Acute ST-elevation Myocardial Infarction in Young Patients: 15 Years of Experience in a Single Center

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ABSTRACT

Background: There have been few studies done regarding young patients with ST-elevation myocardial infarction (STEMI). The purpose of this study was to investigate the clinical characteristics and coronary angiographic features in young patients with STEMI.

Methods: We collected data on 849 consecutive patients with STEMI from 1992 to 2006. Baseline clinical characteristics, coronary anatomy, and outcome were compared in young (≤45 yrs) and older patients (>45 yrs).

Results: Young patients presented 11.6% of all patients with STEMI. These patients were predominantly male (92.9% vs 80.3%, $P < 0.001$), more likely to smoke (75.8% vs 47.2%, $P < 0.001$), obese (48.2% vs 27.9%, $P = 0.002$), have higher triglyceride levels (176.9 ± 153.8 mg/dL vs 140.7 ± 112.7 mg/dL, $P = 0.005$), and lower high-density lipoprotein cholesterol (37.1 ± 7.9 mg/dL vs 42.8 ± 14.3 mg/dL, $P = 0.005$) than older patients. Also, younger patients had a shorter hospital stay (7.1 ± 4.9 d vs 8.5 ± 6.7 d, $P = 0.04$), less in-hospital morbidity (29.3% vs 39.7%, $P = 0.02$), and mortality (3.0% vs 12.3%, $P = 0.002$). Killip class III or IV could predict in-hospital morbidity and mortality in young patients. Both groups had similar rates of repeated percutaneous coronary intervention (PCI; 45.5% vs 41.5%, $P = 0.23$) and reinfarction (6.1% vs 3.2%, $P = 0.32$). Mortality rate during follow-up was significantly lower in younger patients (3.0% vs 19.6%, $P < 0.001$).

Conclusion: Cigarette smoking, obesity, and dyslipidemia were the most important modifiable risk factors in young patients with STEMI. These patients had a better outcome than older patients without differences in repeated PCI and reinfarction between them. Only Killip class III or IV could predict in-hospital morbidity and mortality in young patients with STEMI.

Introduction

Myocardial infarction (MI) is an uncommon disease in young individuals and its incidence varies between 2% and 10%.[1–6] Young patients are more likely to have a history of smoking and dyslipidemia, but less likely to have other comorbidities, such as diabetes mellitus, hypertension, or prior coronary artery disease. In addition, patients with premature MI tend to present fewer diffuse atherosclerotic coronary arteries.[1–9] To date, few studies have focused on acute ST-elevation myocardial infarction (STEMI) in young patients and the clinical characteristics and outcomes of young patients with STEMI have not been reported. The aim of this study was to investigate the significance of premature MI by comparing clinical characteristics, coronary anatomy, and outcome of younger and older patients with STEMI.

Methods

Patients

Between April 1992 and October 2006, 849 patients were admitted for STEMI in this institution. ST-segment elevation myocardial infarction was defined using the following criteria: (1) a typical chest pain lasting at least 20 minutes; (2) elevated serum cardiac biomarkers at least twice the upper limit of normal; (3) ST-segment elevation of 1 mm or more with subsequent evolution of negative T-waves with a depth of 1 mm or more, development of new Q-waves of at least ≥0.04 seconds in duration or deeper than one-fourth of the following R wave in voltage. All the patients had complete occlusion or critical stenosis of infarct-related arteries confirmed by coronary angiography. Classification of weight by body mass index (BMI) was according to the World Health Organization (WHO) recommendation

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for an Asian population.[10] A BMI of more than 27 kg/m^2 was defined as obese. Chronic kidney disease (CKD) was defined as serum creatinine >1.3 mg/dL. For evaluation of the peak serum cardiac biomarkers activity, blood samples were obtained every 6 hours for 48 hours or until activity returned to normal. The reference values for creatine kinase (CK) and CK-MB were 26 to 192 IU/L and 7 to 25 IU/L, respectively. Blood samples for a lipid profile were drawn after an 8-hour fast during the index hospitalization. The following clinical outcomes were analyzed: length of hospital stay, in-hospital mortality and morbidity, repeated percutaneous coronary intervention (PCI), reinfarction, and mortality during follow-up. Repeated PCI was defined as unstable angina that required repeated revascularization during follow-up. Clinical follow-up variables, including repeated PCI, reinfarction, and mortality were obtained at clinic visits and by telephone conversation and chart review.

