

## Original Article

# Relationship between QRS duration on Admission ECG and Angiographic Severity of Coronary Artery Disease in Patients with Acute Anterior Myocardial Infarction

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**Key Words :**  
IHD, CAD,  
Myocardial  
infarction, QRS  
duration, ECG,  
Gensini score.

## Abstract:

**Background:** Early risk stratification of patients with myocardial infarction is critical to determine optimum treatment strategies and improve outcomes. This study was designed to determine the relation between QRS duration on admission ECG and severity of coronary artery disease (CAD) in patients with acute anterior myocardial infarction (AMI).

**Methods:** This observational study was carried out from November 2019 to October 2020 with total of 100 patients with first attack of anterior MI who were treated with thrombolytic therapy. Based on the cut-off value of QRS duration 100, the patients were divided into two groups – one group with QRS duration  $\leq 100$  msec (normal QRS) and another group with QRS duration  $> 100$  msec (prolonged QRS). Severity of CAD was assessed using Gensini score derived from coronary angiographic data. Gensini score  $< 36$  points was regarded as mild coronary artery disease and Gensini score  $\geq 36$  points as moderate to severe coronary artery disease. Then patients with prolonged and normal QRS durations were compared with severity of CAD to find their association.

**Results:** Acute AMI patients with prolonged QRS duration ( $> 100$  msec) more often tend to be associated with severe CAD. Risk of having severe CAD in patients with prolonged QRS duration were almost 8 (95% of CI = 3.2– 19.3) times higher than those with normal QRS duration ( $\leq 100$  msec) ( $p < 0.001$ ).

**Conclusion:** The study concluded that three out of four patients of acute anterior MI with prolonged QRS duration are likely to have severe CAD. QRS duration more than 100 msec can be used as a cheap, easily available prognostic factor in patients with acute anterior MI.

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## Introduction:

Cardiovascular disease (CVD) is known to be the leading cause of death worldwide. In 2015, approximately 20 million deaths occurred due to CVD (accounting for one-third of total global death) and 423 million people have had CVD (1 in 17 of the global population).<sup>1</sup> In Bangladesh death due chronic diseases, especially the ‘fatal four’ i.e. cardiovascular disease (CVD), cancer, chronic

respiratory disease and diabetes is increasing at galloping pace.<sup>2</sup> Acute myocardial infarction (MI) appeared as the top leading cause (3.7%) of deaths across 504 public hospitals in Bangladesh in 2012 as reported by the “Health Bulletin 2013”.<sup>3</sup> Myocardial infarction is the commonest form of Acute Coronary Syndrome (ACS) and is a leading global cause of premature morbidity and mortality.<sup>4</sup>

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The QRS duration determined by electrocardiography (ECG) in acute MI is related to ventricular dysfunction. Prolonged QRS duration can lead to ventricular dysfunction in long-term and also it can be a direct result of ventricular dysfunction. Many studies have documented the prognostic value of ECG with left ventricular (LV) systolic function by echocardiography. Additionally, it was found that prolonged QRS duration was related to poor prognosis in anterior AMI.<sup>5-8</sup> Another study showed that patients with prolongation of QRS duration had increased ventricular volume, decreased left ventricular EF, and higher incidence of sudden cardiac death.<sup>9</sup> ECG can be used as a cheap, easily available and reproducible test for early stratification of patients with acute anterior MI.

However, the relation between QRS duration and angiographic severity has not been searched thoroughly. The present study is, therefore, designed to evaluate the relationship of QRS duration on admission ECG and angiographic severity of CAD. Methods

This present study was designed as an observational study at Department of Cardiology, Sir Salimullah Medical College & Mitford Hospital, Dhaka. This study was conducted from November 2019 to October 2020. Patients with first attack of acute anterior myocardial infarction (MI) admitted in the Department of Cardiology within 12 hours of onset of chest pain and were treated with thrombolytic therapy, were the study population. A total number of 100 patients who fulfilled inclusion and exclusion criteria were selected for the study as the sample population. The samples were collected by purposive sampling method. Patients with Previous history of myocardial infarction, PCI or CABG, known non-ischemic causes of prolonged QRS duration (WPW syndrome, hyperkalemia, Preexisting left and right bundle branch blocks (LBBBs or RBBBs), Pacemaker rhythm, Arrhythmia and patients under anti-arrhythmic drugs, known valvular heart disease, congenital heart disease and cardiomyopathy, Major non-coronary disorders that cause elevation of Troponin-I, such as CKD, myocarditis, acute pulmonary embolism were excluded from this study.

