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Factors Associated with Incomplete ST-Segment Resolution after Coronary Intervention in Patients with ST-Segment Elevation Myocardial Infarction in Erbil City, Iraq.

Mohammed Hasan Alwan[1], SalamNaser Zangana[2]

[1]M.B. Ch. B, F.I.C.M.S (med), FICMS (cardiol). Assistant Professor of internal medicine at Hawler Medical University-College of Medicine
[2]MBChB, DM, MD, FRCP (Glasg.), FRCP (Edin.). Assistant Professor of internal medicine at Hawler Medical University-College of Medicine. (Corresponding Author)
Email:dr_salam2003@yahoo.com.

Abstract

Background: The factors associated with incomplete ST-segment resolution (STR) after primary percutaneous coronary intervention (PPCI) in patients with acute ST-segment elevation myocardial infarction (STEMI) were still not clear.

Aim: The main aim of the current study was to identify the factors associated with incomplete STR after PPCI in a group of patients with acute STEMI in Erbil city, Iraq.

Patients and Methods: In this cross-sectional study, STR was performed 30 minutes after PPCI in 120 patients with acute STEMI. Patients were divided into two groups according to the degree of STR; group I, 86 patients with complete STR (≥ 50%), and group II, 34 patients with incomplete STR (< 50%). Both groups were evaluated and compared regarding baseline clinical and angiographiccharacteristics by univariate and multivariate analysis.

Results: Group II patients were more diabetic and hypercholesterolemic, witha high incidence of prior myocardial infarction. Besides, they had a high prevalence of Killip II and III classes, more anterior and lateral wall infarctions, higher heart rate, with high blood urea,creatinine, troponin,and CK-MB levels. Moreover, they had a lower left ventricular ejection fraction (LVEF). In addition, they had a higher incidence of the occluded left main and left anterior descending arteries,more number of occluded coronary arteries, a higher rate of pre-intervention TIMI flow grade 0,and a lesser rate of post-interventional TIMI flow grade 3.

Conclusion: Several factors were associatedwith incomplete STR .TIMI flow grade, number of diseased arteries, blood urea, and serum creatinine were associated with the highest probability of incomplete STR. Diabetes mellitus, previous MI, Killip class, heart rate, LVEF, culprit coronary artery, troponinand CK-MB levels were also significantly associated with incomplete STR.

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Keywords: ST-segment resolution, ST-segment myocardial infarction, primary percutaneous coronary intervention

Introduction:

Coronary artery disease (CAD) is a common disease in the world,and it is found in both developed and developing countries.[1]It has many types, but ST-segment elevation myocardial infarction (STEMI) was regarded as the most dangerous and lethal one.[2] Finding the necessary methods to treat those patients and to preserve their lives is a priority, andcoronary interventionis one of the most important and effective of these methods. Primary percutaneous coronary intervention (PPCI) is now considered a cornerstone in the management of STEMI, provided that there was a proper time and place to do it.[3]After performing PPCI, it is highly recommended to make sure that the procedure was successful. Although that can be assessed angiographically by using thrombolysis in myocardial infarction (TIMI) flow grade 3, TIMI perfusion grade (TMP grade), or corrected TIMI frame count, which indicates a patency of occluded epicardial artery[4], the perfusion at the level of myocyte cannot be assured .[5]There are many investigational tools to evaluate the prosperity of PPCI. While most of these investigations, such as coronary flow reserve and index of microcirculatory resistance, arecoast, time -consumingor impractical[6, 7], it became substantial to find another test that is simple, non-coasty and informative at the same time. ST-segment resolution (STR) was the proper one, because STR reflects the physiology of myocyte which was considered the last target of coronary blood flow, and hence, it represents a good marker for the assessment of reperfusion failure from the clinical view.[5,8] According to previous studies, rapid STR after PPCI was associated with better outcomes in patients with STEMI [9], instead, incomplete STR was an independent and poor prognostic factor in other studies.[10] Multiple risk factors were associated with incomplete STR.[5,8] Knowing these factors in the early stages will aid for recognizing risky patients more liable to get failure in microcirculation perfusion. In addition, those patients might need further violent treatment to restore their coronary microcirculation. Thus, the main aim of the current study was to identify the factors associated with incomplete ST-segment resolution after PPCI in a group of patients with ST-segment elevation myocardial infarction in Erbil city, Iraq.

