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Echocardiographic evaluation of mitral E/e′ ratio, along with angiographic findings and B-type natriuretic peptide levels as prognostic indicators in patients with ST-elevation myocardial infarction: A prospective cross-sectional study.

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Abstract

Background
The approach to risk assessment in ST-Elevation Myocardial Infarction (STEMI) has evolved with advancements in echocardiographic and biochemical markers. The mitral E/e′ ratio and B-type Natriuretic Peptide (BNP) levels, along with coronary angiographic findings, offer a multidimensional approach to prognosis.

Aim
To evaluate mitral E/e′ ratio, BNP levels, and angiographic findings as prognostic indicators in STEMI patients.

Methods
A prospective, cross-sectional study was carried out at IGIMS, Patna, over 12 months (June 2024–May 2025). Fifty patients aged above 40 years diagnosed with STEMI were enrolled and followed up for six months. Echocardiography (including E/e′ ratio), BNP levels, and coronary angiography were assessed within 24 hours of admission. Follow-ups were conducted at 1 week, 3 months, and 6 months. Data were analyzed using SPSS v26.0.

Results
The participants' average age was 62.9 ± 10.8 years, and 68% of them were men. Among the most prevalent comorbidities were dyslipidemia (74%), diabetes mellitus (50%), and hypertension (54%). From 13.08 ± 3.21 at admission, the mean mitral E/e′ ratio decreased to 12.48 ± 2.47 at 1 week, 12.34 ± 2.10 at 3 months, and 12.12 ± 1.22 at 6 months ($p < 0.001$). From 1012.7 ± 890.4 pg/mL at admission to 195.1 ± 81.3 pg/mL at 6 months, BNP levels demonstrated a comparable progressive decline. Higher E/e′ and BNP levels were associated with worse outcomes, and in-hospital mortality was 14%.

Conclusion
Mitral E/e′ ratio, BNP level, and angiographic profile are effective prognostic tools in STEMI. Their integration enhances early risk stratification and individualized patient management.

Recommendation
Routine incorporation of mitral E/e′ ratio and B-type Natriuretic Peptide assessment, along with angiographic evaluation, is recommended for comprehensive prognostic evaluation and management of patients with ST-Elevation Myocardial Infarction.

Keywords: *ST-Elevation Myocardial Infarction, B-type Natriuretic Peptide, Echocardiography, E/e' Ratio, Coronary Angiography, Prognostic Indicator*
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Introduction

ST-segment Elevation Myocardial Infarction (STEMI) represents a severe form of acute coronary syndrome, contributing significantly to global cardiovascular morbidity and mortality (1). STEMI occurs due to the total blockage of a coronary artery, leading to transmural myocardial ischemia and necrosis. It is estimated that STEMI accounts for over 25–40% of all myocardial infarctions, with a higher incidence observed among older adults and individuals with multiple cardiovascular risk factors such as hypertension, dyslipidemia, and diabetes (2, 3). Although significant progress has been made in reperfusion therapies and pharmacological treatment, early risk stratification remains vital to improving outcomes for this high-risk group (4).

Traditionally, clinical features, electrocardiographic findings, and coronary angiography have served as the mainstays for assessing STEMI severity and prognosis. However, recent developments in cardiac imaging and biomarker analysis have introduced non-invasive tools such as echocardiographic B-type Natriuretic Peptide (BNP) and Doppler indices levels as valuable prognostic adjuncts (5). The mitral E/e′ ratio, obtained through tissue Doppler imaging, is a surrogate for left ventricular filling pressure and diastolic function. Elevated E/e′ ratios have been associated with poor outcomes, including increased rates of heart failure, reinfarction, and mortality in STEMI patients (6).

Similarly, BNP—a hormone released in response to ventricular pressure overload—has gained recognition as a robust marker of myocardial strain and volume status. Elevated BNP levels during acute MI correlate with larger infarct sizes, worse left ventricular function, and higher in-hospital mortality (7). Meanwhile, coronary angiography remains the gold standard for visualizing the extent and location of coronary artery blockages, which directly influence clinical decision-making and risk stratification.

