

# Prediction of Reperfusion and Infarct-Related Artery Patency after Thrombolysis in Acute Anterior Myocardial Infarction by Degree of P Wave Dispersion on ECG

Md. Monir Hossain Khan<sup>1</sup>, Md. Afzalur Rahman<sup>2</sup>, Abdullah Al Shafi Majumder<sup>3</sup>, Md. Toufiqur Rahman<sup>4</sup>, Md. Monsurul Haque<sup>5</sup>, Khondker Shaheed Hussain<sup>6</sup>, Golam Rahman Mallic<sup>7</sup>, Mohammad Khalilur Rahman Siddiqui<sup>8</sup>, Md. Sariful Islam<sup>9</sup>, Md. Azijur Rahman<sup>10</sup>.

## Abstract

**Background:** The prognosis of patients with persistent occlusion of the infarct related artery (IRA), despite lytic therapy is poor. Early detection of successful reperfusion and IRA patency is of great importance in terms of prognosis and identification of candidates for rescue percutaneous coronary intervention (PCI). P wave dispersion (PWD), a new parameter measured before and after fibrinolytic therapy (FT) is supposed to predict successful reperfusion in patients with anterior acute myocardial infarction (AMI).

**Objectives:** To examine the prediction of successful reperfusion and infarct related artery (IRA) patency by measuring P wave dispersion in 12-lead surface ECG.

**Method:** 132 patients were selected and divided into two groups on the basis of ST segment resolution (STR) after 120 minutes of thrombolysis. Group I: patients with STR >70%; Group II: patients with STR < 70%. All patients underwent coronary angiography (CAG). IRA patency was considered if TIMI flow grade was >2.

**Results:** Mean age of the successfully thrombolysed group was 49.12±9.54 and mean age of failed

thrombolysis group was 52.08±8.23 years. Though higher age was associated with failed thrombolysis and it was statistically insignificant (p=0.06). Patients with higher BMI showed no significant difference in thrombolysis.

It was observed that diabetes mellitus and dyslipidemia were significantly higher in group II patients (p=0.04 and p=0.03, respectively). The mean level of PWD after 120 minutes of thrombolysis (PWD120) was statistically significant (p=0.001) between two groups. After multivariate regression analysis PWD120 was found to be the significant predictor of ST segment resolution as well as IRA patency (OR = 1.101; 95% CI = 1.012 – 1.240; p = 0.01).

**Conclusion:** P wave dispersion (PWD) in patients receiving thrombolytic therapy can be a predictor of successful reperfusion and patent infarct related artery (IRA). PWD values, in combination with other reperfusion parameters, can contribute to the identification of rescue PCI candidates.

*Key words:* Myocardial Infarction, Reperfusion, ECG, Streptokenase.

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(Bangladesh Heart Journal 2017; 32(2) : 100-105)

1. Registrar, Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
2. Director & Professor, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
3. Ex-Director & Professor, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
4. Professor, Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
5. Associate Professor, Dept. of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
6. Associate Professor, Dept. of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
7. Junior Consultant, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
8. Junior Consultant, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
9. Post-Graduate Fellow, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.
10. Junior Consultant, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh.

**Address of Correspondence:** Md. Monir Hossain Khan, Registrar, Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Dhaka, Bangladesh. Cell phone: +8801711225521; E-mail: drmmhkhan@gmail.com

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DOI: <http://dx.doi.org/10.3329/bhj.v32i2.36096>

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## Introduction

Achieving optimal coronary flow following thrombolysis in myocardial infarction (TIMI) reduces mortality, preserves left ventricular function and improves survival following acute myocardial infarction (AMI).<sup>1,2</sup> The prognosis of patients with persistent occlusion of the infarct related artery (IRA), despite lytic therapy is poor compared with that of patients with recanalized coronary arteries. Therefore, early detection of successful reperfusion and IRA patency in patients who received thrombolytic therapy is of great importance in terms of prognosis and identification of candidates for rescue percutaneous coronary intervention (PCI).<sup>3</sup>

For this purpose, some parameters such as: relief of chest pain, early peak of cardiac biomarkers, appearance of reperfusion arrhythmia and various electrocardiographic (ECG) changes are used as noninvasive tools, among which ST segment resolution at 90 minutes is one of the most important markers of successful reperfusion and prognosis.<sup>4</sup>

P wave dispersion (PWD), a parameter measured before and after fibrinolytic therapy (FT) is able to predict successful reperfusion in patients with acute anterior MI.<sup>5</sup> The P-max is the longest atrial conduction time and P-min is the shortest atrial conduction time measured in any of the 12 leads of the surface ECG.<sup>6</sup> PWD is calculated by subtracting the minimum P-min from the P-max.<sup>7</sup> A pathological P-wave duration is considered as  $\geq 120$  msec.<sup>8</sup>

