Corrected thrombolysis in myocardial infarction frame count and ejection fraction in patients undergoing primary percutaneous coronary intervention for myocardial infarction

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Original Article

Abstract

BACKGROUND: This study aimed to assess the associations between corrected thrombolysis in myocardial infarction frame count (CTFC) of the infarct-related artery (IRA) and ejection fraction (EF) after three-six months in patients who underwent primary percutaneous coronary intervention (PPCI) for ST segment elevation myocardial infarction (STEMI).

METHODS: CTFC was determined by a digital system for 78 patients. EF was measured through Simpson's method upon discharge and three-six months later. The subjects were divided into two groups of CTFC ≤ 20 (n = 54) and CTFC > 20 (n = 24). Association between CTFC and EF were then specified.

RESULTS: CTFC ≤ 20 and CTFC > 20 were present in 69.2% and 30.8% of the patients, respectively. There was no significant difference between the two groups regarding baseline characteristics. EF at the time of discharge was 42.1% ± 10.2% and 43.5% ± 11.4% in groups with CTFC ≤ 20 and > 20, respectively. There was no significant association between EF at discharge and CTFC (P = 0.611). After three months, EF changed to 49.6% ± 8.7% and 41.6 ± 12.4% in the groups with CTFC ≤ 20 and CTFC > 20, respectively. Three months after PPCI, EF and CTFC had a significant relation (P = 0.007). Cumulative number and percentage of shock and death were 3 (3.8%) and 2 (2.6%), respectively.

CONCLUSION: Lower CTFC of the infarct-related artery in patients undergoing PPCI for STEMI was associated with higher left ventricular ejection fraction after three months.

Keywords: Corrected Thrombolysis in Myocardial Infarction Frame Count, Ejection Fraction, Percutaneous Coronary Intervention, Myocardial Infarction

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Introduction

ST segment elevation myocardial infarction (STEMI) is a major health problem whose rate increases with increasing age in both sexes. Primary percutaneous coronary intervention (PPCI) is an urgent angiographic strategy following angioplasty with or without stenting. It is accepted as the preferred reperfusion strategy performed in many cases with STEMI.[1]

The thrombolysis in myocardial infarction (TIMI) flow grading system is a qualitative method for measuring reperfusion strategy. On the other hand, the corrected TIMI frame count (CTFC) is a quantitative method to assess the TIMI flow grading system. It is simply performed by counting the number of angiographic frames elapsed until the contrast material arrives in the distal bed of the vessel of interest. The mean CTFC of normal coronary arteries has been reported as 21.1 ± 1.5 for left anterior descending artery (LAD), 22.2 ± 4.4 for left circumflex artery (LCX), and 20.4 ± 3.3 for right coronary artery (RCA).[1,2] CTFC is an independent predictor of in-hospital mortality following STEMI.[3-6]

The objective of this study was to evaluate the associations between CTFC and ejection fraction (EF) soon after PPCI and three-six months later in patients with STEMI. As EF is a known predictor of early and late survival, the findings of the current study may enable cardiologists to better predict cardiovascular outcomes following PPCI in patients with STEMI.

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Materials and Methods

In 2009, this prospective study was conducted on patients who had received PPCI within 12 hours from the diagnosis of STEMI. Overall, 78 patients, including 66 (84.6%) men and 12 (15.4%) women, were included. STEMI was defined as typical chest pain and the presence of electrocardiographic criteria.[7] Patients who had undergone rescue percutaneous coronary intervention (PCI) or late PCI were not included.

A checklist about cardiovascular risk factors, physical examination on admission, door- to-balloon time, systolic blood pressure, location of myocardial infarction (MI), TIMI flow grade, CTFC, ST resolution, EF (upon discharge and after three-six months), and in-hospital adverse events was filled out for all patients. Door-to-balloon time was defined as the interval between arrival to the hospital and the use of a therapeutic device (thrombectomy catheter, balloon, and stent).

