*Original Article*

# Magnitude of ST-Segment Elevation in Acute Inferior Myocardial Infarction and the Proximity of Right Coronary Artery Lesion

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**Abstract:**

**Background & objective: Involvement of the right coronary artery frequently occurs in acute inferior myocardial infarction. Typical ECG changes in this condition involve ST-segment elevation in inferior leads. The present study was intended to predict the site of the lesion in the right coronary artery (RCA) in patients with acute inferior wall myocardial infarction using the height of ST-segment elevation as the predictor variable.**

**Methods: The present cross-sectional study was carried out in the Department of Cardiology, National Institute Cardiovascular Diseases (NICVD), Dhaka, Bangladesh over a period of one year between July 2010 to June 2011. Patients with acute inferior myocardial infarction admitted to CCU of NICVD within 12 hours of the onset of chest pain and underwent coronary angiography within 4 weeks of acute myocardial infarction (AMI) were the study population. With the help of a 12-lead ECG, magnitudes of ST-segment elevation in leads II, III, and aVF were measured. The highest degree of stenosis along the RCA revealed by an angiogram was accepted as the culprit lesion. The right coronary artery was divided into proximal (from its ostium to the origin of the RV branch), mid (from the RV branch to the acute marginal branch), and distal (from the acute marginal branch onward) parts. The sum of ST-segment elevation was then computed and compared among the three groups of patients divided on the basis of the site of lesion in RCA.**

**Result: The findings of the study showed that nearly half (48%) of the patients had lesions in the proximal, 38% in the mid, and the rest (14%) in the distal part of the right coronary artery (RCA). While patients with proximal lesions had the highest mean sum of the ST-segment elevation (12.1 ± 0.6 mm), those with distal lesions had the lowest mean sum of the ST-segment elevation (6.1 ± 0.2 mm). The three groups were significantly heterogeneous ($p < 0.001$). The magnitude of ST-segment elevation in Lead II, III, and aVF and the sum of ST-segment elevation all were significantly higher in patients with proximal lesions than those in patients with mid and distal lesions ($p < 0.001$).**

**Conclusion: The magnitude of ST-segment elevation can predict the site of lesion in RCA in inferior wall myocardial infarction. The greater the height of ST-segment elevation, the higher the probability of lying the lesion in the proximal part of the RCA.**

***Key-words:*** *Acute inferior myocardial infarction, right coronary artery (RCA), ST-Segment elevation, etc.*

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**Introduction:**

Acute myocardial infarction (AMI) is a major component of acute coronary syndrome which usually results from anterior and inferior myocardial wall involvement.[1] Unlike anterior wall acute myocardial infarction, which is a fairly homogenous entity, the extent of acute inferior wall MI depends on the infarct-related artery and its site.[2] Nearly half of the patients with acute inferior wall MI have specific haemodynamic and brady-arrhythmic complications, usually due to the total occlusion of the proximal right coronary artery (RCA), which significantly alters an otherwise favourable prognosis.[1,3] Such patients, including those in whom electrocardiogram (ECG) evidence of right ventricular infarction (RVI) increase the risk for death, shock, and arrhythmia.[4,5]

The incidence of mortality and complications is high in patients with acute inferior wall MI with right ventricular involvement.[6] The incidence of right ventricular infarction in an acute inferior MI setting is about 30%.[5] The mortality of patients with only inferior wall acute myocardial infarction is 5-6%, which increases to 25-30% if the right ventricle is also involved. The patients with RVI had a higher hospitalization rate and a higher incidence of major hospital complications than those without RVI (31 vs. 6%, $p < 0.001$; 64 vs. 28%, $p < 0.001$).[7] Acute inferior myocardial infarction (AIMI) is sometimes complicated by hypotension and arrhythmia. In the majority (80%) of patients with acute inferior wall myocardial infarction, the infarct-related artery is the RCA, while it is the left circumflex artery (LCx) in the rest.[1] In the presence of complications, RCA is generally the infarct-related artery. Therefore, immediate diagnosis of the infarct-related artery and its site of the lesion has implications in predicting prognosis and deciding management. Predicting the probable site of occlusion within RCA is of utmost importance, for proximal occlusions are likely to cause greater myocardial damage and an early invasive strategy may be planned in such cases.