PWD was found to be significantly increased during the anginal episodes irrespective of the presence of history of a previous myocardial infarction.<sup>9</sup> Furthermore, PWD showed higher values during the anginal episode in patients with left ventricular dysfunction independently of the presence of a previous myocardial infarction.<sup>10</sup> PWD at 120 minutes is significantly lower in patients with successful reperfusion and patent IRA.<sup>5</sup> P-max and PWD is higher in slow coronary flow patient.<sup>11</sup>

## Methods:

This was an observational study conducted in Department of Cardiology, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh from July 2013 to July 2014. After judging against inclusion and exclusion criteria 132 AMI (Anterior) patients were divided into two groups on the basis of ST Segment resolution (STR) after 120 minutes of thrombolysis. Group I: patients with STR >70%; Group II: patients with STR < 70%.

Streptokinase was used as a thrombolytic agent. 12 lead resting ECG was done at a paper speed of 25 mm/s and 10 mm standardization. All recordings were performed in the same quiet room during spontaneous breathing, following

20 minute of adjustment in the supine position. ST-segment deviation was measured with a handheld caliper and magnifying glass at 80 milliseconds after the J-point in all available leads. The TP-segment was considered the preferred iso-electric baseline and ST segment deviation was measured to the nearest 0.05 mV. ST segment resolution was calculated and expressed as a percentage with this formula: (baseline ST elevation-120 minute ST elevation)/baseline ST elevation.

ECGs were recorded before, 90 minutes and 120 minutes after onset of thrombolysis. The onset of the P wave was defined as the point of first visible upward slope from baseline for positive waveforms and as the point of first downward slope from baseline for negative waveforms. The return to the baseline was considered as the end of the P wave. Biphasic P waves were measured to the time of final return to baseline. If the onset or offset of the P wave were not clearly determined the lead was excluded from the analysis. P wave duration measurements were obtained manually by using calipers and magnifying lens for accurate definition of the ECG deflection. PWD of both groups was measured by subtracting P wave minimum from P wave maximum durations.

Transthoracic echocardiography was done for chambers size, wall motion abnormality, EF%, valvular and pericardial conditions. All patients underwent coronary angiography (CAG). Anterograde perfusion of the infarct-related artery was graded according to the classification system of the thrombolysis in myocardial infarction (TIMI) trial (grade 0 = no anterograde perfusion, grade 1 = minimal perfusion, grade 2 = partial perfusion and grade 3 = complete perfusion). IRA patency was considered if TIMI flow grade was 2 or 3.

The SPSS Statistical Software (17.0 version, SPSS Inc., Chicago, Illinois, USA) was used for data analysis. Continuous variables were expressed in mean & standard deviation and categorical variables as frequency and percentage. Student's t-test was used to compare normally distributed continuous variables and for the categorical variables the chi-square test was used. Multiple logistic regression analysis was performed to assess the PWD 120 minutes after onset of thrombolysis (PWD120) as a predictor of reperfusion and IRA patency. A p-value <0.05 was considered statistically significant.

## Results

Total 132 patients were studied. The mean age of the studied patients was 50.60 $\pm$ 8.23 years. The mean age of group I was less than group II, but the difference between two groups was not statistically significant (p=0.06). Male, female ratio was 4.3:1. Male was predominant but no significant difference (p=0.82) was found between the groups.

**Table-I**  
*Comparison of the study groups by their demographic characteristics (N = 132)*

Age in years	STR				Total (N = 132)		p-value
	Group I (n = 66)		Group II (n = 66)		Number	%	
	Number	%	Number	%			
< 40	14	21.21	11	16.67	25	18.94	<sup>a</sup> 0.11 <sup>NS</sup>
40 – 60	40	60.61	43	65.15	83	62.88	
> 60	12	18.18	12	18.18	24	18.18	
Mean ± SD	49.12±9.54		52.08±8.23		50.60±8.23		<sup>b</sup> 0.06 <sup>NS</sup>
Sex							
Male	53	80.30	54	81.82	107	81.06	<sup>a</sup> 0.82 <sup>NS</sup>
Female	13	19.70	12	18.18	25	18.94	

Group I= Patients with STR >70%

Group II = patients with STR < 70%

STR = ST segment resolution after 120 minutes of thrombolysis

NS= Not significant (p>0.05)

<sup>a</sup>p value reached from chi-squared test

<sup>b</sup>p value reached from unpaired t test

Total 132 patients were studied. The mean age of the studied patients was 50.60±8.23 years. The mean age of group I was less than group II, but the difference between two groups was not statistically significant (p=0.06). Male female ratio was 4.3:1. No significant difference (p=0.82) was found between the groups in terms of sex distribution