All patients received 325 mg of aspirin, 300-600 mg of clopidogrel, and 40 mg of atorvastatin. PPCI was performed in the presence of reduced TIMI flow grade (< 3), occluded infarct-related artery, and/or a culprit lesion stenosis of > 50%. The use of glycoprotein IIb/IIIa inhibitors, thrombectomy and bare-metal or drug-eluting stents was left to the decision of the interventionalist.

Angiography CDs of the patients were reviewed by two interventional cardiologists and TIMI frame count (TFC) was measured by a digital system in the catheterization laboratory. TFC is the number of cine-frames required for contrast to reach a standardized distal coronary landmark in the culprit vessel and was determined by a previously suggested method.[3,8] The first frame was selected when the column of the contrast extended across > 70% of the arterial lumen with antegrade flow.[9] The reported number was based on a cine filming rate of 30 frames per second. The last frame is a distal landmark to which the contrast enters. Distal landmark in the RCA is the first branch of the posterolateral extension of the RCA after the origin of the posterior descending artery. In the circumflex artery, it is the most distal branch of the obtuse marginal branch which included the culprit lesion. In the left anterior descending artery, it is a distal bifurcation which is usually placed at the apex of the heart. CTFC means that the TFC for LAD must be corrected by dividing it into 1.7 due to the longer length of the LAD.

Electrocardiograms were recorded on arrival and 60 minutes after the angioplasty. ST resolution was measured 60 minutes after PPCI at the corresponding lead with maximal ST elevation in pre-PCI echocardiography.

Patients were requested to come back to the hospital three-six months later for the second echocardiography. Patients' EF was measured with biplane Simpson's method upon discharge and after three-six months. Standard medical treatment comprised aspirin, clopidogrel, beta-blockers, atorvastatin, and enalapril/losartan for all patients.

Baseline characteristics were expressed as mean ± standard deviation (SD) or percentages. Continuous variables were compared by the Student's t-test. Categorical variables were contrasted by the chi-square test (or Fisher's exact test as needed). All analyses were performed with SPSS for Windows 16.0 (SPSS Inc., Chicago, IL, USA). P values less than 0.05 were considered significant.

Results

The patients were divided into two groups of CTFC ≤ 20 and CTFC > 20. Table 1 presents baseline characteristics of the studied population stratified by CTFC. There was not any significant difference between the two CTFC groups regarding baseline characteristics.

Table 2 compares the clinical characteristics of the patients. The mean door-to-balloon time in the groups with CTFC ≤ 20 and CTFC > 20 was 45.1 ± 16.8 and 44.6 ± 11.8 minutes, respectively (P = 0.879). The mean systolic blood pressure/mean diastolic blood pressure in the mentioned groups was 118.5 ± 20.2/72.3 ± 12.0 and 113.7 ± 22.4/69.6 ± 10.8 mmHg, respectively (P > 0.05). Less than 10% of the patients in every group had signs of heart failure at presentation. Moreover, there was no significant differences between the two CTFC groups regarding clinical characteristics.

The two CTFC groups were similar in the administration of aspirin, clopidogrel, heparin, glycoprotein IIb/IIIa inhibitors, and atorvastatin. According to angiography results, in the groups with CTFC ≤ 20 and CTFC > 20, 16.7% and 4.2% of patients had single vessel disease (SVD), 57.4% and 41.7% had two-vessel disease (2VD), and 25.9% and 54.2% had three-vessel disease (3VD), respectively. Number of narrowed coronary arteries in the two groups did not have a significant difference (P = 0.036). Furthermore, stenotic lesions in the LAD were detected in 87.0% and 37.5% of the groups with CTFC ≤ 20 and CTFC > 20, respectively. The corresponding rates of stenotic lesions in the LCX were 1.9% and 25.0%. Stenotic lesions in the RCA were also found in 11.1% of patients with CTFC ≤ 20 and 37.5% of patients with CTFC > 20 (P < 0.001 for all). The most infarcted arteries were LAD in patients with CTFC ≤ 20 and both LAD and RCA in patients with CTFC > 20. The two groups had a significant difference in pre-PCI TIMI flow grade (P = 0.006) (Table 3).