Early and almost accurate identification of infarct-related coronary arteries in acute MI can guide the decision-making process not only regarding the urgency of revascularization but also to avoid therapy that may adversely affect the outcome. But the conclusive diagnosis of the culprit artery with lesion site and size is feasible only with an angiogram, which is a time-consuming and invasive procedure. It has been observed in several studies that the height of ST-segment elevation from bedside ECG can predict the site of lesion in major coronary arteries with a fair degree of accuracy. The present study was intended to predict the site of lesion in RCA in acute inferior myocardial infarction using the height of ST-segment elevation with the hypothesis in mind that the magnitude of ST-segment elevation in acute inferior myocardial infarction correlates with the proximity of the right coronary artery lesion.

**Materials and methods:**

This cross-sectional study was conducted in the Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh over a period of 12 months from July 2010 to June 2011. Patients with acute inferior myocardial infarction who got admitted to CCU within 12 hours of chest pain and underwent coronary angiogram (CAG) within 4 weeks of AMI were the study population. Of them, whose coronary angiogram showed culprit lesions in RCA were included in the study. However, patients with previous MI or a coronary angiogram (CAG) showing a non-dominant RCA or culprit lesion at the LCX, intraventricular conduction defects, ventricular ectopics, and paced rhythm, left ventricular hypertrophy, cardiomyopathy, valvular or congenital heart disease, acute pericarditis, and acute myocarditis were excluded from the study.

Ethical clearance was obtained from the Ethical Review Committee of NICVD. A total of 100 patients were included in the study. Initial evaluation of the patients was done by history, clinical examination, and relevant investigations. Demographic data (age, sex) were recorded. Risk factor profiles, such as hypertension, diabetes, dyslipidemia, family history of coronary artery disease, and smoking were noted. In all patients, a standard 12-lead ECG, right-sided precordial ECG ($V_3R$ through $V_6R$) was recorded at a paper speed of 25 mm/sec and an amplification of 10 mm/mV immediately after admission to the hospital. ST-segment elevation > 0.1 mV in two or more leads of II, III, and aVF was considered to be an indicator of acute inferior myocardial infarction. The isoelectric line was defined as the level of the preceding TP segment. The magnitude of ST-segment elevation in leads (II, III, and aVF) was measured 80 ms after the J point relative to the TP segment. The sum of the ST segment was then calculated. The right ventricular injury (RVI) was diagnosed by the presence of an ST-segment elevation e" 0.1 mV in lead $V_4R$. Coronary angiography was done within 28 days of MI. All standard views were taken. In selected cases, additional views were taken.

The CAG was analyzed by visual estimation. Seventy percent or more luminal stenosis was considered significant. The reporters of CAG had no prior knowledge of the ECG status of the patients. The lesion with the

highest degree of stenosis along RCA was accepted as the culprit lesion. The right coronary artery was divided into proximal, mid, and distal segments. The segment of RCA from its ostium to the origin of the RV branch was considered as proximal, from the RV branch to the acute marginal branch as mid, and from this point onward as the distal segment. Based on the site of lesions, patients were divided into three groups – Proximal (n = 48), Mid (n = 38), and Distal (n = 14) groups. The sum of ST-segment elevation was then computed and compared among the three groups of patients divided on the basis of the site of the lesion in RCA. Data were processed and analyzed using computer software SPSS (Statistical Package for Social Sciences). ECG findings were then correlated with angiographic findings. The test statistics used to analyze the data were ANOVA statistics and Chi-square ($\div^2$) Test. The level of significance is 0.05 and a p-value < 0.05 was considered significant.

**Results:**

The demographic characteristics were almost homogeneously distributed among the three groups. The mean duration of chest pain was almost similar among the three groups. The proportion of patients with shortness of breath, sweating, and nausea was significantly higher in the proximal group than those in the other two groups. The distributions of the risk factors like smoking habit, diabetes, and dyslipidemia were significantly higher in the proximal group (p = 0.017, p = 0.001, and p < 0.001 respectively). Hypertension and family history of IHD were also higher in the proximal group than those in the Mid and Distal groups, although the difference did not turn significant (p = 0.199 and p = 0.302 respectively). All the in-hospital complications were also observed to be significantly higher in the proximal group (p < 0.001, p = 0.012, p < 0.001, p = 0.005) (Table I).

