Failure of ST segment resolution post primary percutaneous coronary intervention, predictors and clinical significance

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ABSTRACT

Aim of the study: This study aimed to determine effect of failure of resolution of ST segment on in hospital mortality and after 30 days and to identify the variables that were associated to non-ST-resolution.

Patients and methods: The study included 60 patients with STEMI presented during 24 hours of symptoms and who were treated with PPCI. Analysis of ECG was done before and after the procedure to detect resolution of ST segment elevation, and predictors of resolution. Patients were followed to detect early in hospital and 30 days mortality.

Results: Failure of ST resolution occurred in 28% of the patients. Diabetes, anterior infarction, and chronic renal failure were predictors of non resolution of ST segment. Increased in hospital mortality was associated with non resolution of ST segment.

Conclusion: Incomplete resolution of ST-segment may occur in up to one-third of patients undergoing primary percutaneous coronary intervention, regardless of the restoration of TIMI 3 final epicardial flow. The predictor variables diabetes mellitus, chronic renal failure, heart rate, and ischemia time are associated with incomplete resolution of ST-segment elevation.

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INTRODUCTION

   The analysis of ST-segment resolution on the electrocardiogram (ECG) consists of a simple tool, of easy use and low cost, able to document success of the epicardial reperfusion and tissue reperfusion after primary PCI[4]. Previous studies have convincingly demonstrated that failure of ST-segment elevation resolution is an important predictor of increased risk of death and congestive heart failure in patients with acute ST--segment elevation myocardial infarction (STEMI) [4]. The current theory holds that ST-segment resolution or recovery after reperfusion therapy signifies effective microvascular perfusion [3]. myocardial tissue perfusion [4] and myocardial salvage

   The most solid evidence on the predictive value of ST-segment resolution has come from thrombolytic studies. Primary percutaneous coronary intervention (PPCI) studies have also suggested the existence of an association between ST-segment resolution and improved survival [3, 6]. There are, however, great differences between thrombolysis and PPCI in terms of degree of restoration of epicardial blood flow (60% with thrombolysis vs close to 95% with PPCI) and the speed of blood flow restoration.

    This study aimed to determine effect of failure of resolution of ST segment on in hospital mortality and after 30 days.and to identify the variables that were associated to non-ST-resolution.

 PATIENCE AND METHODS

   The study included a 60 patients with acute STEMI who presented within consecutive series of the first 24 h after symptom onset and who were treated with PPCI at national heart institute The diagnosis of STEMI required: chest pain lasting> 20 minutes and ST-segment elevation of >1 mm

at least two contiguous precordial leads or > 2mm in the extremity ECG leads. The diagnosis was confirmed with coronary angiography at the time of PPCI.

Patients with left branch block or pacemaker rhythm, surgical myocardial revascularization, cardiogenic shock, or life expectation < six months were excluded. The electrocardiographic analysis followed the prevalent normative guidelines,[6] considering complete a ST-segment resolution > 70%.

Ischemia time was defined as the interval between the onset of symptoms and the crossing of the lesion with a pre-dilation balloon, manual thrombus aspiration catheter, or stent. Door-to-balloon time was defined as the interval between hospital admission and the crossing of the lesion with a pre-dilation balloon catheter, manual thrombus aspiration catheter, or stent. A CK-MB analysis was performed every six hours until the occurrence of a reduction in the levels of this biomarker. The choice of antiplatelet therapy, use of prophylactic intracoronary adenosine, manual aspiration thrombectomy, and the access route were left to the discretion of the operator.

All patients gave informed consent for participation in the study.

ST-segment resolution

All included patients had technically adequate 12 leads ECG before and at 90.120 min after the first balloon inflation. The sum of ST-segment elevation was measured 20 ms after the end of the QRS complex in: leads I, aVL, and V1 through V6 for anterior infarction; leads II, III, aVF for inferior infarction and leads V5 to V6 for lateral infarction..

Statistical Analysis

Qualitative variables were summarized as absolute frequencies and percentages. The quantitative data were expressed as means ± standard deviation or medians and interquartile ranges (25th percentile -75th percentile) according to distribution for each variable. To compare the groups with and without resolution of the ST-segment, the chi-squared test or Fisher's exact test were used for qualitative variables, and Student's t-test or the Mann-Whitney test were used for quantitative variables.

