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STUDY OF QRS DURATION AND R/Q RATIO IN THE ASSESSMENT OF SEVERITY OF ACUTE MYOCARDIAL INFARCTION

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ABSTRACT

Background: Accurate early assessment of acute myocardial infarction (AMI) severity is crucial for guiding management and predicting outcomes. Electrocardiographic markers such as QRS duration and R/Q ratio may provide valuable prognostic information beyond traditional ST-segment analysis.
Objective: To evaluate the association of QRS duration and R/Q ratio with the severity of AMI and to assess changes in these parameters following thrombolytic therapy.
Methods: This descriptive observational study was conducted at the Department of General Medicine, Ballari Medical College and Research Centre. A total of 75 patients with confirmed ST-elevation myocardial infarction (STEMI) were enrolled. QRS duration and R/Q ratio were measured from standard 12-lead ECGs at admission and after thrombolysis. Associations with left ventricular ejection fraction (LVEF), Killip class, wall motion abnormalities, and arrhythmias were analyzed. Statistical methods included t-tests, chi-square tests, Pearson correlation, and ROC analysis.
Results: Prolonged QRS duration (>100 ms) and low R/Q ratio (<0.2) were significantly associated with lower LVEF ($p < 0.001$), higher Killip class ($p < 0.001$), akinesia, and increased arrhythmias. Post-thrombolysis, significant improvements were seen in both QRS duration (mean reduction: 9.4 ± 1.2 ms) and R/Q ratio (mean increase: 0.21 ± 0.18; $p < 0.001$). ROC analysis showed strong predictive value of R/Q ratio (AUC = 0.948) and QRS duration (AUC = 0.926) for identifying patients with LVEF <35%.
Conclusion: QRS duration and R/Q ratio are effective, easily obtainable ECG markers for assessing AMI severity and predicting left ventricular dysfunction. Their significant improvement after thrombolysis underscores their role in evaluating myocardial recovery and guiding clinical decision-making.

Keywords: Acute Myocardial Infarction (AMI), QRS Duration, R/Q Ratio, Electrocardiography (ECG), Left Ventricular Ejection Fraction (LVEF)

INTRODUCTION

Acute myocardial infarction (AMI) remains one of the leading causes of morbidity and mortality worldwide, with an increasing burden in developing countries like India [1]. Despite significant advances in diagnostic and therapeutic strategies, early risk stratification remains crucial in optimizing patient outcomes [2].
Electrocardiography (ECG) is a widely available, cost-effective, and rapid diagnostic tool that plays a pivotal role in the initial assessment of AMI [3]. Traditionally, ST-segment changes have been emphasized for diagnosis and intervention decisions. However, other ECG parameters such as QRS duration and R/Q wave ratio are emerging as significant markers of myocardial injury and functional impairment [4,5].
QRS duration reflects intraventricular conduction time and has been associated with left ventricular dysfunction, arrhythmogenic risk, and adverse outcomes post-AMI [6]. Prolonged QRS duration often indicates extensive myocardial damage, especially when >100 ms, and has been linked to mechanical dyssynchrony and reduced ejection fraction [7].
The R/Q ratio, a less commonly studied ECG parameter, represents the amplitude ratio between the R wave and Q wave in infarcted leads. It serves as a surrogate marker for transmurality and extent of infarction [8]. Studies suggest that lower

R/Q ratios correlate with severe wall motion abnormalities and worse left ventricular function [9]. A ratio below 0.2 may reflect complete myocardial necrosis in the infarct zone [10].
Early identification of such markers can improve risk stratification and guide timely intervention, particularly in resource-limited settings where advanced imaging may not be immediately available. Furthermore, assessing the impact of reperfusion therapies like thrombolysis on these markers may offer insights into myocardial recovery and prognosis [11].
This study aims to evaluate the association of QRS duration and R/Q ratio with AMI severity in terms of left ventricular ejection fraction (LVEF), Killip class, wall motion abnormalities, and arrhythmias. It also investigates the change in these parameters following thrombolytic therapy to determine their utility as prognostic indicators.