Echocardiographic findings demonstrate that over 70% of the patients in the Proximal group had regional wall motion abnormality (RWMA) compared to 52.6% in the Mid group, and 7.1% in the Distal group (p < 0.001). The mean left ventricular ejection fraction (LVEF) of the Proximal group was significantly reduced compared to the other two groups (p = 0.060). More than half (52.1%) of the proximal lesions and 7.9% of the mid lesions in RCA had RVI. None of the distal lesions had RVI. RVI demonstrated a significant presence in the proximal group (p < 0.001) (Table II). The mean heights of ST-segment elevation in Lead II, Lead III, and aVF and the mean sum of ST-segment elevation showed a decreasing trend with the progress of lesion from the proximal to the distal site of RCA (p < 0.001, p < 0.001, p < 0.001 and p < 0.001 respectively) (Table III & Fig. 1).

**Table-I**

*Distribution of baseline characteristics among the three groups*

| Baseline characteristics | Site of RCA lesion | | | p-value |
|---|---|---|---|---|
| | Proximal(n = 48) | Mild(n = 38) | Distal(n = 14) | |
| Age (year)# | 52.5 ± 9.3 | 49.2 ± 9.2 | 50.2 ± 9.6 | 0.241 |
| Sex* | | | | |
| Male | 43(89.6) | 35(92.1) | 14(100.0) | 0.450 |
| Female | 5(10.4) | 3(7.9) | 00 | |
| Mode of presentation | | | | |
| Duration of chest pain*(hrs) | 6.9 ± 2.8 | 7.5 ± 2.6 | 7.1 ± 2.5 | 0.582 |
| Shortness of breath# | 33(68.5) | 16(42.1) | 5(35.7) | 0.016 |
| Sweating# | 34(70.8) | 13(34.2) | 4(28.6) | 0.001 |
| Nausea# | 28(58.3) | 7(18.4) | 4(28.6) | 0.001 |
| Vomiting# | 14(29.2) | 5(13.2) | 4(28.6) | 0.187 |
| Risk factors | | | | |
| Smoking habit | 34(70.8) | 23(60.5) | 4(28.6) | 0.017 |
| DM | 31(64.6) | 10(26.3) | 4(28.6) | 0.001 |
| HTN | 27(56.3) | 15(39.5) | 5(35.7) | 0.199 |
| Dyslipidaemia | 28(58.3) | 5(13.2) | 2(14.3) | <0.001 |
| Family H/O IHD | 11 (22.9) | 4(10.5) | 2(14.3) | 0.302 |
| In-hospital complications | | | | |
| Hypotension | 36(75.0) | 6(15.8) | 3(21.4) | < 0.001 |
| Cardiogenic shock | 13(27.1) | 3(7.9) | 0(0.0) | 0.012 |
| Acute LVF | 22(45.8) | 4(10.5) | 0(0.0) | < 0.001 |
| Arrhythmia | 19(39.6) | 4(10.5) | 2(14.3) | 0.005 |

#Data were analyzed using ANOVA statistics and are presented as mean± SD.

*Data were analyzed using $\div^2$ Test; Figures in the parentheses denote corresponding percentage.

Table-II
*Echocardiographic findings among the three groups*

| Echocardiogram | RCA Lesion | | | p-value |
|---|---|---|---|---|
| | Proximal(n = 48) | Mild(n = 38) | Distal(n = 14) | |
| RWMA* | | | | |
| Yes | 34(70.8) | 20(52.6) | 1(7.1) | < 0.001 |
| No | 14(29.2) | 18(47.4) | 13(92.9) | |
| LVEF (%)# | 48.5 ± 12.7 | 51.5 ± 10.7 | 56.7 ± 7.3 | 0.060 |
| RVI* | | | | |
| Present | 25(52.1) | 3(7.9) | 0(0.0) | <0.001 |
| Absent | 23(47.9) | 35(92.1) | 14(100.0) | |

#Data were analyzed using ANOVA statistics and are presented as mean± SD;
*Data were analyzed using the $\div^2$ Test; figures in the parentheses denote corresponding percentage.