**Table II**  
*Comparison of the study groups by their risk factors (N = 132)*

BM(kg/m <sup>2</sup> )	STR				Total (N = 132)		p-value
	Group I (n = 66)		Group II (n = 66)		Number	%	
	Number	%	Number	%			
Normal	31	46.97	28	42.2	59	18.94	<sup>a</sup> 0.33 <sup>NS</sup>
Overweight	22	33.33	19	28.49	41	62.88	
Obese	13	19.70	19	28.79	32	18.18	
Mean ± SD	23.42±3.67	24.78±4.88	24.10±4.23				<sup>b</sup> 0.06 <sup>NS</sup>
Risk Factors							
Smoking	45	68.18	40	60.61	85	64.39	<sup>a</sup> 0.36 <sup>NS</sup>
Hypertension	30	45.45	35	53.03	65	49.24	<sup>a</sup> 0.28 <sup>NS</sup>
Diabetes	25	37.88	37	56.06	62	46.97	<sup>a</sup> 0.04 <sup>S</sup>
Dyslipidemia	23	34.85	35	53.03	58	43.94	<sup>a</sup> 0.03 <sup>S</sup>
Family history	10	15.15	14	21.21	24	18.18	<sup>a</sup> 0.36 <sup>NS</sup>

Group I= Patients with STR >70%

Group II = patients with STR < 70%

STR = ST segment resolution after 120 minutes of thrombolysis

BMI = Body Mass Index

NS= Not significant (p>0.05)

S= Significant (p<0.05)

<sup>a</sup>p value reached from chi-squared test

<sup>b</sup>p value reached from unpaired t test

BMI demonstrates very close values in both groups with no significant difference between groups (p=0.33). Smoking is higher in group I than in group II (p=0.36). It was observed that diabetes mellitus and dyslipidemia were significantly higher in Group II (p=0.04, p=0.03)

**Table-III**  
*Comparison of the study groups according to P wave dispersions (n=132)*

PWD (millisecond)	STR		P value
	Group I (n = 66)	Group II (n = 66)	
PWD0	48.97±10.72	51.59±8.34	0.45 <sup>NS</sup>
PWD90	44.24±9.12	46.98±7.44	0.19 <sup>NS</sup>
PWD120	40.86±7.25	47.91±6.14	0.001 <sup>S</sup>

Group I= Patients with STR >70%  
Group II = patients with STR < 70%  
PWD = P Wave Dispersion  
STR = ST segment resolution after 120 minutes of thrombolysis  
PWD0 = PWD at 0 minute (before the of onset of thrombolysis)  
PWD90 =PWD 90 minutes after onset of thrombolysis  
PWD120 =PWD 120 minutes after onset of thrombolysis  
NS= Not significant (p>0.05)  
S= Significant (p<0.05)  
p value reached from unpaired t test

Between the two groups, the differences of means of PWD0 and PWD90 were not statistically significant (p=0.45 and p=0.19, respectively). The difference of mean levels of PWD120 across the groups was statistically significant (p=0.001).

**Table-IV**  
*Comparison of the study groups according to infarct related artery (IRA) patency (n=132)*

BMI (kg/m <sup>2</sup> )	STR				Total (N = 132)		p-value
	Group I (n = 66)		Group II (n = 66)		Number	%	
	Number	%1	Number	%			
IRA patent	45	68.18	10	15.15	55	41.66	0.001 <sup>S</sup>
IRA occluded	21	31.82	56	84.85	77	58.44	

Group I= Patients with STR >70%  
Group II = patients with STR < 70%  
STR = ST segment resolution after 120 minutes of thrombolysis  
IRA = Infarct Related Artery  
S= Significant (p<0.05)  
p value reached from chi-square t test

It was observed that IRA patent patients were more in group I than group II (68.18% vs. 15.15%) which was statistically significant (p=0.001).

**Table V**  
*Multivariate logistic regression of determinants of ST-segment resolution*

Variables of interest	β	S.E.	P value	OR	95% CI
Smoking	0.253	0.441	0.56 <sup>NS</sup>	1.288	0.543 – 3.055
Hypertension	0.701	0.501	0.10 <sup>NS</sup>	1.066	0.519 – 2.503
Diabetes mellitus	0.367	0.506	0.46 <sup>NS</sup>	1.444	0.535 – 3.892
Dyslipidemia	0.203	0.249	0.66 <sup>NS</sup>	0.816	0.325-2.054
PWD120	0.912	0.654	0.01 <sup>S</sup>	1.101	1.012 – 1.240

Dependent variable: ST-segment resolution  
Independent variables; smoking, hypertension, diabetes mellitus, dyslipidemia and PWD120  
S = Significant                      β = b error                      OR = Odds ratio  
NS = Not significant              SE = Standard error              CI = Confidence interval

The binary logistic regression analysis of Odds Ratio for characteristics of the subjects likely to develop ST segment resolution, among different variables, PWD120 were found to be the significant predictors to develop ST segment resolution (95% CI: 1.000 – 1.260 ; p=0.03).