Table 1. Baseline characteristics of patients with ST segment elevation myocardial infarction stratified by post-primary percutaneous coronary intervention (PCI) corrected thrombolysis in myocardial infarction frame count (CTFC)

Variables	Total	Post-PCI CTFC		P
		≤ 20	> 20	
Number	78	54	24	-
Age (years; mean ± SD)	58.7 ± 9.2	58.2 ± 9.3	59.9 ± 9.1	0.451
Gender (female)	12 (15.4)	10 (18.5)	2 (8.3)	0.324
Obesity	19 (24.4)	15 (27.8)	4 (16.7)	0.395
Family history of coronary artery disease	10 (12.8)	7 (13)	3 (12.5)	1.000
Smoker	34 (43.6)	21 (38.9)	13 (54.2)	0.227
Hypertension	29 (37.2)	19 (35.2)	10 (41.7)	0.619
Hyperlipidemia	27 (34.6)	15 (27.8)	12 (50.0)	0.073
Diabetes mellitus	24 (30.8)	14 (25.9)	10 (41.7)	0.191
Chronic lung disease	0 (0.0)	0 (0.0)	0 (0.0)	-
Cerebrovascular disease	0 (0.0)	0 (0.0)	0 (0.0)	-
Peripheral vascular disease	0 (0.0)	0 (0.0)	0 (0.0)	-
Previous congestive heart failure	0 (0.0)	0 (0.0)	0 (0.0)	-
Previous myocardial infarction	4 (5.1)	2 (3.7)	2 (8.3)	0.583
Previous PCI	5 (6.4)	4 (7.4)	1 (4.2)	1.000
Previous coronary artery bypass grafting	0 (0.0)	0 (0.0)	0 (0.0)	-
Creatinine (mg/dL; mean ± SD)	1.2 ± 0.3	1.2 ± 0.3	1.2 ± 0.3	0.662

Values are presented as n (%) unless otherwise expressed

Table 2. Clinical and medicine-related characteristics of patients with ST segment elevation myocardial infarction stratified by post-primary percutaneous coronary intervention (PCI) corrected thrombolysis in myocardial infarction frame count (CTFC)

Variables	Total	Post-PCI CTFC		P
		≤ 20	> 20	
Door-to-balloon time (minutes; mean ± SD)	44.9 ± 15.4	45.1 ± 16.8	44.6 ± 11.8	0.879
Door-to-balloon time ≥ 60 minutes	5 (6.4)	3 (5.5)	2 (8.3)	-
Door-to-balloon time ≥ 90 minutes	0 (0.0)	0 (0.0)	0 (0.0)	-
Systolic blood pressure (mmHg; mean ± SD)	117.0 ± 20.9	118.5 ± 20.2	113.7 ± 22.4	0.377
Diastolic blood pressure (mmHg; mean ± SD)	71.5 ± 11.6	72.3 ± 12.0	69.6 ± 10.8	0.325
Signs of heart failure at presentation				
S3	4 (5.1)	2 (3.7)	2 (8.3)	0.583
No rales	69 (88.5)	48 (88.9)	21 (87.5)	
Rales up to 1/3	7 (9.0)	6 (11.1)	1 (4.2)	0.067
Rales more than 1/3	2 (2.6)	0 (0.0)	2 (8.3)	
Cardiac markers (mean ± SD)				
Troponin (ng/ml)	12.7 ± 9.4	13.8 ± 9.6	10.3 ± 8.7	0.118
Creatine phosphokinase (U/l)	3711 ± 3706	3603 ± 2859	3955 ± 5202	0.757
Creatine kinase MB (U/l)	370 ± 386	406 ± 440	288 ± 209	0.114
Drugs				
Aspirin	24 (100)	24 (100)	24 (100)	-
Clopidogrel	24 (100)	24 (100)	24 (100)	-
Unfractionated heparin	24 (100)	24 (100)	24 (100)	-
Glycoprotein IIb/IIIa inhibitors	63 (80.8)	44 (81.5)	19 (79.2)	1.000
Integrilin	60 (76.9)	42 (77.0)	18 (75.0)	0.928
Tirofiban	3 (3.8)	2 (3.7)	1 (4.2)	1.000
Statin	78 (100)	54 (100)	24 (100)	-