To identify variables associated with ST-segment resolution, simple (univariate approach) and multiple (multivariate analysis) logistic regression models were adjusted. The results were expressed as odds ratios (OR) and 95% confidence intervals (95% CI). The level of significance was 0.05. The statistical program used to perform the calculations was the SPSS for Windows, version 19.0.

RESULTS

Comparisons among patients with and without ST-segment resolution

Table 1 shows a comparison among patients with and without ST-segment resolution regarding baseline clinical characteristics. It was observed that the group of patients without ST-segment resolution had, on average, anterior infarction, a higher heart rate and higher prevalence of diabetes mellitus and of chronic renal failure.

Table 1

Variables	General (n=60)	ST resolution (n=43)	Non ST resolution (n=17)	P value
Male (%)	33(55)	25(58.1)	8(47)	0.39
Age(years)	60.2+11.7	61.5+10.6	58.5+9.5	0.58
HR(heart rate) (bpm)	85.4+16.1	82+4.1	91.6+15+3	0.03
Hypertension	40(66.6)	31(72)	9(52.9)	0.67
DM (Diabetes mellitus)(%)	21(35)	11(25.5)	10(58.8)	0.02
Smoking (%)	25(41.6)	21(48.8)	4(23.5)	0.13
Prior Ml (Myocardial infarction) (%)	4(6.6)	3(6.9)	1(5.8)	0.12
Chronic renal failure (%)	8(13.3)	3(6.9)	5(29.4)	0.02
Anterior infarction	40(66.6)	26(60.4)	14(82.3)	0.02

With respect to the procedure and angiographic characteristics (Table 2), a statistically significant difference was observed only in the number of stents used. A trend of longer ischemia time among patients without ST-segment resolution (4.4 ± 2.1 hours vs. 6.6 + 2.9 hours; P = 0.07) was detected.

Table 2

Variables	General (n=60)	ST resolution (n=43)	Non ST resolution (n=17)	P value
Ischeinia time .	5.1+2.4	4.7+2	6.3+3.1	0.7
Manual aspiration (%)	33(55)	22(51.1)	11(46.7)	0.45
Direct stent implantation (%).	28(46.6)	22(51.1)	6(35.2)	0.38
TIMI pre 0 or 1(%)	48(80)	36(83.7)	12(70.5)	0.28
Severe LV dysfunction (%)	5(8)	2(55)	3(17.6)	>.99
LAD culprit artery (%)	29(48.3)	21(55)	8(47)	0.7

Regarding the results and the clinical outcome, a higher in-hospital mortality rate among patients who did not achieve ST-segment resolution was observed (Table 3).

Table 3

Variables	General (n=60)	ST resolution (n=43)	Non ST resolution (n=17)	P value
TIMI 3 post	50(83.3)	39(90.6)	11	0 . 1 2
Length of hospital stay (nights)	3(3-4)	3(3-4)	4(3-5)	0.53
Complication	6(10)	3(6.9)	3(17.6)	0.34
In hospital	4(6.6)	0(0)	4(23.5)	0.01
Mortality 30 days events	1(1.6)	1(2.3)	0(0)	>.99

Identification of variables associated with non-ST segment resolution

This part of the analysis sought to identify, among the clinical, angiographic and procedural characteristics, the factors associated with the increased probability of non-ST-segment resolution. Initially, the isolated effect of each variable were investigated by simple logistic regression models (univariate analysis), considering as dependent variable the non-ST-segment resolution.

Variables with P < 0.20 in the univariate analysis were selected for the multivariate model, in which the effects were analyzed simultaneously (table 4). In order to obtain a more consistent model, the non-significant variables were excluded, step-by-step, until the achievement of a reduced model. In this model, only diabetes (OR = 3.83, 95% CI, 1.17 to

12.51, P = 0.19), anterior infarction, and chronic renal failure (OR = 8.75, 95% CI, 1.50 to 50.90, P = 0.15) remained significant. Other variables were insignificant.

