%), diabetes mellitus in 54 (55.1%), dyslipidemia in 47 (47.9%), and a history of smoking in 42 (42.9%). Of the total cases, 56 patients (57.1%) presented with NSTEMI and 42 (42.9%) with unstable angina. The mean TIMI risk score was 3.9 ± 1.5, with 47 patients (48.0%) categorized as high risk (TIMI ≥4) and 51 (52.0%) as low to moderate risk (TIMI <4). These baseline findings were consistent with previously reported demographic patterns in similar populations (Table1)

Table 1: Baseline characteristics of the study population (n = 98)

Parameter	n (%) / Mean ± SD
Age (years)	61.8 ± 9.3
Male	68 (69.4)
Female	30 (30.6)
Hypertension	61 (62.2)
Diabetes mellitus	54 (55.1)
Dyslipidemia	47 (47.9)
Smoking	42 (42.9)
Diagnosis: NSTEMI	56 (57.1)
Diagnosis: Unstable angina	42 (42.9)

Mean TIMI risk score	3.9 ± 1.5
TIMI <4	51 (52.0)
TIMI ≥4	47 (48.0)

Angiographic Findings

Coronary angiography revealed, 36 (36.7%) had single-vessel disease (SVD), 59 (60.2%) had multi-vessel disease (MVD), and 3 (3.1%) had normal or insignificant coronaries. The most often impacted arterial was the left anterior descending artery (74.5%), which was followed by the left circumflex artery (52.0%) and the right coronary artery (63.2%). Eight patients (8.2%) had left primary disease, and they were all in the high TIMI category (Table 2).

Table 2: Distribution of angiographic findings (n = 98)

Coronary involvement	n (%)
Single-vessel disease (SVD)	36 (36.7)
Multi-vessel disease (MVD)	59 (60.2)
Normal / minor disease	3 (3.1)
Left anterior descending artery	73 (74.5)
Right coronary artery	62 (63.2)
Left circumflex artery	51 (52.0)
Left main artery disease	8 (8.2)

Association between TIMI Risk Score and Vessel Involvement

Table 3 shows the frequency of multi-vessel disease increased proportionally with higher TIMI risk scores. Among patients with TIMI ≥4, 37 (78.7%) had multi-vessel involvement compared to 23 (45.1%) in those with TIMI <4. This difference was statistically significant ($p = 0.001$, $\chi^2 = 11.65$). The odds ratio for multi-vessel disease among patients with high TIMI scores was 4.59 (95% CI: 1.84–11.43), indicating a strong association between a higher risk score and extensive coronary disease. These findings are in agreement with earlier studies, where TIMI ≥4 was strongly predictive of multi-vessel or complex coronary artery disease [4,5].

Table 3: Association between TIMI risk category and coronary vessel involvement

TIMI category	n (%)	SVD n (%)	MVD n (%)	Odds ratio (95% CI)	p-value
TIMI <4	51 (52.0)	28 (54.9)	23 (45.1)	Reference	–
TIMI ≥4	47 (48.0)	10 (21.3)	37 (78.7)	4.59 (1.84–11.43)	0.001
Total	98 (100)	38 (38.8)	60 (61.2)	–	–

Relationship between Clinical Risk Factors and Angiographic Severity

Patients aged 65 years and above, those with diabetes, or with both hypertension and dyslipidemia had a higher prevalence of multi-vessel disease. However, in multivariate logistic regression analysis, none of these factors independently predicted angiographic severity when adjusted for TIMI risk score. The high TIMI risk category (≥4) remained an independent predictor of multi-vessel coronary artery disease with an adjusted odds ratio of 3.92 (95% CI: 1.42–10.83, $p = 0.008$). These results suggest that the TIMI score provides an integrative assessment of risk that outperforms individual variables in predicting the extent of coronary disease (Table 4).

Table 4: Logistic regression analysis for predictors of multi-vessel disease

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Age ≥65 years	1.73 (0.82–3.66)	1.31 (0.57–3.02)	0.51
Diabetes mellitus	1.88 (0.90–3.91)	1.29 (0.56–2.97)	0.54
Hypertension	1.44 (0.69–2.99)	1.17 (0.49–2.78)	0.72
Smoking	1.52 (0.73–3.16)	1.24 (0.52–2.96)	0.63
TIMI ≥4	4.59 (1.84–11.43)	3.92 (1.42–10.83)	0.008

In this retrospective study of 98 patients with non-ST-elevation acute coronary syndromes, angiography revealed multi-vessel coronary artery disease in nearly two-thirds of them. Multi-vessel disease was nearly five times as common in patients with higher TIMI risk scores (≥4) than in those with lower values. After controlling for conventional cardiovascular risk variables, the TIMI risk score

continued to be an independent predictor of angiographic disease severity. These findings support existing research showing that the TIMI score is a straightforward, non-invasive, and useful clinical tool for predicting both the structural extent of coronary artery disease and short-term poor outcomes.