Informed written consent was taken from each patient before enrollment. Meticulous history was

taken and detailed clinical examination was performed. Risk factors profile including smoking, hypertension, dyslipidemia and family history of myocardial infarction were noted. Necessary physical examinations were done. Some primary investigations were done including serum troponin value, random blood sugar, serum creatinine, serum electrolytes, lipid profile on the day of admission. Resting ECG of all patients was done within 12 hours of chest pain at a paper speed of 25 mm/s and 10 mm standardization at admission using Fukuda ECG machine (Model: FX -2111) Denshi Co Ltd. Japan. QRS duration was manually measured and calculated from the beginning of the first appearing Q or R wave to the end of the S wave. All measurements were taken from the precordial leads (V1 to V6). Average of measurements from all precordial leads was considered. Based on the cut-off value of QRS duration 100 msec, the patients were divided into two groups – one group with QRS duration  $\leq$ 100 msec (normal QRS, 44 patients) and another group with QRS duration  $>$  100 msec (prolonged QRS, 56 patients). Trans thoracic echocardiography was routinely done. Coronary angiogram (CAG) was done by conventional method using SHIMADZU BRANSIST ALEXA device using at least two views of the right coronary artery and four views of the left coronary artery during the same hospital stay as per protocol of the hospital.

Angiographic severity of coronary artery disease was assessed by Gensini score and it was calculated by 2 independent experienced interventional cardiologists. For severity of CAD the Gensini scoring system was used.<sup>10</sup> Gensini score 36 points was regarded as cut-off value for CAD severity (Gensini score  $<$  36 points – absent or mild coronary atherosclerosis, Gensini score  $\geq$ 36 points – moderate to severe coronary atherosclerosis).<sup>11</sup> Then patients with prolonged and normal QRS duration was correlated with severity of CAD to find their association.

Collected data were processed and analyzed using SPSS (Statistical Package for Social Science), version 23.0 available. Data were analyzed according to the objectives and hypothesis of the study. The test statistics used analyze the data were descriptive statistics, Chi-squared Test (for categorical variables) and Unpaired t-test (for continuous variables). The Odds Ratio (along with

its 95% confidence interval) for a certain factor/variable was calculated to estimate the risk of developing the defined outcome (severity of anterior MI) due to this factor/variable. Spearman correlation was done to see the nature of correlations between QRS duration and Gensini score as well as between QRS duration and LVEF.

The level of significance was set at 5% and p-value < 0.05 was considered significant. Word processing was done by the WORD module of Microsoft Office 2016 (Microsoft Corporation, USA). The study protocol was approved by ethical committee of Sir Salimullah Medical College, Dhaka.

Confidentiality regarding all information's and records was maintained strictly and the patients had the right to withdraw him/herself from the study at any time during the study period.

### Results:

This observational analytical study aimed at determining the association between QRS complex duration and coronary artery severity (based on Gensini score) included a total of 100 acute anterior myocardial infarction patients. Based on the cut-off value of QRS duration 100 msec, the patients were divided into two groups –

one group with QRS duration  $\leq 100$  msec (normal QRS, n = 44) and another group with QRS duration  $> 100$  msec (Prolonged QRS, n = 56). The outcome variable, severity of coronary artery disease (CAD), assessed by Gensini score, was also divided into two categories – less severe or mild CAD (Gensini score  $< 36$ , n = 44) and moderate to severe CAD (Gensini score  $\geq 36$ , n = 56). The exposure variable (QRS duration) and all the confounding variables of interest (age, sex, risk factor/comorbidities etc.) were then compared between the two outcome groups to find their association with severity of CAD. Spearman correlation was done to see the nature correlations between QRS duration and Gensini score as well as between QRS duration and LVEF. The findings obtained from data analyses are presented below:

