

## Original Article

# In-hospital Outcome of Acute Anterior Myocardial Infarction with Right Ventricular Dysfunction

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## Abstract

### Key words:

IHD, Myocardial infarction, Electrocardiography, Echocardiography, Right ventricular dysfunction.

**Background:** In anterior ST-segment elevation myocardial infarction (STEMI), attention paid mainly to the left ventricle. The predictive significance of right ventricular (RV) dysfunction in patients with anterior STEMI has been frequently neglected. In this study, we evaluated the prognostic effect of RV dysfunction on in-hospital outcomes in patients with first anterior STEMI.

**Methods:** Present study is based on the analysis of 77 patients admitted to Coronary care unit of the Sir Salimullah Medical College & Mitford Hospital, Dhaka during April, 2019 to March, 2020, with acute anterior wall myocardial infarction. 12 lead ECG with thorough physical examination was done along with echocardiographic assessment of RV and LV function within index hospitalization, preferably within 24 hours of admission. Patients were divided into two groups depending on right ventricular function assessment. Group I included anterior MI with right ventricular dysfunction and group II included anterior MI without right ventricular dysfunction. In hospital outcomes were observed and compared between two groups.

**Results:** Patients with RV dysfunction had statistically significant higher incidence of cardiogenic shock (22.2 % vs. 2.4%,  $p < 0.05$ ), acute heart failure (69.4% vs. 24.4%,  $p < 0.05$ ), arrhythmia (11.1% vs. 0.0%,  $p < 0.05$ ), increase length of hospital stay in patients of RV dysfunction group. In-hospital mortality was non significantly higher in RV dysfunction group (8.3% vs. 2.4%,  $p > 0.305$ ).

**Conclusion:** In this study, we observed that in-hospital outcomes were worse in patients with anterior STEMI with RV dysfunction and demands more intense invasive management. Thus, special care should be given for the assessment function of right ventricle in anterior STEMI.

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## Introduction

Coronary heart disease (CHD) is the leading cause of morbidity and mortality throughout the world. The most common form of CHD is the myocardial infarction. It is responsible for over 15% of mortality each year.<sup>1</sup> Coronary artery disease (CAD) is an increasingly important medical and public health problem, and is the leading cause of mortality in Bangladesh.<sup>2</sup> The location of infarction (MI) is an important prognostic factor for risk stratification of patients with first myocardial

infarction (AMI). Anterior myocardial infarction is an important component of acute coronary syndrome. It usually causes left ventricular (LV) dysfunction. Prevalence of right ventricular dysfunction following anterior myocardial infarction is 10%.<sup>3</sup>

The prognostic value of right ventricular (RV) function has not been well evaluated in the past, but recently RV dysfunction was identified as an important prognostic factor for mortality, atrio-ventricular blocks, arrhythmias, cardiogenic shock

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and mechanical complications patients with AMI. However, it is unclear whether RV dysfunction after anterior AMI also portends poor prognosis or not. Some novel studies have drawn attention to the cardiogenic shock associated with RV dysfunction and have provided new information about the management and outcomes. RV dysfunction has been shown in up to 50% of patients with acute infero-posterior STEMI, and in up to 10% of patients with anterior STEMI. Mechanism of depression in RV functions in inferior wall infarction was found to be similar with the left ventricular (LV) function depression in anterior wall infarction. Nonetheless, to date, the prognostic value of RV dysfunction after AMI remains unclear especially in anterior STEMI. There is no study evaluating the outcomes of patients with isolated anterior STEMI with this regard. We aimed to examine the prognostic effect of RV dysfunction in predicting in-hospital mortality in patients present with first anterior STEMI in a cross-sectional analytical fashion.

Assessment of left ventricular function using 2D echocardiography shortly after acute MI is essential and one of the most important prognostic parameters. However, the association between right ventricular function and adverse events after acute MI is poor known, especially in patients with mild LV dysfunction. Because of therapeutic implications, there has been growing interest in early recognition of right ventricular dysfunction with non-invasive techniques. Zornoff et al. demonstrated that in patients with LV ejection fraction less than or equal to 40%, RV function was a significant independent predictor of death and development of heart failure after acute MI.<sup>4</sup> Therefore, the function of both ventricles after AMI should be considered. RV assessment with these imaging modalities will have an increased value. The sensitivity and specificity of echo may be as high as 82% and 93%, respectively, for detection of right ventricular function assessment.<sup>5</sup> Therefore, echocardiographic evaluation of RV function is very important for prognostic risk stratification of acute anterior wall MI.