**Table-III**
*Association of ST-segment elevation with the site of lesion in RCA*

| ST-segment elevation (mm)# | RCA Lesion | | | p-value |
|---|---|---|---|---|
| | Proximal(n = 48) | Mild(n = 38) | Distal(n = 14) | |
| Lead II | 3.4 ± 0.5 | 2.0 ± 0.5 | 1.5 ± 0.5 | <0.001 |
| Lead III | 4.7 ± 0.4 | 3.4 ± 0.5 | 2.6 ± 0.5 | <0.001 |
| aVF | 4.2 ± 0.8 | 2.6 ± 0.5 | 2.0 ± 0.3 | <0.001 |
| Sum of ST-segment elevation | 12.1 ± 0.6 | 8.0 ± 0.1 | 6.1 ± 0.2 | <0.001 |

#Data were analyzed using ANOVA statistics and are presented as mean ± SD;

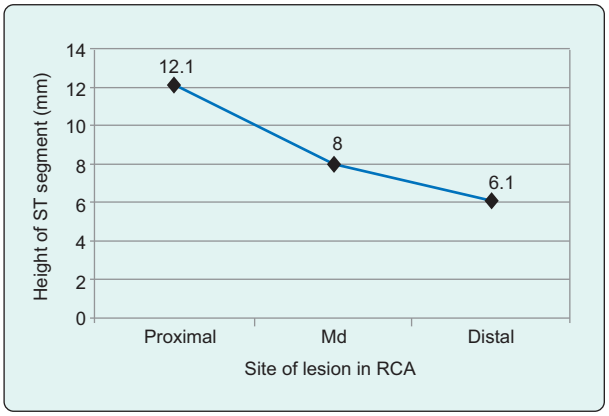


**Fig.-1:** *Relationship between the height of ST-elevation and the site of lesion in RC*

**Discussion:**

In the present study, the age and sex distribution were almost identical among the three groups. The mean duration of chest pain was also similar among the groups. The presence of smoking habit, diabetes, and dyslipidemia was higher in the proximal group than those in the mid and distal groups. Naqvi and associates[8] in a similar study reported that nearly half (48.4%) of the patients had the culprit lesion in the proximal, 38.5% in the mid, and 13.4% in the distal part of RCA bearing consistency with the findings of the present study. In our study, the magnitude of ST-segment elevation in leads II, III, and aVF and the sum of ST-segment elevation all were significantly greater in patients with proximal RCA lesions than that in the mid-lesion group, which, in turn, were again greater than that in the distal group ($p < 0.001$). These findings indicate that the greater the magnitude of ST-segment elevation, the higher the likelihood of proximity of lesion in RCA. Consistent with these findings, Naqvi et al[8] reported that total ST-elevation showed a decreasing trend as the lesion progressed from the proximal to the distal location in RCA.

Alim and colleagues[9] reported that patients with the culprit lesions in the proximal portion of the RCA had a mean ST-segment elevation of 12.6 ± 3.8 mm, while the patients having culprit lesions in the mid and distal portions had mean ST-segment elevations of 6.9 ± 1.2 mm and 5.1 ± 0.9 mm respectively which favour the findings of the present study. They also demonstrated a significant positive correlation between the magnitude of ST-segment elevation and the culprit lesion proximity ($r = 0.82$, $p < 0.01$ for the proximal and $r = 0.7$, $p < 0.05$ for the mid portions of RCA). In addition to the occlusion of RCA, the proximity of the culprit lesion along the course

of the artery is also important with regard to the potential complications (SA node dysfunction, RV infarction, etc.) in the setting of acute inferior-wall MI. Right ventricular myocardial infarction is associated with an increased risk of death, shock, ventricular tachycardia or fibrillation, and atrioventricular blocks.[10] The majority of the patients with proximal lesions in RCA exhibited higher rates of in-hospital complications like hypotension, cardiogenic shock, acute LVF, and arrhythmias compared to their mid and distal counterparts which are consistent with the findings of Manka.[10] The frequency of RVI associated with inferior wall MI was demonstrated to be 33% in Naquvi's study[8], which is quite similar to the findings of the present study (28%). Several investigators and [11] also reported similar incidences of RVI (28% and 27% respectively).[11,12]

Conclusion:

The findings of the study suggest that the magnitude of ST-segment elevation is indicative of the proximity of the lesion in RCA. The greater the height of ST elevation, the higher the probability that the lesion will lie in the proximal part of the artery.

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