Distributions of demographic and clinical characteristics are illustrated in Table I. None of the demographic characteristics like age, sex and BMI was significantly different between patients with prolonged and normal QRS durations. Risk factors like hypertension, smoking habit, diabetes and family history of CAD were almost identically distributed between the two groups (p = 0.565, p = 0.338, p = 0.660 and p = 0.259). The serum TC and

**Table-I**  
*Baseline characteristics between prolonged and normal QRS durations.*

Baseline characteristics	Group I (Prolonged QRS) msec (n = 56)	Group II (normal QRS) msec (n = 44)	p value
Age*(years)	50.9 $\pm$ 8.7	49.1 $\pm$ 5.9	0.244
Sex# (male)	44(78.6)	31(70.5)	0.352
BMI*(kg/m <sup>2</sup> )	25.2 $\pm$ 2.7	25 $\pm$ 3.7	0.734
Hypertension#	35(62.5)	25(56.8)	0.565
Smoking habit#	27(48.2)	17(38.6)	0.338
Diabetes Mellitus #	23(41.1)	20(45.5)	0.660
Family history of CAD#	10(17.9)	12(27.3)	0.259
Fasting blood sugar* (mmol/L)	7.2 $\pm$ 1.8	7.1 $\pm$ 1.2	0.756
Serum TC* (mg/dL)	202.2 $\pm$ 22	192 $\pm$ 20.7	0.021
Serum LDL* (mg/dL)	138 $\pm$ 15.9	125 $\pm$ 23.6	0.003
Serum HDL* (mg/dL)	36.8	38.6 $\pm$ 4.8	0.082
Serum TG* (mg/dL)	204.7 $\pm$ 43	198.6 $\pm$ 25	0.377
Serum creatinine* (mg/dL)	1.13 $\pm$ .29	1.09 $\pm$ .20	0.503
Serum Troponin-I* ((nmol/L)	18.5 $\pm$ 12.8	8.2 $\pm$ 1.7	<0.001

#Data were analyzed using  $\chi^2$  Test; figures in the parentheses denote corresponding %. \*Data were analyzed using Unpaired t-Test and were presented as mean  $\pm$  SD.

LDL cholesterol were significantly higher, while HDL cholesterol was considerably lower in patients with prolonged QRS duration ( $p = 0.021$  and  $p = 0.003$  and  $p = 0.082$  respectively). The serum Troponin-I was staggeringly higher in the prolonged QRS group than that in the normal QRS group ( $p < 0.001$ ).

Analysis of association between QRS complex duration and severity CAD revealed that over three-quarters (76.8%) of the severe CAD cases had prolonged QRS complex ( $>100$  msec) compared to 29.5% of the mild CAD cases. The acute anterior MI patients with prolonged QRS duration were nearly 8 (95% of CI = 3.2– 19.3) times more prone to have severe CAD than those with normal QRS duration ( $\leq 100$  msec) ( $p < 0.001$ ) (Table II).

Triple-vessel disease was staggeringly higher in patients with prolonged QRS duration (83.3%) than that with normal QRS duration (16.7%). However, the association between QRS duration and number vessels affected was not statistically significant ( $p = 0.370$ ) (Table III).

Analysis of association between QRS duration and LVEF shows that 62% of the patients with reduced LVEF ( $< 50\%$ ) had prolonged QRS duration as compared 33.3% of the patients with preserved LVEF ( $\geq 50\%$ ). The individuals with prolonged QRS duration was 3.2(95% of CI = 1.2 – 9.0) times more likely to have reduced LVEF than those with normal QRS duration ( $p = 0.019$ ) (Table IX).