Coronary Angiography

After providing written informed consent, all study patients received coronary artery angiography. Judgment of vessel flow was according to the thrombolysis in myocardial infarction (TIMI) flow grade. Angiographic stenosis was defined as a diameter reduction of ≥50%. Critical stenosis was defined as ≥70% narrowing of the coronary artery luminal diameter. Complete coronary occlusion was defined as the total absence of anterograde flow of contrast media or TIMI flow grade 0 in the infarct-related coronary artery. The infarct-related lesion was identified based on morphology including complete occlusion, thrombus and ulcerative stenosis, or assumed to be the tightest stenosis if these features were absent.

Statistics

Quantitative data are expressed as mean ± standard deviation. The χ^2 test with a Yates correction or Fisher exact test was used to analyze the nonparametric data. If the frequency of any cell was <5, then a Fisher exact test was used. $P < 0.05$ was considered statistically significant. A multivariate analysis with a logistic regression model was conducted for the 2 age groups separately, to identify the baseline variables independently associated with in-hospital morbidity and mortality. The variables that were independently associated with in-hospital morbidity and mortality are presented as odds ratio (OR) followed by 95% confidence interval (CI). A significant OR was obtained if the 95% CI exceeded 1 and P value was <0.05.

Results

The mean age of the 849 patients was 61 ± 13 years old (range, 26–98 yrs). Among these subjects, 99 patients (11.7%) were 45 years old and younger and 750 (88.3%) were 46 years old and older.

Risk Factors

Both groups were predominantly male, but the younger patients were more likely to be male than the older patients (92.9% vs 80.3%, $P < 0.001$, Table 1). Also, the young patients were more likely to be obese (48.2% vs 27.9%, $P = 0.002$), were more likely to smoke (75.8% vs 47.2%, $P < 0.001$), and have dyslipidemia (28.3% vs 19.9%, $P = 0.03$) compared with the older patients. The prevalence of diabetes mellitus (17.2% vs 33.4%, $P < 0.001$), hypertension (34.3% vs 50.0%, $P = 0.02$), CKD (10.1% vs 36.1%, $P < 0.001$), history of cerebral vascular accident (1.0% vs 5.9%, $P = 0.02$), and previous coronary artery disease (1.0% vs 6.9%, $P = 0.01$) was significantly lower in the young patients.

Presentation

The young patients had significantly more typical angina (94.9% vs 86.7%, $P = 0.006$), while fewer presented with Killip class III or VI during hospitalization (20.2% vs 31.5%, $P = 0.01$, Table 1). Laboratory analysis revealed that young patients had more leukocytosis (70.7% vs 55.5%, $P = 0.002$), less anemia (1.0% vs 4.8%, $P = 0.05$), increased triglyceride (TG) levels (176.9 ± 153.8 mg/dL vs 140.7 ± 112.7 mg/dL, $P = 0.005$), and decreased high-density lipoprotein cholesterol (HDL-C) levels (37.1 ± 7.9 mg/dL vs 42.8 ± 14.3 mg/dL, $P = 0.002$). Also, young patients had greater peak CK activity (3552.3 ± 2755.6 IU/L vs 2878.4 ± 2489.1 IU/L, $P = 0.01$) and CK-MB activity (294.6 ± 240.2 IU/dL vs 248.7 ± 229.2 IU/dL, $P = 0.06$) than older patients.

Angiographic Data and Interventional Therapy

Young patients were more likely to have single-vessel disease (56.6% vs 27.6%, $P < 0.001$, Table 2). Analysis of coronary angiogram also showed that the left anterior descending artery was the most commonly involved infarct-related artery. Both groups had a similar incidence of total occlusion of the infarct-related arteries. Additionally, both groups had a similar incidence of receiving primary PCI, intracoronary or intravenous thrombolytic therapy, number of stent placement, total length, mean diameter of placed stent, and post-PCI TIMI flow grade.