### Methods:

This present study was designed as observational analytical study at Department of Cardiology, Sir Salimullah Medical College & Mitford Hospital,

Dhaka. This study was conducted from April, 2019 to March, 2020. Patients admitted into the Department of Cardiology with first attack of Acute Anterior Myocardial Infarction. A total number of 77 patients who fulfilled inclusion and exclusion criteria were selected for the study as the sample population. The samples were collected by purposive sampling method. Study population was divided into two groups on the basis of right ventricular function. In group I, 36 patients with right ventricular dysfunction and in group II, 41 patients without right ventricular dysfunction. Patients with acute Inferior MI or Non-ST-elevation myocardial infarction, old MI, left ventricular EF less than or equal to 35%, patients with valvular heart disease, congenital heart disease and cardiomyopathy. patients having major non cardiovascular disorder which causes elevation of Troponin-I such as severe end-stage liver and kidney diseases, prolonged immobilization, major surgery, chest trauma, myocarditis, pericarditis, acute pulmonary embolism, prolonged tachyarrhythmia, patients with previous cor-pulmonale or pulmonary HTN, renal failure, features of portal HTN, any respiratory infection 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 including pulse, blood pressure, jugular venous pressure, basal crepitation, auscultation for any cardiac murmur. 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 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. Transthoracic echocardiography was done preferably within 24 hours of admission by 2D & M-mode and Doppler echocardiography modalities by VIVID E 95 series echo machine. Echocardiography was performed to look for left ventricular ejection fraction, any mechanical complications. Variables specially included left ventricular internal diameter in diastole (LVIDD),

left ventricular internal diameter in systole (LVIDs), regional wall motion abnormality (RWMA), left ventricular ejection fraction (LVEF) by modified Simpson's method. Right ventricular study includes Tricuspid Annular Planner Systolic Excursion (TAPSE) in mm, S<sup>1</sup> in cm/sec, Fractional Area Change (FAC) in %, Myocardial Performance Index (MPI), Right ventricular size in mm. TAPSE < 16 mm, S' < 10 cm/sec, FAC < 35% and MPI >0.40.<sup>6</sup> Presence of any of these parameters regarded as right ventricular dysfunction.

The data obtained from the study were analyzed and significance of differences were estimated by using statistical methods. Continuous variables were expressed as mean values  $\pm$  standard deviation and compared using Student's t-test. Categorical variables were expressed as frequencies with corresponding percentages and compared using Chi-square test when & where appropriate. Relevant clinical variables or baseline variables were compared between the sub-groups. A p value of < 0.05 was considered statistically significant. Statistical analyses were carried out by using SPSS (Statistical Package for the Social Sciences by SPSS Inc., Chicago, IL, USA, 2015) Version 23. The study protocol was approved by ethical committee of Sir Salimullah Medical College, Dhaka.

### Results:

The main objective of the study was to assess influence right ventricular function on in-hospital outcome of acute anterior wall myocardial infarction by different echocardiographic modalities. Patients were assigned into two groups according to RV function. Thirty-six (36) patients were comprised of right ventricular dysfunction and forty-one (41) patients were comprised of without of right ventricular dysfunction.

Minimum age of the respondent was 35 years and maximum 78 years. Table I showed the age distribution was almost identical between patients with and without right ventricular dysfunction ( $56.5 \pm 10.12$  vs  $54.4 \pm 10.72$  years). Analysis provided statistically no significant ( $p > 0.05$ ) mean age difference between study groups.

**Table-I**

*Comparison of age between two groups (N=77).*

Age (in years)	Group I (n = 36) No. (%)	Group II (n = 41) No. (%)	p value
30-40	3(7.3%)	8(19.5%)	
41-50	9(24.4%)	8(19.5%)	
51-60	16(43.9%)	16(39.0%)	
61-70	7(19.5%)	9(22.0%)	
71-80	1(4.9%)	0(0.0%)	
Mean $\pm$ SD	$56.5 \pm 10.12$	$54.4 \pm 10.72$	0.359 <sup>ns</sup>
Range	(35-80) yrs.	(34-70) yrs.	

Male patients were predominant in both groups. No significance ( $p > 0.05$ ) was found between two groups in terms of sex distribution (Table II).