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Patients and Methods:

One –hundred and twenty patients with acute STEMI were enrolled in this cross-sectional study. The study was performed between June 2020 and February 2021. The patients were admitted to the Emergency Unit of Hawler hospital for surgical specialties, in Kurdistan region- Iraq, and they were treated successfully with PPCI (successful PPCI means TIMI flow grade 3 with a proper stent deployment). Acute STEMI was diagnosed according to the Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction.[11]12-lead ECG was performed to all patientsbefore PPCIand 30 minutes afterrestoration of TIMI flow grade 3.When the sum of ST-segment elevation was reduced to ≥ 50% from the base value, it was called complete STR, and it was called incomplete STR when the percentage was < 50%.[12, 13]Accordingly, patients were divided into two groups: group I, included 86 patients with ≥ 50% ST-segment resolution (complete STR), and group II, included 34 patients with < 50% ST-segment resolution (incomplete STR).Coronary angiography was performed according to ACC/AHA Guidelines.[14] PPCI and periprocedural care was performed according to the standard criteria.[15] Patients were excluded if they had chest pain more than 12 hours, pacemaker, advanced heart failure, old LBBB or cardiogenic shock. Many cardiovascular risk factors such as hypercholesterolemia, type 2 diabetes mellitus, hypertension, previous myocardial infarctions, smoking, and family history of ischemic heart disease were compared between the two groups. In addition, baseline characteristics at the time of admission like age, gender, Killip class [16], infarct location [such as Anterior wall, Inferior wall, and others] , heart rate, hemoglobin level, left ventricular ejection fraction [LVEF], and pain-to-admission interval were also assessed and compared. Some important laboratory findings such as blood urea, serum creatinine, and serum troponin level were evaluated and compared.Angiographic characteristics like occluded coronary artery, number of affected coronary arteries, TIMI flow grade post PPCI were compared between complete and incomplete STR groups. The TIMI groups were defined as: TIMI 0, no reperfusion; TIMI 1, penetration without perfusion; TIMI 2, partial reperfusion; and TIMI 3, complete perfusion.[17]Transthoracic echocardiography was done to all patients to assess the left ventricular ejection fraction. Heart failure was defined as ejection fraction ≤ 40% according to the standards of the American Society of Echocardiography.[18]

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Ethical considerations:

The current study was authorized by the Ethics Committee of the College of Medicine-Hawler Medical University.

Statistical analysis

The statistical package for social sciences (SPSS, version 22) was used for data analysis. Continuous variables wereexpressed as mean ± standard deviation (SD), and were compared using the t-test. Categorical variables were analyzed using frequency of distribution, Chi square test of association was used to compare proportions, and a 95% C.I. reference range was calculated. Fisher's exact test was used when the expected count of more than 20% of the cells of the table was less than 5. Appropriate tables and graphs was used for data representation .P-value of ≤ 0.05 was considered statistically significant.

Results:

120 patients were treated successfully by PPCI due to acute STEMI were participated in this study. The patients were divided into two groups depending on the degree of ST-segment resolution (STR). 86(71.7%) patients with complete STR were present in group I, and34 (28.3 %) patients with incomplete STR were present in group II. In Table 1, which shows the baseline clinical characteristics between the two groups, group II patients hadmore diabetes (P=0.001), hypercholesterolemia (P=0.003), and a high rate of previous myocardial infarction (P=0.011). In addition, group II patients had a less Killip I class, but a high prevalence of Killip II and III classes (P=0.001). They had also a high percentage of anterior wall infarction (P=0.001), more heart rate (P=0.001), high blood urea (P=0.001), creatinine (P=0.001),troponin, and CK-MB levels (P=0.001). Moreover, LVEF after PPCI was significantly lower in group II patients (P=0.01).The pain-to-admission interval was closed to be statistically significant (P=0.06).The other clinical characteristics showed no statistical differences.