**Table-VI**  
*Multivariate logistic regression of determinants of infarct related artery patency*

Variables of interest	$\beta$	S.E.	P value	OR	95% CI
Smoking	0.253	0.441	0.56 <sup>NS</sup>	1.288	0.543 – 3.055
Hypertension	0.701	0.501	0.10 <sup>NS</sup>	1.066	0.519 – 2.503
Diabetes mellitus	0.367	0.506	0.46 <sup>NS</sup>	1.444	0.535 – 3.892
Dyslipidemia	0.203	0.249	0.66 <sup>NS</sup>	0.816	0.325-2.054
PWD120	0.912	0.654	0.01 <sup>S</sup>	1.101	1.012 – 1.240

Dependent variable: infarct related artery patency

Independent variables: smoking, hypertension, diabetes mellitus, dyslipidemia and PWD120

S = Significant

$\beta$  = b error

OR = Odds ratio

NS = Not significant

SE = Standard error

CI = Confidence interval

The binary logistic regression analysis of Odds Ratio for characteristics of the subjects likely to cause IRA patency, among different variables, PWD120 was found to be the significant predictor of IRA patency (95% CI: 1.012 – 1.240; p=0.01<sup>S</sup>).

### Discussion

In this study, the mean age of the successfully thrombolysed group was 49.12±9.54 and mean age of failed thrombolysis group was 52.08±8.23 years. Though higher age was associated with failed thrombolysis it was statistically insignificant (p=0.06). In a similar study conducted by Karabag et al. observed that the mean age was higher in failed thrombolysis group.<sup>5</sup> Successful thrombolysis had higher percentage of male though statistically not significant (p=0.82). Another study showed the similar higher percentage of male in successful thrombolysed group.<sup>6</sup> Patients with higher BMI demonstrated successful thrombolysis as was found in the similar study conducted by Mahmoud.<sup>6</sup> Among the studied patients, hypertension, diabetes mellitus, dyslipidemia and family history of IHD were higher in group II and smoking was higher in group I. It was also observed that diabetes mellitus and dyslipidemia were significantly higher in Group II (p=0.04, p=0.03). Another study conducted by Mahmoud 2012, similar results observed in Blood glucose level (78.1±4), (p= 0.28); LDL level(113±9.3), (p=0.08); and triglyceride level (162.8±23), (p=0.76) in failed reperfusion group which were similar to this study.<sup>6</sup>

The mean level of PWD120 was statistically significant (p=0.001). Similar observation was conducted by Karabag et al., 2012 showed that the mean PWD at 120 ms in both groups with AMI (Anterior) were statistically significant (p<0.001).<sup>5</sup> The study conducted by Dilaveris PE, et al., 2006 showed that PWD was significant between the groups of during spontaneous angina period and asymptomatic period, P < 0.001<sup>12</sup>. Another study by Mahmoud, K, 2012 to evaluate PD, PWD and QT dispersion (QTD) in patients with Coronary Slow Flow (CSF) and its relationship between

thrombolysed MI patients group and control group where CSF patients had significant PWD (P=0.001).<sup>6</sup>

The multivariate regression analysis of odds ratios for characteristics of the subjects likely to cause IRA patency was studied. Out of the 5 variables, PWD120 was found to be the significant predictor of ST segment resolution as well as IRA patency. Karabag et al. also showed that PWD120 could predict IRA patency and ST-segment resolution on ECG (OR: 0.907, CI: 0.856 to 0.960; p=0.001; OR: 0.942, CI: 0.896 to 0.991; p=0.02, respectively).<sup>5</sup>

### Conclusion

From this study, it may be concluded that low P wave dispersion (PWD) in patients receiving thrombolytic therapy can be a predictor of successful reperfusion and patent infarct related artery (IRA). PWD values, in combination with other reperfusion parameters, can contribute to the identification of rescue PCI candidates.

### Study Limitations:

This was an observational study on patients who presented to hospital with acute MI (anterior) and who refused the option of primary PCI. We use streptokinase for thrombolysis which was less superior to other thrombolytics like tenecteplase due to unavailability. Purposive sampling was done instead of random sampling method in my study. Although 90 minutes after thrombolytic therapy is standard time for rescue PCI in most centers, PWD was measured at 120 minutes in our study. Most of our hypertensive patients were on antihypertensive medications. We could not exclude patients who were using drugs that might affect atrial conduction and PWD like antihypertensive agent.



### Recommendations

Further prospective studies are needed to assess the temporality of the association between P wave dispersion (PWD) value and successful reperfusion and IRA patency by ECG following thrombolysis of acute MI (Anterior) patients. Similarly, in future randomized clinical trials using large number of patients may be used.

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