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Higher Long-Term Mortality in Patients with Non-ST-Elevation Myocardial Infarction than ST-Elevation Myocardial Infarction after Discharge

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Purpose: This study aimed to compare mortality rates after discharge between the patients with non-ST-elevation myocardial infarction (NSTEMI) and those with ST-elevation myocardial infarction (STEMI), and identify each mortality risk factors in these two types of myocardial infarction.

Materials and Methods: Between 2011 and 2015, 13105 consecutive patients were enrolled in the Korea Acute Myocardial Infarction-National Institute of Health registry (KAMIR-NIH); 12271 patients with acute myocardial infarction met the inclusion criteria and were further stratified into the STEMI (n=5828) and NSTEMI (n=6443) groups. The occurrence of mortality and cardiac mortality at 3 years were compared between groups, and the factors associated with mortality for NSTEMI and STEMI were evaluated.

Results: The comparison between these two groups and long-term follow-up outcomes showed that the cumulative rates of all-cause and cardiac mortality were higher in the NSTEMI group than in the STEMI group [all-cause mortality: 10.9% vs. 5.8%; hazards ratio (HR), 0.464; 95% confidence interval (CI), 0.359–0.600, $p<0.001$; cardiac mortality: 6.6% vs. 3.5%, HR, 0.474; 95% CI, 0.344–0.654, $p<0.001$, respectively). In the NSTEMI group, low left ventricular ejection fraction (LVEF; <40%), no percutaneous coronary intervention (PCI), old age (≥65 years), and low hemoglobin level (<12 g/dL) were identified as risk factors for 3-year mortality. In the STEMI group, old age, low glomerular filtration rate (<60 mL/min/1.73 m^2), low LVEF, high heart rate (>100 beats/min), no PCI, and low hemoglobin level were identified as the risk factors for 3-year mortality.

Conclusion: The NSTEMI group had higher mortality compared to the STEMI group during the 3-year clinical follow-up after discharge. Low LVEF and no PCI were the main risk factors for mortality in the NSTEMI group. In contrast, old age and renal dysfunction were the risk factors for long-term mortality in the STEMI group.

Key Words: Acute myocardial infarction, risk factors, prognosis

INTRODUCTION

Acute myocardial infarction (AMI) is one of the main causes of death worldwide due to its rapid progression and high mortality rates.[1] ST-elevation myocardial infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI) are types of AMI, and the comparison between these two types has been a focus of extensive research. Both the pathophysiology and disease severity of STEMI and NSTEMI are different, leading to different prognoses.[2,3] Currently, two evaluation methods are widely used to predict the outcomes of AMI. For example, according to the Thrombolysis in Myocardial Infarction (TIMI) risk

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score, STEMI and NSTEMI have different risk factors.[4,5] Conversely, another well-known scoring system—the Global Registry of Acute Coronary Events (GRACE)—does not separately assess the risks of STEMI and NSTEMI, although the scoring system uses changes in ST-segment deviations on electrocardiogram.[6,7] In the 1980s, the 3-year mortality rate of AMI was very high (approximately 30%);[8,9] however, since then, the mortality rates have been significantly decreasing, dropping down to ~10%, as reported by a long-term, 22-year follow-up study.[10]

The abovementioned scoring methods were employed in Western studies, and are more suitable for people in Western countries. The current literature does not offer detailed data pertaining to the Asian population. Previous studies have reported that the Asian population comprises a higher proportion of diabetes patients with an increased incidence of bleeding events and fewer thrombotic events, a smaller proportion of patients with dyslipidemia, and a smaller proportion of smokers than the Western population.[11,12] To date, only two limited scoring studies have been published on Asian populations: a Least Absolute Shrinkage and Selection Operator 3 score-based study and the China Patient-centered Evaluative Assessment of Cardiac Events Retrospective Study of Acute Myocardial Infarction study (China PEACE-Retrospective AMI Study).[13] Nevertheless, further research is needed to identify the predictors of AMI prognosis in Asian populations.

Previous studies have suggested that long-term mortality was relatively higher in patients with STEMI than in those with NSTEMI.[8,9] There are several studies evaluating the mortality of STEMI and NSTEMI patients in foreign countries; unfortunately, only few long-term comparative observational studies have investigated the mortality of STEMI and NSTEMI patients in Asia. Therefore, this study aimed to compare the risk factors for STEMI and NSTEMI, and to identify the differences in disease outcomes between these two types of AMI in the Korean population.