Medical Treatment

For the most part, both groups of patients received similar inpatient medical treatment, such as angiotensin-converting enzyme inhibitors or angiotensin receptor blocker, and antiplatelet or anticoagulant therapy (Table 3). However, young patients were more likely to receive β-blocker (40.4% vs 26.4%, $P = 0.002$) and statin therapy (24.2% vs 13.5%,

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Table 1. Comparison of Patients Characteristics

	Patients ≤45 Years Old (n = 99)	Patients >45 Years Old (n = 750)	*P* Value
Age	40.4 ± 4.3	63.7 ± 10.6	
Male	92 (92.9)	602 (80.3)	<0.001
Obesity (BMI ≥27 kg/m²)	27 (48.2)	101 (27.9)	0.002
Smoking	75 (75.8)	354 (47.2)	<0.001
Diabetes mellitus	17 (17.2)	250 (33.4)	<0.001
Hypertension	34 (34.3)	375 (50.0)	0.002
Dyslipidemia	28 (28.3)	149 (19.9)	0.03
Chronic kidney disease	10 (10.1)	269 (36.1)	<0.001
Previous coronary artery disease	1 (1)	52 (6.9)	0.01
Heart failure	2 (2.0)	25 (3.3)	0.26
Chronic obstructive pulmonary disease	2 (2.0)	31 (4.1)	0.23
History of CVA	1 (1.0)	44 (5.9)	0.02
Presentation			
Typical angina	94 (94.9)	650 (86.7)	0.006
Killip class III or IV during hospitalization	20 (20.2)	236 (31.5)	0.01
Initial vital signs at emergency department			
SBP	124.0 ± 26.6	128.0 ± 31.9	0.25
DBP	76.0 ± 20.6	73.1 ± 19.7	0.18
Heart rate	78.0 ± 16.1	78.6 ± 22.2	0.82
Respiratory rate	18.3 ± 3.0	19.4 ± 7.4	0.16
Laboratory analysis			
Anemia (hemoglobin <10 mg/dL)	1 (1.0)	36 (4.8)	0.05
Leukocytosis (white blood cell >10 k/ul)	70 (70.7)	411 (55.5)	0.002
CK (IU/L)	3552.3 ± 2755.6	2878.4 ± 2489.1	0.01
CK-MB (IU/L)	294.6 ± 240.2	248.7 ± 229.2	0.06
Cholesterol (mg/dL)	191.9 ± 40.0	184.1 ± 42.9	0.09
Triglyceride (mg/dL)	176.9 ± 153.8	140.7 ± 112.7	0.005
HDL (mg/dL)	37.1 ± 7.9	42.8 ± 14.3	0.002
LDL (mg/dL)	119.3 ± 31.4	117.7 ± 37.3	0.76

Abbreviations: BMI, body mass index; CK, creatine kinase; CVA, cerebral vascular accident; DBP, diastolic blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein; SBP, systolic blood pressure.
Values presented as number (%) and mean ± SD.

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Table 2. Comparisons of Coronary Angiographic Features Between Patients With STEMI

	Patients ≤45 Years Old (n = 99)	Patients >45 Years Old (n = 750)	*P* Value
Number of diseased vessels			<0.001
Single-vessel disease	56 (56.6)	207 (27.6)	
Multiple-vessel disease	43 (45.4)	543 (72.4)	
Infarct-related artery			0.84
Left main artery	1 (1.0)	13 (1.7)	
Left anterior descending artery	57 (57.6)	392 (52.3)	
Left circumflex artery	8 (8.1)	69 (9.2)	
Right coronary artery	33 (33.3)	274 (36.5)	
Intermediate artery	0 (0)	2 (0.3)	
Total occlusion of infarct-related artery	80 (80.8)	551 (73.5)	0.06
Coronary artery intervention			
Primary PCI	95 (96.0)	708 (94.4)	0.36
Initial success of primary PCI	93 (93.9)	674 (90.0)	0.10
Number of stent placements	0.79 ± 0.54	0.74 ± 0.59	0.50
Total stent lengths (mm)	22.2 ± 9.15	21.6 ± 9.04	0.61
Mean stent diameter (mm)	3.31 ± 0.58	3.3 ± 1.81	0.82
Post-PCI TIMI flow grade	2.8 ± 0.68	2.7 ± 0.84	0.44
Thrombolytic therapy	3 (3.0)	15 (2.0)	0.35
IABP	14 (14.3)	161 (21.5)	0.05
Elective or emergent CABG	1 (1)	28 (3.7)	0.13

Abbreviations: CABG, coronary artery bypass grafting; IABP, intra-aortic balloon pump; PCI, percutaneous coronary intervention, STEMI, ST-segment elevation myocardial infarction; TIMI, thrombolysis in myocardial infarction.
Values presented as number (%) and mean ± SD.