Table 1: Baselineclinical characteristics between the two study groups.

characteristics	**Group I Complete STR (n=86, %)**	**Group II Incomplete STR (n=34, %)**	**P**

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Gender: male	51 (59.3%)	20(58.8%)	
female	35 (40.7%)	14 (41.2%)	0.54
Age, years	59.3 ± 12.4	60.4 ± 10.2	0.62
Hypertension	52 (60.5%)	21(61.8%)	0.32
Diabetes mellitus	26 (30.2%)	17 (50%)	**0.02**
Hypercholesterolemia	43 (50%)	20(58.9%)	**0.04**
Family history of IHD	4(4.7%)	2 (5.8%)	0.45
Previous MI	10 (11.6%)	10(29.4%)	**0.01**
Current smoking	43 (50%)	18 (52.9%)	0.3
Killip class			
I(No HF)	30 (34.8%)	2(5.8%)	
II(basal rales)	48 (57.8%)	23 (67.6%)	**0.001**
III (acute, severe HF)	8 (9.3%)	9 (26.4%)	
Infarct location			
Anterior	53 (61.7%)	24(70.5%)	
Inferior	19 (22%)	7(20.5%)	**0.01**
Lateral	14 (16.3%)	3(9%)	
Heart rate, bpm	75.6±7.2	91.25±11.4	**0.001**
Hemoglobin level, g/dl	13.66±0.8	13.2±1.3	0.7
BU, mg/dl	37.4±3.1	51.4±16.6	**0.001**
S. creatinine, mg/dl	0.7±0.12	1.2±0.42	**0.001**
Troponin level, ng/ml	6.2±12	14.3±25	**<0.001**
CK-MB, U/l	28±72	60±91	**0.002**
LVEF (%) after PPCI	54±3	44±5	**0.01**
Pain-to-admission interval, h	8.5±2	10±3	0.06

Table 2 shows the angiographic characteristics among patients with complete STR and incomplete STR. Patients with group II had a higher incidence of left main and left anterior descending arteries' occlusion (P=0.001) , a lower incidence of occluded left circumflex artery (P=0.001) , a more number of occluded coronary arteries , 3 versus 1 (P=0.01) , a higher rate of pre-interventional TIMI flow grade 0 (P=<0.00), and a lesser rate of post-interventional TIMI flow grade 3 (P=<0.001).

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Table 2: Angiographic characteristics among patients with complete STR and incomplete STR after PPCI.

characteristics	Group I Complete STR (n=90, %)	Group II Incomplete STR (n=30, %)	P
Culprit coronary artery			
Left main(LM)	1 (1.2%)	2 (5.9%)	
Left anterior descending(LAD)	39(45.3%)	19 (55.9%)	**0.01**
Left circumflex (LCX)	21 (24.4%)	5(14.8%)	
Right coronary artery (RCA)	25 (30.1%)	10 (29.4%)	
Number of diseased arteries			
1	60(69.8%)	7(20.6%)	**<0.001**
2	26(30.2%)	10(29.4%)	
3	0(0%)	17(50%)	
TIMI flow grade (Pre-intervention)			
0	28 (32.6%)	22 (64.7%)	
1	58(67.4%)	12 (35.3%)	**<0.001**
2	0	0	
3	0	0	
TIMI flow grade (Post-intervention)			
0	0	0	
1	0	0	**<0.001**
2	17 (19.8%)	26 (76.5%)	
3	69 (80.2%)	8 (23.5%)	

In order to identify the factors that had the tendency to increase the probabilityof incomplete STR (dependent factors), a univariate analysis was performed as shown in Table 3. TIMI flow grade 0 before PPCI, TIMI flow grade 3 after PPCI, number of diseased arteries, BU, and S. creatinine were associated with the highest probability of incomplete STR. The other variables like diabetes mellitus, previous MI, Killip class, heart rate, LVEF, culprit coronary artery, troponin and CK-MB levels were also significantly associated with incomplete STR, as shown in Table 3.

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Table 3: Baseline clinical and angiographic variables associated with incomplete STR (univariate analysis)

variables	OR	95% CI	P
Diabetes mellitus	2.75	0.89 ─ 6.43	**0.02**
Hypercholesterolemia	1.88	0.68 ─ 5.73	0.3
Previous MI	3.71	1.57 ─ 13.11	**0.03**
Killip class	20	4.217 ─ 69.36	**0.01**
Infarct location	0.7	0.2 ─ 2.2	0.61
Heart rate	1.18	1.102 ─ 1.277	**0.04**
BU	12.16	1.78 ─ 112.51	**0.001**
S Cr	40.44	19.59 ─ 253.07	**0.001**
Troponin level	22.87	4.77 ─ 72.67	**0.01**
CK-MB	5.1	1.2─ 30.4	**0.02**
LVEF	0.42	0.28 ─ 0.94	**0.04**
Culprit coronary artery	8.317	3.474 ─ 19.91	**0.01**
Number of diseased coronary artery	21.591	6.28 ─ 74.18	**< 0.001**
TIMI flow grade:			
Pre-intervention	28.82	7.71 ─ 118.4	**< 0.001**
Post-intervention	30.76	9.236 ─ 122.46	

OR=odds ratio, IC 95%=confidence interval of 95%

The above-mentioned significant variables in Table 3 were chosen for the multivariate analysis, to find out which of them was independently associated with incomplete STR. None of the variables were significant, as shown in Table 4.