Values are presented as n (%) unless otherwise expressed SD: Standard deviation

Table 3. Incidence of events in patients with ST segment elevation myocardial infarction stratified by post-primary percutaneous coronary intervention (PCI) corrected thrombolysis in myocardial infarction frame count (CTFC)

Variables	Overall	Post-PCI CTFC		P
		≤ 20	> 20	
Number of narrowed coronary arteries				
1	10 (12.8)	9 (16.7)	1 (4.2)	0.036
2	41 (52.6)	31 (57.4)	10 (41.7)	
3	27 (34.6)	14 (25.9)	13 (54.2)	
Infarct-related artery				
Left main	0 (0.0)	0 (0.0)	0 (0.0)	< 0.001
Left anterior descending	56 (71.8)	47 (87.0)	9 (37.5)	
Left circumflex	7 (9.0)	1 (1.9)	6 (25.0)	
Right coronary artery	15 (19.2)	6 (11.1)	9 (37.5)	
Saphenous vein graft	0 (0.0)	0 (0.0)	0 (0.0)	
Pre-PCI TIMI flow grade of the infarct-related artery				
0	53 (67.9)	38 (70.4)	15 (62.5)	0.006
1	8 (10.3)	8 (14.8)	0 (0.0)	
2	14 (17.9)	5 (9.3)	9 (37.5)	
3	3 (3.8)	3 (5.6)	0 (0.0)	
Stent implantation				
No stents	2 (2.6)	0 (0.0)	2 (8.3)	0.067
One stent	66 (84.6)	48 (88.9)	18 (75.0)	
Two stents	9 (11.5)	6 (11.1)	3 (12.5)	
Three stents	1 (1.3)	0 (0.0)	1 (4.2)	
Drug eluting stent	29 (37.2)	26 (48.1)	3 (12.5)	< 0.001
Stent diameter (mm; mean ± SD)	2.9 ± 0.3	2.9 ± 0.3	2.8 ± 0.3	0.474
Stent length (mm; mean ± SD)	24.7 ± 5.3	25.7 ± 5.0	22.0 ± 5.3	0.007
Intra-aortic balloon pump	3 (3.8)	2 (1.9)	1 (8.3)	0.223
Thrombectomy	3 (3.8)	1 (1.9)	2 (8.3)	0.223
Stent thrombosis	1 (1.3)	1 (1.9)	0 (0.0)	1.000
Cardiogenic shock	3 (3.8)	3 (5.6)	0 (0.0)	0.549
No ST resolution	4 (5.1)	2 (3.7)	2 (8.3)	0.583
In-hospital events				
Major bleeding	0 (0.0)	0 (0.0)	0 (0.0)	-
Stroke/transient ischemic attack	0 (0.0)	0 (0.0)	0 (0.0)	-
Dialysis	2 (2.6)	0 (0.0)	2 (8.3)	> 0.05
Death	2 (2.6)	2 (3.7)	0 (0.0)	1.000

Values are presented as n (%) unless otherwise expressed
SD: Standard deviation

Table 4. Post-primary percutaneous coronary intervention (PCI) corrected thrombolysis in myocardial infarction frame count (CTFC) and ejection fraction (EF) before discharge and three months after discharge