$P = 0.004$), but fewer received diuretic agents (6.1% vs 14.3%, $P = 0.008$) compared with older patients.

Prognosis

The mean days in intensive care unit were similar in both groups, however, young patients had a shorter total hospital stay (7.1 ± 4.9 d vs 8.5 ± 6.7 d, $P = 0.04$, Table 3). In addition, young patients had significantly less in-hospital morbidity (27.3% vs 35.6%, $P = 0.05$) and mortality (3.0% vs 12.3%, $P = 0.002$) compared with older patients. During mean follow-up periods of 53.4 ± 44.2 and 45.5 ± 43.4 months ($P = 0.09$) in young and older groups, respectively, there were no differences in rates of repeated PCI (45.5% vs 41.5%, $P = 0.23$) and reinfarction (6.1% vs 3.2%, $P = 0.32$) between the 2 groups. However, the young patients had significantly lower mortality during follow-up than older patients (3.0% vs 19.6%, $P < 0.001$).

The multivariate analysis showed that Killip class III or IV during hospitalization could predict the presence of in-hospital morbidity alone (OR: 31.15, 95% CI: 7.22–137.06, $P < 0.001$) and the combination of in-hospital morbidity and mortality (OR: 42.15, 95% CI: 8.13–218.57, $P < 0.001$) in young patients (Table 4). Also, CKD (OR: 3.37, 95% CI: 1.97–5.76, $P < 0.001$) and Killip class III or IV (OR: 11.09, 95% CI: 6.08–20.21, $P < 0.001$) could predict the presence of in-hospital mortality in older patients. Furthermore, gender, nonsmoking status, CKD, and Killip class III or IV could predict in-hospital morbidity alone or in combination with in-hospital mortality in older patients.

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Table 3. Comparison of Management and Clinical Outcomes Between Patients With STEMI

	Patients ≤45 Years Old (n = 99)	Patients >45 Years Old (n = 750)	*P* Value
Medical treatment			
Glycoprotein IIb/IIIa inhibitors	8 (8.1)	56 (7.5)	0.40
Heparin	96 (97.0)	725 (96.7)	0.58
Low-molecular-weight heparin	5 (5.1)	28 (3.7)	0.26
Aspirin	87 (87.9)	647 (86.3)	0.34
Clopidogrel	51 (51.5)	379 (50.5)	0.43
ACEI/ARB	64 (64.6)	428 (57.1)	0.08
β-Blocker	40 (40.4)	198 (26.4)	0.002
Statin	24 (24.2)	101 (13.5)	0.004
Diuretic	6 (6.1)	107 (14.3)	0.008
Hospital outcomes			
Days in intensive care unit	3.2 ± 2.4	4.0 ± 4.2	0.07
Length of hospital stay (d)	7.1 ± 4.9	8.5 ± 6.7	0.04
In-hospital mortality	3 (3.0)	92 (12.3)	0.002
In-hospital morbidity	29 (29.3)	298 (39.7)	0.02
Ventricular arrhythmia	12 (12.1)	76 (10.1)	0.27
Atrioventricular block	5 (5.1)	66 (8.8)	0.10
Cardiogenic shock	17 (17.2)	188 (25.1)	0.04
Cardiac rupture/tamponade	1 (1.0)	6 (0.8)	0.58
Cardiac surgery	1 (1.0)	28 (3.7)	0.13
Bleeding complications	2 (2.0)	24 (3.2)	0.40
Acute renal failure	1 (1.0)	7 (0.9)	0.63
Infection	0 (0)	27 (3.6)	0.03
Stroke	0 (0)	3 (0.4)	0.69
Long-term outcome			
Repeated PCI	45 (45.5)	311 (41.5)	0.23
Recurrent myocardial infarction	6 (6.1)	24 (3.2)	0.09
Overall mortality	3 (3.0)	147 (19.6)	<0.001
Follow-up (mo)	53.4 ± 44.2	45.5 ± 43.4	0.09

Abbreviations: ACEI, angiotensin-converting enzyme inhibitors; ARB, angiotensin receptor blockers; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction.
Values presented as number (%) and mean ± SD.