Several observational studies and meta-analyses have explored the individual prognostic value of E/e′, BNP, and angiographic parameters in acute coronary syndromes (8). However, there is limited prospective data from Indian tertiary care settings evaluating the integrated role of these modalities in predicting outcomes after STEMI. Moreover, patient populations in Indian centers often present with delayed treatment, variable access to primary PCI, and diverse clinical profiles, which may influence prognostic patterns.

This present study aimed to evaluate the mitral E/e′ ratio, angiographic findings, and BNP levels as prognostic indicators in patients admitted with STEMI at a tertiary care center in Patna. The main goal was to examine the correlation between these parameters and in-hospital mortality, while secondary aims included evaluating trends over time and their relationship with clinical outcomes such as Killip class, echocardiographic function, and need for interventions.

Materials and Methods

Study design and setting

A prospective, observational study was carried out over 12 months (June 2024 to May 2025) in the Department of Cardiology at Indira Gandhi Institute of Medical Sciences (IGIMS), Patna.

Participants

50 consecutive patients diagnosed with STEMI who fulfilled the inclusion criteria were recruited for the study. Each patient received echocardiographic assessment, serum BNP testing, and coronary angiography during hospitalization, with clinical follow-up extending up to six months after discharge.

Inclusion Criteria

- Adults aged >40 years
- Diagnosis of STEMI
- Presentation within 12 hours of symptom onset

Exclusion Criteria

- NSTEMI
- Previous myocardial infarction or heart failure
- Significant valvular heart disease
- CKD stage ≥3
- Inadequate echocardiographic window

Study size

Based on the feasibility of recruiting during the study period and in accordance with prior research of a comparable design and setting, a total of 50 patients were included.

Bias control

To minimize inter-observer variability, all echocardiographic assessments were performed by a single experienced operator blinded to patient clinical outcomes. Uniform imaging protocols and laboratory procedures were followed to reduce measurement bias.

Data Collection and Measurements

Echocardiographic evaluations were conducted within 24 hours of hospital admission by one skilled operator,

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following a uniform protocol that included both color Doppler and tissue Doppler imaging techniques. The key parameters recorded included:

- Left ventricular EF%
- Mitral inflow velocities (E and A waves)
- Mitral annular early diastolic velocity (e′)
- E/e′ ratio
- Left ventricular dimensions and wall motion abnormalities

BNP levels were measured using a standardized immunoassay technique. Coronary angiography was performed via femoral or radial access, and findings such as the number of diseased vessels, culprit lesion location, and TIMI flow grade were documented.

The primary outcome assessed was mortality during hospitalization. Secondary outcomes encompassed changes in E/e′ ratio, EF%, and BNP levels at baseline, 1 week, 3 months, and 6 months; Killip class on admission; and the need for inotropic support or percutaneous coronary intervention (PCI).

Follow-up evaluations were conducted at 1 week, 3 months, and 6 months post-discharge for repeat echocardiographic and BNP assessment, and clinical outcome documentation.

Statistical methods

Statistical analysis was performed using SPSS version 26. Continuous variables were expressed as mean ± SD and analyzed using paired or unpaired t-tests as appropriate. Categorical data were reported as numbers and percentages and analyzed using the Chi-square test or Fisher's exact test. For repeated measurements, ANOVA was applied. A p-value less than 0.05 was deemed statistically significant.

Results

Participant Flow

During the study period, 58 patients who had suspected ST-Elevation myocardial infarction (STEMI) were screened. Fifty of these patients were enrolled after meeting the inclusion criteria. A poor echocardiographic window (n=3), prior myocardial infarction (n=2), and chronic renal disease (n=3) led to the exclusion of eight patients. The initial in-hospital evaluation was completed by all 50 patients; 46 patients were accessible for follow-up at three months, and 44 patients finished the evaluation at six months. 88% of follow-ups were completed overall.