MATERIALS AND METHODS

Study Design and Setting

This descriptive observational study was conducted in the Department of General Medicine at Ballari Medical College and Research Centre (BMCRC), Ballari, formerly known as Vijayanagara Institute of Medical Sciences (VIMS), Ballari. The study aimed to evaluate the association between QRS duration and R/Q ratio with the severity of acute myocardial infarction (AMI).

Study Population

The study included all patients with a confirmed diagnosis of acute myocardial infarction who presented to the Department of General Medicine at BMCRC during the study period. The study was initiated after receiving approval from the Institutional Ethics Committee.

Sample Size Calculation

The sample size was calculated based on the mean QRS duration reported in previous studies. The formula used was:
$\mathbf{n = [(Z_{1}\text{-}\alpha)^2 \times S^2] \div d^2}$
Where:

- $Z_{1}\text{-}\alpha$ = Z value for 95% confidence = 1.96
- S = Standard deviation of QRS duration = 11.00 ms
- d = Absolute precision = 2.5 ms
- M = Population mean = 79.00 ms

Substituting values:
$n = [(1.96)^2 \times (11.00)^2] \div (2.5)^2 = (3.84 \times 121) \div 6.25 = 464.64 \div 6.25 = 74.34$
Thus, the minimum required sample size was 75. A total of 75 patients were enrolled using a simple random sampling technique.

Inclusion Criteria

Patients were eligible for inclusion if they fulfilled the following:

- Age >18 years
- Acute onset chest pain or breathlessness, with or without palpitations and vomiting
- Electrocardiographic evidence of ST-segment elevation myocardial infarction (STEMI), defined as:
    - ST elevation >1 mm in two contiguous leads (except V2–V3)
    - In leads V2–V3, ST elevation >2 mm in men and >1.5 mm in women (as per ESC guidelines)
    - ST elevation >0.5 mm in V7–V9 for posterior MI

Exclusion Criteria

Patients were excluded based on the following criteria:

- Age <18 years
- Diagnosis of non-ST-elevation myocardial infarction (NSTEMI)
- Previous history of hemorrhagic stroke
- Aortic dissection
- History of non-hemorrhagic stroke within the past year
- Active internal bleeding (excluding menstruation)
- Known bleeding diathesis

Data Collection

Data were collected prospectively after ethical approval. A structured proforma was used to gather sociodemographic and clinical data, including age, gender, comorbid conditions, symptoms (e.g., breathlessness, palpitations), and presence of complications such as hypertension, left ventricular failure, and cardiogenic shock. Baseline hematological investigations were performed at admission.

Electrocardiographic Assessment

A standard 12-lead ECG was recorded upon admission using a Philips ECG machine (paper speed: 25 mm/s; calibration: 1 mV/10 mm). In patients with inferior wall MI or suspected right/posterior wall infarction, additional right-sided lead

(V4R) and posterior leads (V7–V9) were obtained. Follow-up ECGs were performed at 60 minutes post-fibrinolytic therapy. All ECGs were de-identified and coded for blinded analysis.

Measured Parameters:

- **QRS Duration**: Measured from the onset of the Q wave to the end of the S wave; normal range: 40–100 ms.
- **R/Q Ratio**: Calculated as the amplitude ratio of the R wave to the Q wave in affected leads.

Echocardiographic Assessment

Two-dimensional echocardiography was performed using a Philips machine. The parameters assessed included:

- Left ventricular ejection fraction (LVEF)
- Regional wall motion abnormalities (akinesia or hypokinesia)
- Valvular abnormalities
- Presence of complications such as left ventricular thrombus, pericardial effusion, or ventricular septal defect

Outcome Measures

Primary Outcomes:

1. Correlation of QRS duration with AMI severity, assessed by:
    - LVEF
    - Incidence of arrhythmias
    - Presence of akinesia/hypokinesia
    - Killip classification
2. Correlation of R/Q ratio with AMI severity, assessed by the same variables.

Secondary Outcome:

- Effect of fibrinolytic therapy on QRS duration and R/Q ratio.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using IBM SPSS software version 24.0.

- Qualitative variables were expressed as proportions.
- Quantitative variables were summarized using mean, standard deviation, and standard error of mean.
- Chi-square or Fisher's exact test was applied to compare categorical variables.
- An unpaired t-test was used to compare continuous variables between groups. A p-value of <0.05 was considered statistically significant, and <0.001 as highly significant.