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Table 4. Baseline Variables Associated With In-hospital Morbidity or/and Mortality in Patients

	Patients ≤45 Years Old[a]						Patients >45 Years Old								
	In-hospital Morbidity			In-hospital Morbidity and Mortality			In-hospital Mortality			In-hospital Morbidity			In-hospital Morbidity and Mortality		
	OR	95% CI	*P* Value	OR	95% CI	*P* Value	OR	95% CI	*P* Value	OR	95% CI	*P* Value	OR	95% CI	*P* Value
Male	13.54	0.60–303.26	0.10	17.48	0.68–446.42	0.08	0.95	0.50–1.82	0.87	2.16	1.24–3.76	0.006	1.75	1.03–2.99	0.04
Smoking	2.29	0.47–11.15	0.31	2.63	0.53–13.11	0.34	0.83	0.48–1.45	0.51	0.55	0.36–0.85	0.006	0.53	0.35–0.81	0.003
Diabetes	3.62	0.83–15.84	0.09	3.57	0.81–15.67	0.09	1.43	0.84–2.44	0.19	0.97	0.63–1.49	0.90	1.03	0.68–1.57	0.88
Hypertension	1.13	0.31–4.09	0.85	0.998	0.28–3.61	0.998	0.77	0.46–1.30	0.33	1.04	0.70–1.55	0.85	1.01	0.68–1.49	0.97
Dyslipidemia	1.70	0.46–6.27	0.43	1.35	0.37–5.00	0.65	0.88	0.44–1.74	0.71	1.15	0.70–1.89	0.58	1.07	0.66–1.74	0.79
CKD	1.34	0.20–9.12	0.76	1.06	0.15–7.53	0.96	3.37	1.97–5.76	<0.001	1.84	1.22–2.77	0.004	1.96	1.31–2.93	0.001
Prior CAD	. . .	. . .	. . .	. . .	. . .	. . .	1.22	0.52–2.85	0.65	0.54	0.24–1.18	0.12	0.49	0.22–1.07	0.07
Killip class III or IV	31.45	7.22–137.06	<0.001	42.15	8.13–218.57	<0.001	11.09	6.08–20.21	<0.001	27.85	17.49–44.33	<0.001	24.71	15.60–39.13	<0.001

Abbreviations: CAD, coronary artery disease; CI, confidence interval; CKD, chronic kidney disease; OR, odds ratio.
[a] Logistic regression of in-hospital mortality in this group was negative because only 3 patients ≤45 years old died.

Discussion

Major Findings

Young patients with STEMI were more likely to be male, obese, smokers with hypertriglyceridemia and low HDL-C levels, and less likely to have other comorbid conditions than older patients. Young patients had a better outcome than older patients without an apparent difference in the frequency of repeated PCI or reinfarction between them. Furthermore, Killip class III or IV during hospitalization could predict in-hospital morbidity and mortality in young patients.

Risk Factors

The present study showed that 11.7% of all patients who presented with acute STEMI were ≤45 years old when admitted to our institution over a 15-year period. Young patients were a relatively small proportion of those having STEMI; however, it is important to recognize these patients for the purpose of risk factor modification and secondary prevention in younger patients. Previous and current studies demonstrated that young patients with STEMI are predominantly male, smoke, and had dyslipidemia.[1–4,11] Cigarette smoking, which is a well-known risk factor for development of coronary heart disease,[12,13] was found in 75% to 86% of young patients with STEMI.[1–3,7] Also, the young patients described in the present study had a greater prevalence of high TG and low HDL-C levels. Correlations of high TG and low HDL-C levels in the present study were similar with studies in the past.[14–16] High TG and low HDL-C levels, which characterize the dyslipidemia of metabolic syndrome, have roles in atherosclerosis and coronary heart disease development.[16–18] In addition, the current study showed that obesity was a risk factor of STEMI in young patients. All these findings suggest that young patients with STEMI are more likely to meet most of the Adult Treatment Panel III criteria for metabolic syndrome, including obesity, high TG, and low HDL-C levels.[20] Therefore, metabolic syndrome plays an important role in young patients with STEMI.[21,22]

Clinical Presentation and Coronary Angiographic Features

Current and previous studies showed young patients were more likely to have typical angina and less cardiogenic shock at presentation.[11] Furthermore, our study predominantly found single-vessel disease in young patients and this might reflect that premature acute coronary syndrome in these patients resulted from rapid disease progression, such as thrombogenesis or plaque rupture, rather than a gradually evolving process, such as atherosclerosis.[3,11,16] Previous studies had demonstrated young patients more often underwent PCI with higher initial success rate and relatively few complications.[1,23] However, in our study, both young and older patients had a similar frequency of undergoing primary PCI with a similar initial success rate.