**Table-II**

*Distribution of sex between two groups (N = 77).*

Sex	Group I (n = 36) No. (%)	Group II (n=41) No. (%)	p value
Male	31(87.8%)	36(87.8%)	1.000 <sup>ns</sup>
Female	5(12.2%)	5(12.2%)	
Male: Female ratio	6.2:1	7.2:1	

Hypertension, diabetes, dyslipidemia and smoking were significant risk factors among the groups, prevalent more in group I patients (Table III). Among the group I, smoking (66.7%) was the most common risk factor followed by HTN (41.7%), DM (29.6%), dyslipidemia (30.6%) and family history of CAD (12.5%). Among the group II, HTN (58.5%) was the most common risk factor followed by smoking (51.2%), DM (31.7%), dyslipidemia (24.8%) and family history of CAD (7.3%). There was statistically not significant risk factor difference between two study groups.

**Table-III**

*Distribution of the study subjects by risk factors between two groups (N=77).*

Variables	Group I (n = 36) No. (%)	Group II (n = 41) No. (%)	p value
Smoking	24(66.7%)	21(51.2%)	0.178 <sup>ns</sup>
HTN	15(41.7%)	24(58.5%)	0.122 <sup>ns</sup>
DM	11(29.6%)	13(31.7%)	0.067 <sup>ns</sup>
Family history of CAD	6(12.5%)	3(7.3%)	0.105 <sup>ns</sup>
Dyslipidemia	11(30.6%)	10(24.8%)	0.090 <sup>ns</sup>

Regarding clinical findings, pulse rate is higher and systolic blood pressure is lower in group I than group II which are statistically significant ( $p < 0.05$ ). Mean difference of diastolic blood pressure between two groups is not statistically significant. Increased JVP and basal crepitation were found more prevalent in group I than group II ( $p < 0.05$ ). Murmur was absent in both groups.

Troponin values were higher in group I. Other laboratory parameters were not different between comparison groups (Table IV).

Regarding echocardiographic evaluation, LVEF which was obtained by modified Simpson's method was identical in both groups. TAPSE,  $S^1$ , FAC value

were lower significantly in group I where as MPI value was higher in group I. Pulmonary artery systolic pressure values were higher in group I (Table VIII). RV size was increased in group I people.

Table VI shows frequency of right ventricular dysfunction assessment parameter among group I people. TAPSE less than 16 were more prevalent among all parameters.

It was found that occurrence of significant arrhythmia, cardiogenic shock and acute heart failure were more prevalent in group I people. Occurrences of death was non significantly more in group I. Length of hospital was higher in group I people which was non-significant (Table VII).

**Table-IV**

*Comparison of laboratory findings between two groups (N = 77).*

Laboratory findings	Group I (n = 36) Mean $\pm$ SD	Group II (n=41) Mean $\pm$ SD	<i>p value</i>
Troponin(ng/ml)	15.46 $\pm$ 9.45	10.51 $\pm$ 4.11	<0.001 <sup>s</sup>
RBS (mmol/l)	7.23 $\pm$ 1.75	7.51 $\pm$ 1.58	0.453 <sup>ns</sup>
Creatinine(mg/dl)	1.17 $\pm$ 0.22	1.13 $\pm$ 0.19	0.429 <sup>ns</sup>
Na(mmol/l)	135.12 $\pm$ 1.97	136.35 $\pm$ 2.66	0.338 <sup>ns</sup>
K(mmol/l)	4.00 $\pm$ 0.30	4.00 $\pm$ 0.86	0.974 <sup>ns</sup>
Cl(mmol/l)	100.85 $\pm$ 1.17	101.00 $\pm$ 1.81	0.676 <sup>ns</sup>

**Table-V**

*Comparison of echocardiographic findings between two groups (N = 77).*

Echocardiographic findings	Group I (n = 36) Mean $\pm$ SD	Group II (n = 41) Mean $\pm$ SD	<i>p value</i>
LVIDd (mm)	51.80 $\pm$ 3.23	50.44 $\pm$ 2.61	0.038 <sup>s</sup>
LVIDs (mm)	39.68 $\pm$ 4.26	36.78 $\pm$ 4.51	0.004 <sup>s</sup>
LVEF (%)	43.47 $\pm$ 2.89	46.15 $\pm$ 4.96	0.080 <sup>ns</sup>
TAPSE (mm)	11.26 $\pm$ 1.24	17.66 $\pm$ 0.66	<0.001 <sup>s</sup>
$S^1$ (cm/sec)	8.36 $\pm$ 0.72	12.56 $\pm$ 1.03	<0.001 <sup>s</sup>
MPI	0.42 $\pm$ 0.01	0.38 $\pm$ 0.02	<0.001 <sup>s</sup>
FAC (%)	29.73 $\pm$ 2.18	39.66 $\pm$ 1.26	<0.001 <sup>s</sup>
PASP (mm of Hg)	31.07 $\pm$ 6.64	23.51 $\pm$ 6.47	<0.001 <sup>s</sup>