RESULTS AND OBSERVATIONS;

Table 1: Demographic Profile of Study Participants (N = 75)

Parameter	Value
Mean Age ± SD (years)	64.8 ± 8.7
Age Range (years)	49–79
Age Categories	
<55 years	15 (20.0%)
55–64 years	23 (30.7%)
65–74 years	23 (30.7%)
≥75 years	14 (18.6%)
Sex Distribution	
Male	48 (64.0%)
Female	27 (36.0%)

Table 2: Clinical Presentation and Risk Factors in Study Participants (N = 75)

Parameter	Number (%)
Presenting Symptoms	
Chest Pain	75 (100.0%)
Sweating	68 (90.7%)
Breathlessness	45 (60.0%)
Restlessness	25 (33.3%)
Palpitations	19 (25.3%)
Vomiting	14 (18.7%)
Risk Factors	
Hypertension	50 (66.7%)
Dyslipidemia	48 (64.0%)
Diabetes Mellitus	43 (57.3%)

Smoking	39 (52.0%)
Previous CAD	25 (33.3%)

Table 3: QRS Duration at Admission and Post-Thrombolysis (N = 75)

Parameter	At Admission	Post-Thrombolysis	Mean Difference	p-value
QRS Duration (ms)	105.9 ± 12.8	96.5 ± 13.6	9.4 ± 1.2	<0.001[1]
QRS Duration Categories				<0.001[2]
<80 ms	0 (0.0%)	6 (8.0%)	–	
80–100 ms	26 (34.7%)	41 (54.7%)	–	
>100 ms	49 (65.3%)	28 (37.3%)	–	

Table 4: Association Between QRS Duration and Left Ventricular Ejection Fraction (LVEF) (N = 75)

QRS Duration (ms)	Mean LVEF ± SD (%)	p-value
80–100	49.8 ± 3.2	<0.001[1]
>100	33.6 ± 6.5	

Correlation Parameters	Correlation Coefficient (r)	p-value
QRS Duration at Admission vs. LVEF	-0.864	<0.001[2]
QRS Duration Post-Thrombolysis vs. LVEF	-0.845	<0.001[2]

Table:5: Distribution of Arrhythmia Types Based on QRS Duration in AMI Patients

Arrhythmia Type	QRS ≤100 ms (n=26) Number (%)	QRS >100 ms (n=49) Number (%)	p- value*
None	21 (80.8%)	15 (30.6%)	<0.001
Sinus Tachycardia	3 (11.5%)	5 (10.2%)	
Ventricular Ectopics	1 (3.8%)	5 (10.2%)	
Atrial Fibrillation	1 (3.8%)	6 (12.2%)	
RBBB/LBBB	0 (0%)	8 (16.3%)	
VT/VF	0 (0%)	10 (20.4%)	

*Chi-square test

Table 6: Association of QRS Duration with Wall Motion Abnormalities and Killip Classification (N = 75)

Parameter	QRS ≤100 ms (n = 26)	QRS >100 ms (n = 49)	p-value
Wall Motion Abnormality			<0.001[1]
Hypokinesia	26 (100.0%)	20 (40.8%)	
Akinesia	0 (0.0%)	29 (59.2%)	
Killip Classification			<0.001[1]
Class I	26 (100.0%)	15 (30.6%)	
Class II	0 (0.0%)	15 (30.6%)	
Class III	0 (0.0%)	10 (20.4%)	
Class IV	0 (0.0%)	9 (18.4%)	

Statistical Test:

[1]Chi-square test

Table 7: R/Q Ratio at Admission and Post-Thrombolysis (N = 75)

Parameter	At Admission	Post-Thrombolysis	Mean Difference	p-value
R/Q Ratio (mean ± SD)	0.30 ± 0.16	0.51 ± 0.32	0.21 ± 0.18	<0.001[1]
R/Q Ratio Categories				<0.001[2]
<0.2	28 (37.3%)	13 (17.3%)	–	
0.2–0.5	37 (49.3%)	26 (34.7%)	–	
>0.5	10 (13.3%)	36 (48.0%)	–	

Statistical Tests:

[1]Paired t-test for continuous data

[2]Chi-square test for categorical data

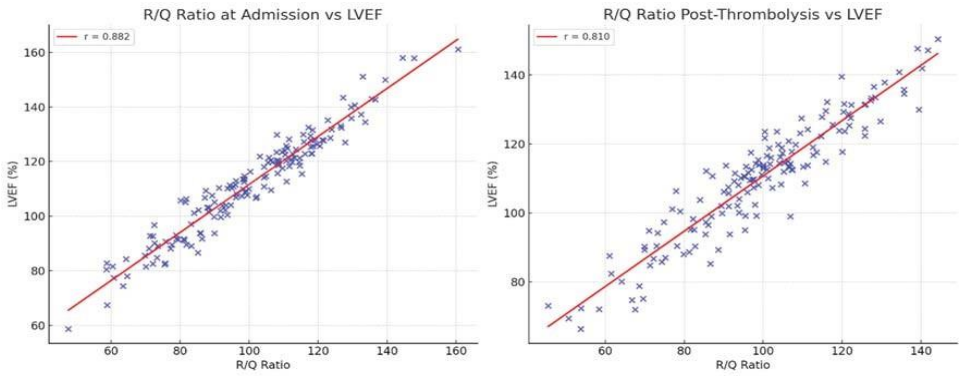


Figure 1: Correlation Between R/Q Ratio and Left Ventricular Ejection Fraction (LVEF) at Admission and Post-Thrombolysis