Medical Treatment for STEMI

Few patients in the present study received glycoprotein IIb/IIIa inhibitors. Both groups received antiplatelet and antithrombotic therapy regularly, as well as angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, which were well documented to decrease mortality.[24,25] In the present study, young patients were more likely to receive statin therapy, probably because of a greater frequency of dyslipidemia in young patients compared with those who were older. Given the evidence of the benefits of the early use of β-blockers in STEMI, patients without a contraindication, irrespective of administration of thrombolytic therapy or performance of primary PCI, should promptly receive an oral β-blocker.[26] However, the prescription of β-blockers was somewhat low, at around 28% in both groups, and it appeared higher in younger patients. The prescription of β-blockers is still underused in the real-world. These findings could be explained if most of the study patients were included before the benefits of β-blocker were widely recommended in STEMI.[26,27]

Prognosis of Patients With STEMI

In comparative series, including the present study, young patients had a shorter length of hospital stay and lower rates of in-hospital morbidity.[1,3] The present study demonstrated that gender, nonsmoker status, CKD, and Killip class III or IV could predict in-hospital morbidity and mortality in the older patients. In contrast, only Killip class III or IV could predict in-hospital morbidity and mortality in young patients. Barbash et al reported that cardiogenic shock, nonsmoker status, diabetes, and prior MI could predict in-hospital mortality in older patients.[3] Our results, as well as studies in the past, found that older STEMI patients who smoked had a significantly better in-hospital outcome.[3,28] One possible explanation is that smoking increased thrombogenicity and the coronary obstruction in patients who smoke may be more thrombogenic and less atherosclerotic than that of nonsmokers. Thus, smoking patients with STEMI may respond better to PCI or antithrombotic agents and may be left with less significant athermanous residual stenosis and better myocardial function. This could also explain why young patients, who had a higher prevalence of smoking than older patients, had less extensive coronary artery disease and better clinical outcomes. Overall, these results suggest that less extensive coronary artery disease and fewer comorbidities in the young patients with STEMI resulted in better clinical outcome. However, the present and previous studies showed no apparent difference in frequency of repeat PCI and reinfarction among the 2 groups.[4]

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Clinical Implications

ST-segment elevation myocardial infarction in young working adults contributes to greater social, family, and health care burdens, because these patients have a similar frequency of repeated PCI and reinfarction compared with older patients. Also, our findings showed that cigarette smoking, obesity, hypertriglyceridemia, and low HDL-C level were important modifiable risk factors in these patients. Therefore, the foci of prevention should be cigarette cessation and reduction of components of metabolic syndrome, such as obesity, hypertriglyceridemia, and low HDL-C level in young people, to avoid the early occurrence of STEMI by primary prevention. Furthermore, Killip class III or IV could predict in-hospital morbidity and mortality in young patients. Thus, physicians should be aware that young STEMI patients with advanced Killip classification probably needed more attention in intensive care, adherence of STEMI guidelines, and risk modification for secondary prevention.[26]

Study Limitations

First, total and HDL cholesterol may be significantly reduced, an effect likely due to stress, such as major surgery, trauma, and acute MI.[29,30] Lipid profiles were performed during the index hospitalization for STEMI. Therefore, the accuracy of the lipid profile might be decreased because of an in-hospital sampling effect. Second, patients were treated according to the experiences and judgments of their clinical physicians, which may have influenced the outcome of the patients.

Conclusion

Cigarette smoking, obesity, and dyslipidemia were the most important modifiable risk factors in young patients with STEMI. These patients had less in-hospital morbidity and mortality and better overall survival rate than older patients without differences in repeated PCI and reinfarction between them during follow-up. Furthermore, Killip class III or IV during hospitalization could predict the in-hospital morbidity and mortality in young patients with STEMI.

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