**Table-VI**

*Frequency of right ventricular dysfunction assessment parameter among group I people (n = 36)*

Name of tools	Frequency
TAPSE less than 16 mm	33
$S^1$ less than 10 cm/sec	24
FAC less than 35%	28
MPI above 0.40	20

**Table-VII**  
*Comparison of outcome variables between two groups (N = 77).*

Outcome variables	Group I (n = 36) No. (%)	Group II (n = 41) No. (%)	<i>p value</i>
Arrhythmia	4(11.1%)	0(0.0%)	0.0283 <sup>s</sup>
Cardiogenic shock	8(22.2%)	1(2.4%)	0.007 <sup>s</sup>
Acute heart failure	25(69.4%)	10(24.4%)	<0.001 <sup>s</sup>
Thrombo-embolism	0(0.0%)	0(0.0%)	-
Death	3(8.3%)	1(2.4%)	0.245 <sup>ns</sup>
Hospital stay (Days)	4.90 ± 0.83 (Mean±SD)	4.68± 0.69 (Mean±SD)	0.196 <sup>ns</sup>

### Discussion:

The current study was designed to evaluate the prognostic effect of RV dysfunction on clinical outcomes in patients with first anterior STEMI. On admission, along with compatible history, ECG was taken in every patient, acute anterior myocardial infarction was diagnosed, after initial resuscitation echocardiographic evaluation was done and patients were grouped I (n = 36) and group II (n = 41) according to presence or absence of right ventricular dysfunction.

There was no significant age difference between the two age groups. The mean age of group I was 56.5 ± 10.12 years and mean age of group II was 54.4 ± 10.72 years. The highest number of patients was in the age group (51 – 60) years. One of the studies in Bangladesh found that mean age was 50.15 ± 8.8 years of patients of IHD.<sup>7</sup> South Asian are unduly prone to develop CAD at a younger age. Statistically not significant mean sex difference was found between patients of both study group (p>0.05). The result was consistent with the other studies of Bangladesh.<sup>8</sup>

Among the group I patients, smoking was the most common risk factor where as in group II patients, HTN was the most common risk factor. There was statistically not significant risk factor difference between two study groups. The data are almost similar to the study done in Bangladesh.<sup>8</sup>

Comparison between echocardiographic variables reveals that mean difference of echocardiographic parameter. Mean difference of ejection fraction (EF) is 43.47 ± 5.23 vs. 46.15 ± 4.96 % in between group I and group II which was statistically non-significant. Mean difference of TAPSE between

group I and group II are 11.26 ± 1.24 vs 17.66 ± 0.66 mm. Mean difference of S' is 8.36 ± 0.72 vs 12.56 ± 1.03 cm/sec in between group I and group II. Mean difference of Myocardial performance index (MPI) is 0.42 ± 0.01 vs 0.38 ± 0.02 in between two groups. Mean difference of Fractional area change (FAC) is 29.73 ± 2.18 vs 39.66 ± 1.26% in between group I and group II. Mean difference of pulmonary artery systolic pressure (PASP) between group I and group II are 31.07 ± 6.64 vs 23.51 ± 6.47 mm of Hg. The above mentioned all differences are statistically significant (p<0.05). RV size is increased in all study people in group I. Similar results were found in the study done by Muhammed Keskin et al.<sup>9</sup>

In-hospital mortality was non significantly higher in the RV dysfunction group (8.3% vs. 2.4%, p>0.245). These patients also had a statistically significant higher incidence of cardiogenic shock, acute heart failure, occurrence of arrhythmia including RBBB, VT, increased length of hospital stay in patients of right ventricular dysfunction group. Similar outcome was observed in a study of Keskin, M.et al. That study showed incidence of cardiogenic shock was 26.7% in right ventricular dysfunction group and it was 1.6% in without right ventricular dysfunction group. Recurrent myocardial ischemia was also higher in right ventricular dysfunction group (11.1% vs. 1.3%, p<0.001).<sup>9</sup> Another study of Pereira, A.C et al. showed similar outcome of patients with right ventricular dysfunction group. It showed hemodynamic complications (heart failure and cardiogenic shock) were more in RV dysfunction group (71% vs. 38%; p = 0.0023) and electrical complications also were more in RV dysfunction group (58% vs. 30%, respectively; p = 0.0005).<sup>10</sup>