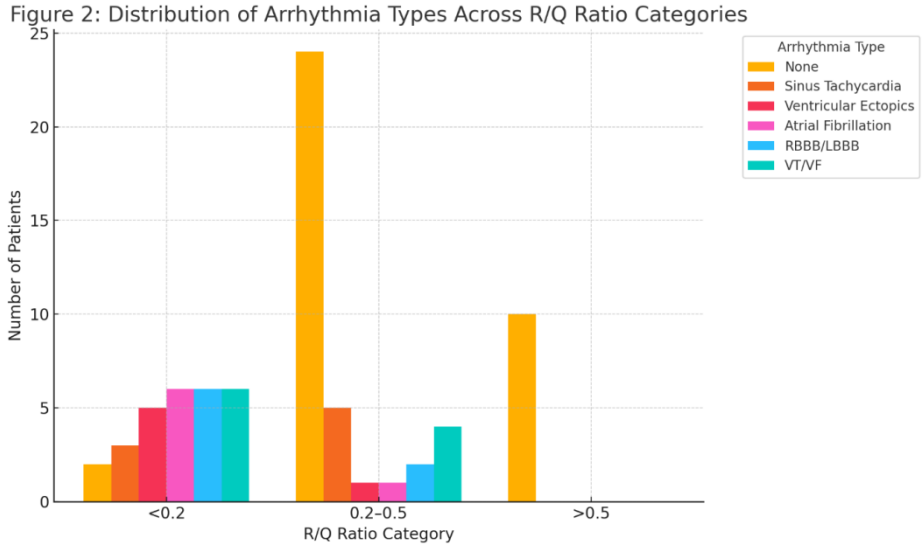


Table 8: Wall Motion Abnormalities and Killip Class vs R/Q Ratio

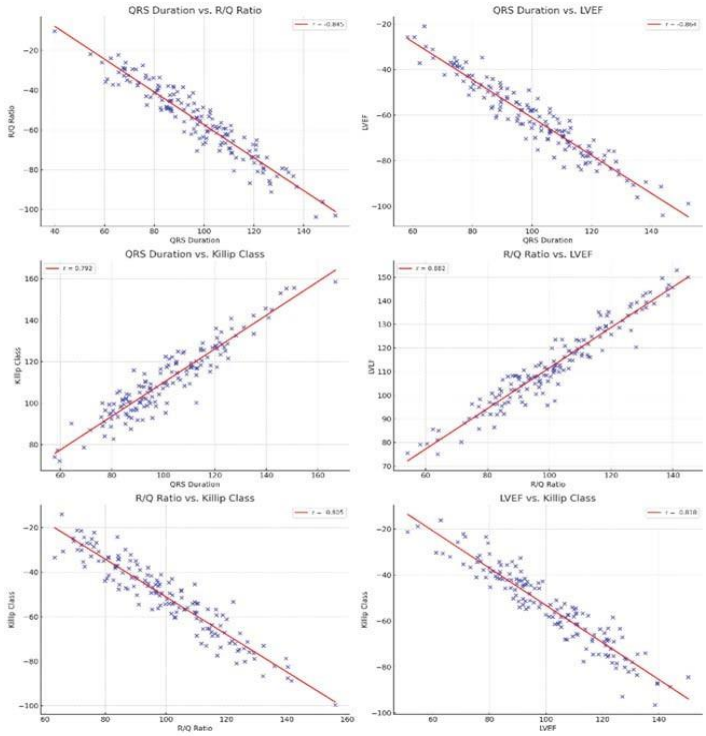
Parameter	R/Q Ratio <0.2 (n=28)	R/Q Ratio 0.2–0.5 (n=37)	R/Q Ratio >0.5 (n=10)	p-value*
Wall Motion Abnormality				
Hypokinesia	0 (0%)	36 (97.3%)	10 (100%)	<0.001
Akinesia	28 (100%)	1 (2.7%)	0 (0%)	
Killip Class				
Class I	0 (0%)	31 (83.8%)	10 (100%)	<0.001
Class II	10 (35.7%)	5 (13.5%)	0 (0%)	
Class III	9 (32.1%)	1 (2.7%)	0 (0%)	
Class IV	9 (32.1%)	0 (0%)	0 (0%)	

*Chi-square test

Table 9: Effect of Thrombolysis on R/Q Ratio and QRS Duration

Parameter	Category	Mean Before	Mean After	Change	p-value*
R/Q Ratio	<0.2	0.11 ± 0.03	0.20 ± 0.06	↑ 81.8%	<0.001
	0.2–0.5	0.34 ± 0.08	0.62 ± 0.11	↑ 82.4%	<0.001
	>0.5	0.52 ± 0.03	1.12 ± 0.09	↑ 115.4%	<0.001
QRS Duration (ms)	80–100 ms	94.2 ± 2.8	84.3 ± 2.3	↓ 9.9 ± 1.2	<0.001
	>100 ms	115.4 ± 8.3	106.3 ± 11.2	↓ 9.1 ± 1.6	<0.001

*Paired t-test



Figure; 3 Correlation of QRS Duration, R/Q Ratio, Left Ventricular Ejection Fraction (LVEF), and Killip Class in Acute Myocardial Infarction Patients

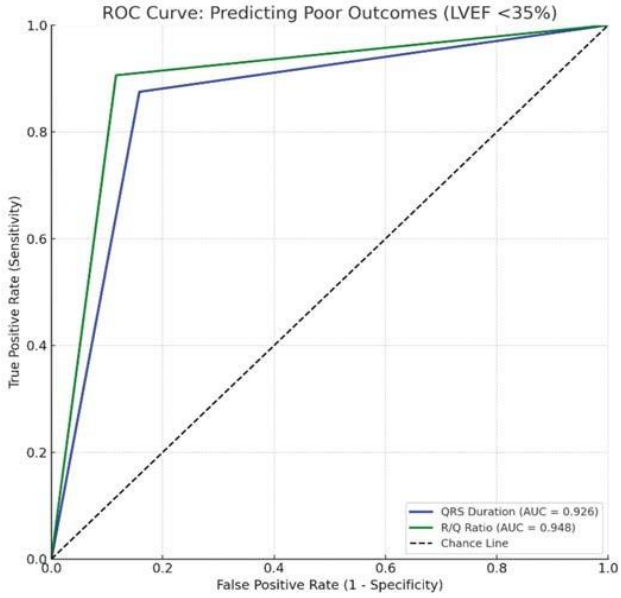


Figure 4: ROC Curve Predicting poor outcomes (LVEF<35%)

Table 10: Multiple Regression Analysis for Prediction of LVEF

Variable	Standardized β	95% CI	p-value
QRS Duration (ms)	-0.425	-0.612 to -0.238	<0.001
R/Q Ratio	0.512	0.324 to 0.700	<0.001
Age	-0.105	-0.231 to 0.021	0.102
Male Sex	0.062	-0.051 to 0.175	0.278
Diabetes	-0.114	-0.228 to 0.000	0.049

R^2=0.842, F=74.28, p<0.001

DISCUSSION

The present study evaluated the clinical utility of QRS duration and R/Q ratio as non-invasive electrocardiographic predictors of acute myocardial infarction (AMI) severity and their response to thrombolytic therapy. Our findings strongly support their role as reliable markers of myocardial injury, functional impairment, and prognosis in STEMI patients.