Correlation between QRS duration and Gensini score shows that the two variables exhibit a linear

**Table-II***Association between QRS complex duration and severity of CAD.*

QRS duration (msec)#	Gensini score		Odds Ratio (95% CI of OR)	<i>p value</i>
	$\geq 36$ (n = 56)	$< 36$ (n = 44)		
$> 100$	43(76.8)	13(29.5)	7.9 (3.2 -19.3)	$< 0.001$
$\leq 100$	13(23.2)	31(70.5)		

Figures in the parentheses indicate corresponding %; #Chi-squared Test )was done to analyze the data

**Table-III***Association between QRS duration and number of vessels affected.*

QRS duration# (msec)	Number of vessels affected			<i>p-value</i>
	SVD (n=14)	DVD (n=80)	TVD (n=6)	
$>100$	8 (57.1)	43 (53.8)	5 (83.3)	0.370
$\leq 100$	6 (42.9)	37 (46.2)	1 (16.7)	

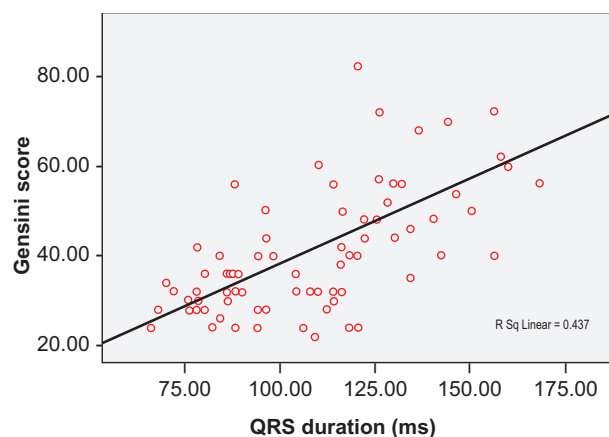
Figures in the parentheses denote corresponding percentage. # Data were analyzed using Chi-square ( $\chi^2$ ) Test.

**Table-IV***Association between QRS duration and LVEF.*

QRS duration(msec)	LVEF (%)		Odds Ratio (95% CI of OR)	<i>p value</i>
	$< 50$ (n=79)	$\geq 50$ (n = 21)		
$> 100$	49 (62.0)	7 (33.3)	3.2 (1.2-9.0)	0.019
$\leq 100$	30 (38.0)	14 (66.7)		

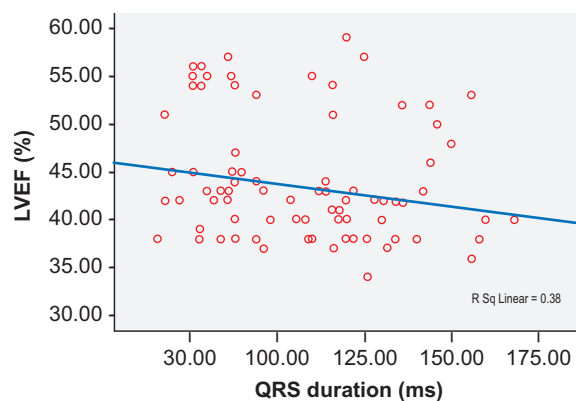
Figures in the parentheses indicate corresponding %; # Chi-squared Test was done to analyze the data.

relationship suggesting that Gensini score increases with the increase of QRS duration ( $r = 0.692$ ,  $p < 0.001$ ) (Fig. 1).



**Fig.-1:** Spearman correlation between QRS duration and Gensini score.

Correlation between QRS duration and LVEF is depicted in Fig. 2. The two variables bear an inverse relationship indicating that LVEF decreases with the increase of QRS duration ( $r = -0.250$ ,  $p = 0.012$ ) (Fig. 2).



**Fig.-2:** Spearman correlation between QRS duration and LVEF.

### Discussion:

Cardiovascular diseases are leading causes of mortality and morbidity in industrialized countries, and they are also emerging as prominent public health problem in developing countries like Bangladesh. Control of cardiovascular diseases is, therefore of utmost importance to improve life expectancy and quality of life.