We observed that RV dysfunction remained an independent risk factor for in-hospital worse outcome in a definite patient population. The location, shape and unique contractile functions of right ventricle make the RV systolic assessment challenging. Because of these methodological limitations, few parameters like TAPSE, S', FAC & MPI have been commonly considered as an efficacious way to determine RV dysfunction. Several previous studies examined the association of RV dysfunction with AMI. Azevedo et al. showed the effectiveness of RV FAC measuring in assessment of RV dysfunction after anterior STEMI. Moreover, they revealed that FAC can predict RV failure 6-months after AMI, although they did not evaluate the clinical outcomes of these patients.<sup>11</sup> The VALIANT Echo study is another prospective multi-center study demonstrating that RV FAC is a useful way of predicting mortality in AMI. In a comprehensive analysis, Zornoff et al. revealed that RV dysfunction is an independent predictor of death in AMI; however, they included all types of AMI and did not exclude the patients who presented with previous AMI which could significantly affect RV functions and outcomes.<sup>4</sup> Unlike this study, we enrolled patient population with first anterior STEMI to better reveal the prognostic value of RV dysfunction in acute anterior wall MI.

In a cardiac magnetic resonance imaging (MRI) study, Bodi et al. reported that approximately 1/3 of the RV mass was at risk in anterior STEMI; however, 94% of the area at risk was restored, and the final infarct size was only 2% of the RV. The infarct size remained small owing to successful revascularization of LAD.<sup>12</sup> Bonanad et al. reported that in anterior STEMI, micro-vascular obstruction frequently occurs in the RV.<sup>13</sup> In addition, Abbate et al. revealed significant myocardial apoptosis of RV in patients with LV AMI.<sup>14</sup> Another MRI study, which is conducted by Jensen et al. showed that there was remarkable myocardial edema in the RV of patients with anterior STEMI. These studies demonstrate that RV dysfunction after anterior STEMI does not originate solely from RV infarction but may also arise from LV failure and ventricular interdependence.<sup>15</sup> The results of the current study confirmed this hypothesis. Although the co-existence of LV and RV failure might have caused

higher mortality, RV dysfunction has gained much attention after echocardiographic improvements in right-chambers' quantification. Some previous studies evaluated the prognostic effect of RV dysfunction via different modalities on different patient populations. In anterior STEMI, the focus has commonly been on LV functions and PPCI. Although the above-mentioned studies have drawn attention to the RV functions, there has been no comprehensive evaluation of the impact of RV dysfunction in anterior STEMI.

Although accumulated evidence suggests that FAC could be a reliable marker of RV dysfunction and could provide an important prognostic value, we observed that TAPSE and RV S2 velocity had a significant correlation with the FAC in these patients. Hence, TAPSE and RV S2 velocity may provide rapid and accurate measurements of RV systolic functions in these patients. Therefore, we propose that RV functions should be evaluated in patients with anterior STEMI as in inferior STEMI. Echocardiography is a reliable modality to examine the RV functions and may provide an additional prognostic value in patients presented with anterior STEMI.

#### **Limitations of the study**

Several limitations of this study should be noted before interpreting results of this study. First and the most important limitation of the current study was the complexity of RV geometry when assessing the RV. The method used to quantify RV function was not a true volumetric based method. Three-dimensional echocardiographic data are especially valuable for obtaining RV quantification. We included patients of acute anterior myocardial infarction who received thrombolysis as primary reperfusion strategy, effects of RV dysfunction on in-hospital prognosis could be more precisely defined if primary PCI would be primary reperfusion strategy.

#### **Conclusion:**

Evaluation of RV dysfunction after anterior STEMI is not so common as in LV dysfunction and in this study, we evaluated the effect of RV dysfunction on in-hospital outcomes in patients with first anterior STEMI. In this study, we observed that in-hospital outcomes were worse in patients with anterior STEMI with RV dysfunction and demands

more intense invasive measure. Thus, special care should be given for the assessment function of right ventricle in anterior STEMI.

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### Conflict of Interest - None.

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