Baseline Characteristics and Clinical Profile

The study population was 68% male and had an average age of 62.96 ± 10.87 years. Of the patients, 54% had hypertension, 50% had diabetes mellitus, 74% had dyslipidemia, and 20% had smoked. Killip Class II was the most prevalent at presentation (54%), followed by Class I (26%), and then Classes III and IV (10% each). 14% of patients experienced cardiogenic shock, and 14% of patients died while in the hospital. In 20% of instances, inotropic assistance was necessary, and 34% of patients underwent percutaneous coronary intervention (PCI). *Table 1 shows baseline demographic and clinical characteristics of STEMI patients enrolled in the study.*

Table 1: Baseline Characteristics and Clinical Profile of the Study Population (n=50)

Parameter	Value
Mean Age (years)	62.96 ± 10.87
Male Sex	68%
Diabetes Mellitus	50%
Hypertension	54%
Dyslipidemia	74%
Smoking	20%
Killip Class II	54%
Cardiogenic Shock	14%
PCI Performed	34%
Inotropic Support	20%
In-hospital Mortality	14%

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Echocardiographic and Biochemical Findings

The follow-up showed a significant decrease from the mean mitral E/e′ ratio of 13.08 ± 3.21 at admission to 12.48 ± 2.47 at 1 week, 12.34 ± 2.10 at 3 months, and 12.12 ± 1.22 at 6 months ($p < 0.001$). From 1012.7 ± 890.37 pg/mL at admission to 691.34 ± 551.78 pg/mL at 1 week, 400.15 ± 328.26 pg/mL at 3 months, and 195.11 ± 81.28 pg/mL at 6 months, BNP levels likewise dramatically decreased ($p < 0.001$). The left ventricular ejection fraction (EF%) decreased to 36.95 ± 15.27% at 6 months after improving from 39.06 ± 6.53% at admission to 41.44 ± 6.58% at 3 months ($p < 0.001$). Table 2 presents trends in E/e′ ratio, EF, and BNP levels from admission to 6 months, demonstrating significant improvement over time.

Table 2: Serial Changes in Echocardiographic and BNP Parameters Over 6-Month Follow-up

Parameter	Admission	1 Week	3 Months	6 Months	*p*-value
E/e′ Ratio	13.08 ± 3.21	12.48 ± 2.47	12.34 ± 2.10	12.12 ± 1.22	<0.001
EF (%)	39.06 ± 6.53	—	41.44 ± 6.58	36.95 ± 15.27	<0.001
BNP (pg/mL)	1012.7 ± 890.37	691.34 ± 551.78	400.15 ± 328.26	195.11 ± 81.28	<0.001

Correlation with Outcomes

In-hospital mortality was substantially higher for patients with higher admission E/e′ ratios (>15) and BNP levels (>1000 pg/mL) than for those with lower values ($\chi^2 = 6.21$, $p = 0.014$). Likewise, death and the need for inotropic support were significantly correlated with adverse angiographic results, such as multivessel disease and TIMI flow grade ≤2 ($p < 0.05$). Table 3 demonstrates that elevated admission E/e′ ratio, higher BNP, lower EF, and adverse angiographic features were significantly associated with mortality.

Table 3: Association Between Admission Parameters and In-hospital Mortality

Parameter	Survivors (n=43)	Non-survivors (n=7)	*p*-value
Mean E/e′ Ratio	12.7 ± 2.9	15.6 ± 3.0	0.014
BNP (pg/mL)	884.2 ± 776.4	1523.6 ± 912.8	0.021
EF (%)	40.1 ± 6.1	33.5 ± 5.9	0.031
Multivessel Disease	37%	71%	0.046
TIMI Flow ≤ 2	28%	57%	0.038

Discussion

This prospective observational study conducted at IGIMS, Patna, over a period of 12 months evaluated the prognostic value of mitral E/e′ ratio, angiographic findings, and BNP levels in patients presenting with STEMI. The findings indicate that elevated E/e′ ratios and BNP levels at admission are strongly linked to in-hospital mortality, while progressive normalization of these parameters correlates with clinical improvement. These observations are consistent with previous literature underscoring the role of diastolic dysfunction and neurohormonal activation in predicting adverse outcomes following acute myocardial infarction (9).