Variables	Overall	Post-PCI CTFC		P
		≤ 20	> 20	
EF before discharge (%; mean ± SD)	42.5 ± 10.5	42.1 ± 10.2	43.5 ± 11.4	0.611
EF after three months (%; mean ± SD)	47.1 ± 10.6	49.6 ± 8.7	41.6 ± 12.4	0.007
EF ≥ 50% before discharge	29 (37.2)	18 (33.3)	11 (45.8)	0.319
EF ≥ 50% after three months	44 (57.9)	34 (65.4)	10 (41.7)	0.079
EF change (%; mean ± SD)	4.2 ± 8.9	7.0 ± 8.3	-1.9 ± 6.9	< 0.001

Values are presented as n (%) unless otherwise expressed
SD: Standard deviation

Stenting was performed for all patients in the group with CTFC ≤ 20. In the other group, however, two subjects (8.3%) underwent balloon angioplasty without stenting. Drug-eluting stents were used for 48.1% of the patients in the group with CTFC ≤ 20 and for 12.5% of other patients (P < 0.001). Two patients (3.7%) in the group with CTFC ≤ 20 and two (8.3%) in the group with CTFC > 20 had no ST resolution (P = 0.583) (Table 3).

The use of the intra-aortic balloon pump and thrombectomy devices was low in both groups and without a significant difference. Acute in-stent thrombosis occurred in one patient who underwent coronary artery bypass graft surgery. The rate of cardiogenic shock and death were 5.6% and 3.7% in the group with CTFC ≤ 20, respectively. The corresponding values in the group with CTFC > 20 were 0% and 0%, respectively. No significant differences were identified between the two groups (P > 0.05) (Table 3).

Table 4 compares CTFC and EF before discharge and after three months of treatment. No significant difference was observed for EF at discharge between the two CTFC groups (P > 0.05). However, the two groups significantly differed in EF after three-six months. After three-six months, the mean EF was 49.6% ± 8.7% and 41.6% ± 12.4% in patients with CTFC ≤ 20 and CTFC > 20, respectively (P = 0.007).

Discussion

According to the obtained results, lower CTFC was associated with higher EF after three-six months. CTFC is a quantitative and reproducible method for assessment of infarct-related artery flow. EF is the most powerful determinant of survival. We measured EF a few months after MI when myocardial stunning was likely to resolve.

Research has shown lower CTFC of the infarct-related artery immediately after PCI to be associated with better improvement in left ventricular function.[10,11] CTFC also has a significant correlation with wall motion score index.[10] Gibson et al. suggested higher CTFC 90 minutes after thrombolytic therapy to be linked with higher adverse outcomes.[11] In another study, Gibson et al. reported that patients with acute coronary syndrome who died after PCI had a higher CTFC compared to those who survived.[12] On the other hand, some studies have failed to identify any relations between CTFC and adverse clinical outcomes or functional recovery after thrombolytic therapy.[13,14]

French et al. found a significant correlation between CTFC and three-week survival after MI. They concluded that CTFC ≥ 40 is a predictor of adverse outcomes including mortality, 30-day in-hospital major adverse cardiac events, reinfarction, congestive heart failure, and left ventricular remodeling.[6] Gibson et al. detected a weak correlation between CTFC and radionuclide left ventricular EF measured through ventriculography.[11]

In this study, baseline and clinical characteristics were similar to recently published studies in the field of MI. Like the finding of Nielsen et al. door-to-balloon time was short.[15] Success rate of primary PCI was high, and the presence of CTFC ≤ 20 immediately after PPCI could be a predicator of high EF in patients with STEMI three months after the procedure.

Study limitations

There are several limitations in the current study. First, the number of patients was relatively small. Second, patients referred for primary PCI might have had different LAD length; and a factor of 1.7 to correct the TFC for all of them is not perfect.[9] Third, the follow-up period was short and hence further studies with longer follow-up are recommended. This allows for better understanding of the role of CTFC in predicting EF and prognosis of patients who undergo PPCI for STEMI.

Conclusion

Lower CTFC of infarct-related artery is associated with better EF after a few months in patients who receive PPCI for STEMI. Post-PPCI CTFC may be an independent predictor of clinical and functional outcome and can thus provide better risk assessment and triage in such patients.

Conflict of Interests

Authors have no conflict of interests.

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