Table 4

	Univariate			Multivariate		
Factor	OR	95% CI	P	OR	95%CI	P
Heart rate x10	1.47	(1.03-2.10)	0.03	1.42	(0.93-2.18)	0.11
DM	3.83	(1.17-12.51)	0.03	2.55	(0.63-10.31)	0.19
Smoking	0.37	(0.10-1.31)	0.12	0.55	(0.12-2.46)	0.43
Chronic renal failure	8.75	(1.50-50.90)	0.02	4.41	(0.57-33.97)	0.15
Anterior infarction	8.70	(1.60-49.90)	0.02	3.45	(0,59-32.90)	0.16
Ischemia time (hours)	1.31	(1.03-1.68)	0.03	1.22	(0.90-1.65)	0.21

DISCUSSION

Incomplete ST-segment resolution after primary PCI correlates strongly with mortality and reinfarction, regardless of the degree of patency of the target vessel[5]. In a series from real-world practice, characterized by a mean age of 59 years, 31% diabetics, 11% with chronic renal failure, ischemia time of 5 hours, and median door-to-balloon time of 55 minutes, the rate of obtaining a final Thrombolysis in Myocardial Infarction (TIMI) flow 3 was 84%, with ST-segment resolution > 70% in 72% of the sample. Diabetes mellitus, chronic renal failure, anterior infarction, elevated heart rate, longer ischemic time, and fewer implanted stents were the characteristics most commonly observed in patients who did not achieve ST-segment resolution; the first three factors are important predictors of failure.

Previous studies of ST-segment resolution after PPCI have demonstrated an association between the degree of ST-segment resolution and clinical outcome [5]. A recent analysis of 4,866 patients in the Assessment of Pexelizumab in Acute Myocardial] Infarction (APEX-AMI trial) demonstrated that the degree of ST-segment resolution 30 min (median 32 min) after PPCI was closely associated with the rates of 90-day death or composite end point of 90-death, heart failure or shock [10]

Other trials failed to find correlation between resolution of ST segment and cardiac mortality. This controversy may be due to more ischemia time, and may be the different methods to analyze ST segment(11).

In pre-specified analysis of the randomized trial "Harmonizing Outcomes with Revascularization and Stents in Acute Myocardial Infarction" (HORIZONS-AMI), comprising 2,484 of 3,345 patients undergoing primary PCI, the rate of resolution of ST-segment > 70% was 50.5%, with a lower incidence of death, reinfarction, target vessel revascularization, and stent thrombosis at three years in this group{7}. In the same clinical trial, final TIMI flow 3 was achieved in 87.1% of the sample, and age, anterior wall AMI, TIMI pre0/l, and extent of injury were independent predictors of final TIMI flow < 3 by multivariate analysis{8}. In an Argentinean multicenter registry, despite obtaining a final TIMI flow 3 in 90% of the sample, the rate of complete ST- segment resolution was 48.5% [9].

The present series displays characteristics that differ from those previously mentioned, which could explain the high percentage of complete ST-segment resolution. Initially, the sample of patients undergoing the procedure was restricted to within 12 hours after onset of symptoms. The mean ischemia time was 5.1 hours and the median door-to-balloon time was only 55 minutes, favored by the logistical conditions set forth in a previos publication.[10] Moreover, manual aspiration thrombectomy was used in 54% of the sample, and glycoprotein IIb/IIIa inhibitors and adenosine were administered prophylactically to 59% and 36% of cases, respectively.

In fact, in the electrocardiographic sub-analysis of the trial Platelet Inhibition and Patient Outcomes (PLATO), [11] 70% of patients randomized in the interval of 3-6 hours from the onset of symptoms exhibited ST-segment resolution, compared to 51% of those randomized after 6 hours.

Glycoprotein IIb/IIIa inhibitors, despite lack of consistent evidence to justify their routine indication, find an application niche in patients classified as high risk. [14] Finally, in the "Intracoronary Nitroprusside Versus Adenosine in Acute Myocardial Infarction"(REOPEN-

AMI) randomized trial, 71% of patients who received intracoronary adenosine after thrombus aspiration exhibited ST-segment resolution > 70%, compared to 54% in the group receiving sodium nitroprusside and to 51% of the saline group (P = 0.009), limiting the reperfusion injury, as measured by the occurrence of angiographic microvascular obstruction (TIMI flow < 2 or 3 with TIMI myocardial blush < 2) [15].

Limitations of the study

Apart from the non-random sampling, the main limitation of this study resided in the small size of their sample, making it impossible to identify potential determinant variables for failure of complete ST-segment resolution after primary PCI.

CONCLUSIONS

Incomplete resolution of ST-segment may occur in up to one-third of patients undergoing primary percutaneous coronary intervention, regardless of the restoration of TIMI 3 final epicardial flow. The predictor variables diabetes mellitus, chronic renal failure, heart rate, and ischemia time are associated with incomplete resolution of ST-segment elevation, requiring new pharmacological or interventional strategies to minimize this condition.

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