In the present study, the ECG, a critical component of the early assessment and risk stratification of

patients presenting with acute anterior infarction, contains valuable prognostic information. Acute anterior MI patients with prolonged QRS duration ( $> 100$  msec) in more than three-quarters of the cases have had severe CAD compared to that in 30% of the mild CAD cases. The acute anterior MI patients with prolonged QRS duration were almost eight times more likely to have severe CAD than those with normal QRS duration ( $\leq 100$  msec).

The baseline characteristics and risk factors were almost identically distributed between prolonged QRS duration group and normal QRS duration group. The mean ages of patients in Prolonged QRS duration and normal QRS duration groups were  $50.9 \pm 8.7$  and  $49.1 \pm 4.7$  years respectively. Ahmed et al. showed mean age of ACS patients to be  $51.2 \pm 8.8$  years which is similar to this study. Another study in Bangladesh found mean age of IHD patients to be  $50.15 \pm 8.8$  years which is also similar to this study.<sup>2</sup>

In this study, male patients were 78.6% and 70.5% in Prolonged QRS duration group and normal QRS duration group respectively and the difference between the two groups was not significant. The study conducted by Zahid et al. found that 66.7% were male and male female ratio was 2:1<sup>13</sup>. Ahmed et al. showed that majority (78.5%) of ACS patients was male.<sup>14</sup> In the study by Bastawesy et al., male patients in prolonged and normal QRS groups were 83.8% and 80.3% respectively.

None of the risk factors like diabetes mellitus, hypertension, family history of CAD and obesity were different significantly between patients with prolonged QRS duration group and normal QRS durations. Khaleque and colleagues also demonstrated hypertension, diabetes mellitus, family history of CAD, BMI to be almost identically distributed between two groups ( $p > 0.05$ ). Studies done by Rahman et al. also reported similar data.<sup>15</sup>

In our study over 60% of the patients with reduced LVEF ( $< 50\%$ ) had prolonged QRS duration group ( $\geq 100$  msec) as compared 33.7% of the patients with preserved EF. The QRS duration and LVEF bear a negative relationship indicating that LVEF decreases with the increase in QRS duration with 29.7% decrease in LVEF could be explained by increase QRS duration. Another study showed that patients with prolongation of QRS duration had increased ventricular volumes, decreased left

ventricular EF, and higher incidence of sudden cardiac death.<sup>9</sup>

Despite the central role of the ECG in patient evaluation, large studies have provided only limited qualitative information about ECG variables, most critical to the assessment of prognosis. The present study attempted to evaluate the role of QRS duration in the assessment of severity of CAD in patients with acute anterior MI. In this study, QRS duration prolongation on admission was associated with angiographically severe CAD in patients with acute anterior MI.

The QRS duration in ECG is established to be an important prognostic marker as shown in patients with heart failure and myocardial infarction<sup>16-19</sup> In previous studies, interventricular conduction delay due to myocardial ischemia was directly reflected as prolongation in QRS duration.<sup>20,21</sup> In addition, Kosuge et al. showed an association between high QRS score on admission and impaired myocardial reperfusion.<sup>22</sup>

Prolong QRS duration is also a sign of poor coronary collateral circulation.<sup>23,24</sup> In addition, the QRS duration was related to increased 30-day mortality after myocardial infarction.<sup>25</sup> A similar association was indicated in the GUSTO-1 patients with normal QRS duration ( $d > 100$  msec) after myocardial infarction.

Different from the previous studies, we searched the relation of QRS duration and severity of CAD in patients with anterior wall AMI thus giving this study a unique status. The present study showed an association between QRS duration prolongation and severe CAD, which is consistent with the previous study done among patients with non-ST elevation AMI.<sup>26</sup>

### Conclusion:

The study concluded that, three fourth patients of acute anterior MI with prolonged QRS duration possess severe CAD. The acute STEMI patients with prolonged QRS duration are almost eight fold more likely to have severe CAD than those with normal QRS duration. So this ECG criteria can be used as a easily available prognostic criteria in patients with acute anterior MI. Further large-scale, multicenter study is recommended to validate the findings of the present study.

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### Conflict of Interest - None.

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