The decline in the E/e′ ratio over time observed in this study suggests recovery of left ventricular filling dynamics, particularly in patients receiving timely reperfusion and supportive care. This finding aligns with earlier prospective analyses, which reported that normalization of E/e′ is a reliable marker of favorable prognosis in STEMI, especially when combined with other indices of ventricular function (10). Similarly, the significant and steady reduction in BNP levels in our cohort mirrors trends documented in global studies, where BNP was shown to reflect infarct size, ventricular strain, and response to therapy (11).

Ejection fraction showed a modest initial improvement, consistent with myocardial stunning recovery. However, the subsequent decline at 6 months could reflect underlying ventricular remodeling or late post-infarction changes. These EF fluctuations underscore the importance of serial imaging in post-MI follow-up and support the inclusion of diastolic parameters and biomarkers alongside traditional systolic measures in risk stratification (12).

While angiographic analysis was primarily descriptive, it was noted that multivessel disease and poor initial TIMI flow were more frequent in non-survivors, echoing findings from multicenter registries that link angiographic burden to mortality and heart failure risk (13). Integration of these

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anatomical insights with non-invasive prognostic tools like E/e′ and BNP enhances early clinical decision-making.

Despite the robustness of our results, several limitations must be considered. The modest sample size may limit the power to detect small but clinically relevant differences in long-term outcomes. The single-center design, although standardized, may restrict external applicability. Additionally, the follow-up period was limited to six months, and longer observation may be necessary to assess post-discharge morbidity, reinfarction, and late heart failure events.

Nevertheless, the strengths of this study include prospective data collection, uniform echocardiographic assessment by a single operator, and real-world insights from a tertiary care setting catering to a mixed patient demographic. In conclusion, mitral E/e′ ratio and BNP level serve as valuable, non-invasive prognostic indicators in STEMI and can effectively complement angiographic data in guiding clinical management. Larger, multicenter studies with extended follow-up are warranted to validate these findings and integrate them into standardized prognostic models.

Generalizability

The study's conclusions are particularly relevant to tertiary care settings in comparable low- and middle-income areas. However, direct applicability to all populations may be limited by differences in patient presentation and resource availability.

Conclusion

Echocardiographic assessment of mitral E/e′ ratio, along with BNP level and coronary angiographic findings, offers a valuable and integrated approach to early risk evaluation in STEMI patients. Elevated E/e′ and BNP levels are strongly associated with increased in-hospital mortality, while serial improvement in these parameters reflects favorable clinical progression. Although systolic function remains important, diastolic indices and biomarkers provide additional prognostic insight, particularly in the early post-infarction period. These non-invasive tools are safe, practical, and effective in routine clinical settings.

Limitations

The small sample size, single-center design, and brief six-month follow-up period were the study's limitations. To validate these results and evaluate long-term consequences, larger, multicenter trials with longer follow-up are needed.

Recommendation

Selection and interpretation of prognostic modalities should be individualized based on patient profile, available resources, and institutional capabilities.

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List of Abbreviations

STEMI – ST-Elevation Myocardial Infarction
BNP – B-type Natriuretic Peptide
EF – Ejection Fraction
PCI – Percutaneous Coronary Intervention
TIMI – Thrombolysis in Myocardial Infarction

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Conflict of Interest

None declared.

Author Contributions

All authors contributed equally

Data Availability

The data supporting the findings of this study are available from the corresponding author on reasonable request.

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