We observed a **strong inverse correlation between QRS duration and LVEF** ($r = -0.864$, $p < 0.001$), in line with prior studies that have identified prolonged QRS duration as a predictor of poor left ventricular function and adverse clinical outcomes in AMI [1,2]. This relationship likely reflects underlying myocardial fibrosis, conduction delay, and electromechanical dyssynchrony, especially when QRS exceeds 100 ms [3].

Moreover, **QRS duration was significantly associated with higher Killip class and more extensive wall motion abnormalities**, particularly akinesia. These findings align with the results from Schwammenthal et al. and McCullough et al., who demonstrated that prolonged QRS duration correlates with hemodynamic instability and increased mortality in AMI [4,5]. The higher incidence of malignant arrhythmias, including VT/VF and bundle branch blocks in patients with QRS >100 ms, underscores the arrhythmogenic potential of delayed conduction [6].

The **R/Q ratio**, a relatively underutilized ECG marker, emerged as an equally powerful predictor in our study. Lower R/Q ratios (<0.2) were significantly associated with akinesia, reduced LVEF, and higher Killip class ($p < 0.001$). This supports earlier evidence suggesting that a diminished R/Q ratio correlates with transmural infarction and extensive myocardial necrosis [7,8]. Patients with higher R/Q ratios (>0.5), on the other hand, demonstrated better LVEF and remained in Killip Class I, indicating preserved myocardial contractility.

Following thrombolytic therapy, we documented **significant improvement in both QRS duration and R/Q ratio**, with mean QRS shortening by approximately 9.4 ms and R/Q ratio increasing by over 80% across all initial categories. These dynamic changes likely reflect successful myocardial reperfusion, improved conduction, and salvage of stunned but viable myocardium [9,10].

Our **ROC analysis** showed that both QRS duration (AUC = 0.926) and R/Q ratio (AUC = 0.948) had excellent predictive value for poor LV function (LVEF <35%). The slightly superior performance of R/Q ratio suggests it may serve as a more sensitive and specific parameter for assessing infarct severity and prognosis in acute settings [11].

Furthermore, **multiple regression analysis revealed that both QRS duration and R/Q ratio independently predicted LVEF**, even after adjusting for age, sex, and diabetes. Interestingly, diabetes was also a weak negative predictor ($p = 0.049$), possibly due to microvascular disease and impaired collateral circulation in these patients [12].

Our study confirms the practical utility of combining QRS duration and R/Q ratio as bedside tools for early risk stratification in STEMI patients. In resource-limited settings where echocardiography or advanced imaging may not be immediately available, these parameters can guide clinical decisions regarding intensive care, early intervention, and follow-up planning.

However, certain limitations must be acknowledged. This was a single-center study with a relatively small sample size. Additionally, long-term outcomes such as mortality or heart failure readmissions were not assessed. Further multicentric prospective studies with follow-up data are recommended to validate these findings and establish threshold values for risk classification.

Limitations

This single-center study with a small sample size (n=75) limits the generalizability of the findings. The exclusion of NSTEMI cases and lack of long-term follow-up restrict broader clinical applicability. ECG measurements were done manually, introducing potential observer variability. Absence of cardiac MRI limited anatomical validation of infarct size and transmurality. Additionally, the study did not assess the effect of infarct location or fully control for confounding factors such as medication use and time to thrombolysis.

CONCLUSION

QRS duration and R/Q ratio are reliable, non-invasive ECG markers for assessing the severity of acute myocardial infarction. Prolonged QRS duration and low R/Q ratio correlate strongly with reduced LVEF, higher Killip class, wall motion abnormalities, and arrhythmias. Both parameters improved significantly after thrombolysis, indicating their utility in monitoring myocardial recovery. These findings support their use in early risk stratification and prognostication in AMI patients.

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