Table 4: Factors associated with incomplete STR (multivariate analysis)

factors	OR	95% CI	P

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Diabetes mellitus	0.349	0.027─4.525	0.42
Previous MI	0.142	0.007─2.806	0.2
Killip class	0.564	0.024─13.494	0.72
Heart rate	1.114	0.938─1.323	0.21
BU	1.016	0.88─1.172	0.83
S Cr	20	0.07─55.21	0.45
Troponin level	0.09	0.01─17.9	0.53
CK-MB	0.19	0.016─2.46	0.27
LVEF	2.71	0.54─13.4	0.22
Culprit coronary artery	1.21	0.91─2.21	0.8
Number of diseased coronary artery	18.5	0.17─55.2	0.4
TIMI flow grade: Pre-intervention Post-intervention	1.41	0.944─1.87	0.21

Discussion:

Incomplete STR after revascularization therapy is associated with high mortality and unfavorable outcomes.[10] To identify the factors that predict incomplete STR from the beginning will aid to distinguish high risk patients and to enhance the use of additional treatment that satisfy microvascular perfusion, decreasing cell damage and meliorate prognosis. The results of this study showed that there was no single factor had an independent effect on incomplete STR, but there were severaldependent factors. These influencing and harmful factors differed from one study to another.In Andrade et al study, the variables' heart rate, diabetes mellitus, and chronic renal failure were closely associated with non STR when they were investigated by univariate analysis, but they lost their importance and became non-significant in the multivariate analysis, which was consistent with this study.[19] Our patients with incomplete STR were more hypercholesterolemic, and had more exposure to previous MI. The same findings were seen in Park et al[8], Farkouh et al[10], andFabriset al[20]studies. Many previous studies correlated between cholesterol levels and coronary artery diseases.[21]In a large meta-analysis from many prospective studies proposed that cholesterol level was firmly associatedwith cardiovascular

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mortality.[22]MoreKillip II and III classes were noticed in our patients with incomplete STR, which was also observed in previous studies.[23]It had been mentioned that patients with a high Killip class are more likely to die early after acute myocardial infarction.[16]Anterior wall infarction was highly prevalent in patients with incomplete STR. This finding was observed in other studies.[23-25]Anterior wall MI was regarded as important independent prognostic factors for an incomplete STR, andas pivotal functional marker in microvascular flow defect to heart tissue after PPCI in Park et al study.[8]Patients with anterior wall infarction usually had a big infarction size, and accordingly they might have high levels of inflammatory markers as a severe inflammatory response. This might explain the elevated troponinand CK-MB levels in our patients with incomplete STR. The same finding was noticed in other studies.[8] What was seen in this study that patients with incomplete STR had lower LVEF than those with complete STR. Similar results were observed in Sanati et al[5], Park et al[8], Ndrepepa et al[25], and Domingoa et al[26] studies.In Sanati et al study, they mentioned a strong association between failed reperfusion (represented by failed STR) and ejection fraction according to their multivariate analysis. Another solid positive correlation between STR% and LVEF was revealed in Kiron and George study.[27]

The most powerful angiographic factors that associated with incomplete STR in our study were culprit coronary artery, number of diseased coronary artery, and TIMI flow grade. Similar findings were detected inFarkouh et al[10], Unikas and Budrys[23], Sejersten et al[28], and Corbalan et al[29] studies.

Conclusion:

No single factor had an independent effect on incomplete STR, but there were several dependent factors.TIMI flow grade, number of diseased arteries, blood urea, and serum creatinine were associated with the highest probability of incomplete STR. The other variables like diabetes mellitus, previous MI, Killip class, heart rate, LVEF, culprit coronary artery, troponin and CK-MB levels were also significantly associated with incomplete STR

Conflict of interest:

The authors have none to declare.

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