DISCUSSION

The present study evaluated the association between the Thrombolysis in Myocardial Infarction (TIMI) risk score and coronary vessel involvement in patients with non–ST-elevation myocardial infarction (NSTEMI) and unstable angina. The results demonstrated a significant relationship between higher TIMI risk scores and the presence of multi-vessel coronary artery disease (MVD). Patients with TIMI scores of four or greater were almost five times more likely to have multi-vessel involvement compared to those with lower scores. Even after adjusting for traditional cardiovascular risk factors such as age, diabetes, hypertension, and smoking, the TIMI score remained an independent predictor of angiographic severity.

The results of this study confirm the usefulness of the TIMI risk score as a useful bedside tool for both evaluating the anatomical degree of coronary disease and predicting short-term outcomes. Patients with elevated TIMI scores are more likely to have multi-vessel disease, which suggests that the factors included in the score—such as advanced age, multiple risk factors, recurrent angina, ST deviation, and elevated cardiac biomarkers—collectively serve as a surrogate for more extensive atherosclerosis. The TIMI score is useful for triaging patients for early invasive evaluation because of the excellent association between clinical risk assessment and angiographic results, particularly in healthcare settings with limited catheterization capability.

The current study's findings regarding the relationship between TIMI score and angiographic disease load are in line with a number of other studies. According to Iragavarapu et al. (2024), patients with a TIMI score of four or higher were seven times more likely to have a SYNTAX score above 22 and thirteen times more likely to have multi-vessel disease [4]. Similarly, Abbas et al. (2020) found that in patients with NSTEMI and unstable angina, a TIMI score of ≥4 was a good predictor of multi-vessel coronary disease [5]. Hussein and Sabah (2022) discovered that higher TIMI scores were linked to triple-vessel involvement in an Iraqi population, whereas intermediate levels were linked to double-vessel disease [9]. Namazi et al. (2022) also identified a direct linear relationship between TIMI risk score and the number of diseased vessels, while Bashiruddin et al. (2019) reported significant correlations between TIMI and Gensini scores [10,3]. These findings, together with the present study, strengthen the evidence that the TIMI score reliably reflects both functional and anatomical severity of coronary artery disease.

The results of the present study are also consistent with earlier work by Antman et al. (2000), who developed and validated the TIMI risk model as an outcome-based prognostic tool in unstable angina and NSTEMI [1]. Later studies, such as those by Morrow et al. (2002) and Varughese et al. (2023), expanded its application to predict ischemic complications and guide therapeutic decisions [2,11]. Although the original score was intended primarily for event prediction, accumulating evidence including the current findings supports its additional role as a surrogate marker for angiographic disease burden.

The demonstration of a strong relationship between the TIMI score and coronary vessel involvement has practical implications for clinical decision-making. In many tertiary hospitals, immediate access to coronary angiography may be constrained by resource limitations. In such circumstances, the TIMI score offers an efficient and inexpensive means of identifying high-risk patients who are most likely to benefit from early invasive evaluation and revascularization. Moreover, recognizing that patients with TIMI ≥4 have a high probability of multi-vessel disease can help prioritize interventional resources and guide discussions regarding prognosis and management intensity.

The TIMI score can be used as a quality-improvement tool in addition to risk stratification as it standardizes evaluation across clinical settings. It is especially useful in low- and middle-income nations where modern imaging modalities would not be widely available because to its simplicity and dependence on frequently available data. The 2025 AHA/ACC recommendations for non-ST-elevation acute coronary syndromes, which support tailored, risk-based approaches to intervention timing and intensity, are among the current guideline-directed care techniques that are consistent with the use of such a validated clinical score [6].

The findings of this study should be interpreted in light of certain limitations. The retrospective design carries inherent risks of selection bias and incomplete data capture. Although efforts were made to ensure data accuracy through dual review and verification, residual confounding cannot be entirely excluded. The study was conducted in a single center with a relatively small sample size, which may limit generalizability to other populations. Moreover, the use of angiographic assessment alone without incorporation of functional indices such as fractional flow reserve (FFR) or intravascular imaging may not fully reflect lesion severity. Nonetheless, the study provides valuable local data and reinforces the relevance of a

simple, validated clinical scoring system in predicting anatomical disease extent.

CONCLUSION

In conclusion, this study demonstrates that the TIMI risk score correlates strongly with the extent of coronary vessel involvement in patients with NSTEMI and unstable angina. A score of four or higher was associated with a significantly greater likelihood of multi-vessel disease and remained an independent predictor after adjustment for traditional risk factors. These results confirm the utility of the TIMI score as a practical, non-invasive tool for identifying high-risk patients who may benefit from early invasive evaluation. Incorporating this simple scoring system into initial clinical assessment can enhance risk stratification and optimize resource allocation in the management of non–ST-elevation acute coronary syndromes.

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