MATERIALS AND METHODS

The data pertaining to the study population involved in the present study were derived from the Korea Acute Myocardial Infarction-National Institute of Health Registry (KAMIR-NIH). The current study included data obtained from October 2011 to December 2015. The KAMIR-NIH is a prospective, open, online (website: www.kamir.or.kr), multicenter registry that comprises data from more than 20 tertiary hospitals in Korea with resources to perform percutaneous coronary intervention (PCI), and was established to monitor the real-life treatment practices and outcomes in patients with AMI.[14] During the course of the present analysis, a total of 13105 patients were enrolled in the KAMIR-NIH registry. Among them, patients who were lost to follow-up, those with incomplete data over the time period of 3 years (n=319), or those who showed all-cause mortality in the hospital (n=515) were excluded from the present study. A total of 12271 patients with AMI were divided into the STEMI (n=5828) and NSTEMI (n=6443) groups (Fig. 1). All of the patients completed the 3-year interview, chart review, or phone calls regarding the outcomes. The Institutional Review Board number was CNUH-2020-362 and it was instituted by Chonnam National University Hospital.

The diagnosis of AMI was based on clinical presentations, increased levels of cardiac biomarkers, including creatine kinase-MB (CK-MB), troponin-I or T (Tn-I or Tn-T), and the changes observed on 12-lead electrocardiography including ST-segment deviation and development of pathologic Q waves.[14] The patients were categorized into the STEMI or NSTEMI group based on 12-lead electrocardiography findings. STEMI was defined as a new ST-segment elevation of >0.1 mV in ≥2 contiguous leads or the detection of a new left bundle branch block on 12-lead electrocardiography.[15,16] After discharge, patients continued taking the same medications that they received during hospitalization, and the present study was based on discharge medications. The definition of cardiac mortality included pump failure, mechanical complications, arrhythmia, and other cardiovascular diseases.[14]

The primary objective was to assess the occurrence of mortality within 3 years after discharge, which was defined as all-cause mortality in both groups. The second objective was to assess the cardiac mortality in both groups with regard to 3-year outcomes. The third and final objective was to evaluate the differences between STEMI and NSTEMI with regard to the risk factors associated with long-term mortality after discharge.

All continuous variables are expressed as mean±standard deviation or median with interquartile ranges. All categorical variables are expressed as number and percentage. For con-

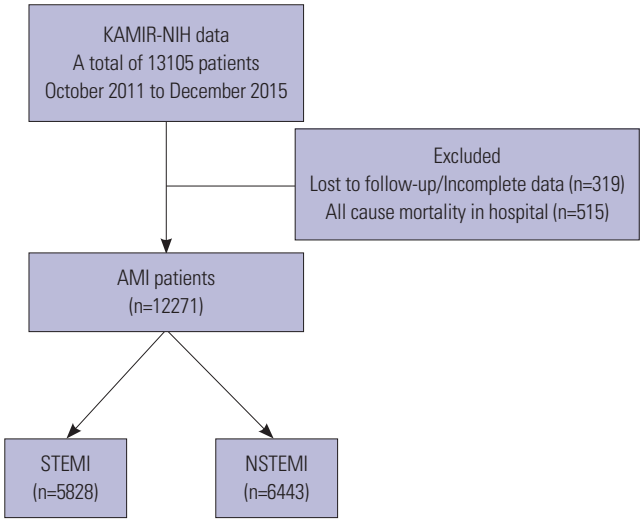

Fig. 1. Flow chart of study inclusion. AMI, acute myocardial infraction; KAMIR-NIH, Korean Acute Myocardial Infarction Registry-National Institutes of Health; NSTEMI, non-ST-elevation myocardial infarction; STEMI, ST-elevation myocardial infarction.

tinuous variables, data were compared using either unpaired Student's t-test or Mann-Whitney U test, as appropriate. Categorical variables were analyzed using the chi-square or Fisher's exact test. All available baseline clinical, laboratory, and medication variables were tested. To adjust for potential confounders, the propensity score matching (PSM) analysis was created using a logistic regression model, and the C-statistic for PSM was 0.686 in this study. Patients from the STEMI group were matched one-to-one with those from the NSTEMI group according to their propensity scores using the nearest available pair matching method. The patients were matched with a caliper distance equal to 0.01 and divided into 1435 patients in each group. In the matched population, the baseline clinical and laboratory findings, angiography results, and medications prescribed were compared between the two groups (Supplementary Fig. 1, only online). Subsequently, the propensity score was used to perform inverse probability weight (IPW) testing for the precise adjustment of data to further prove the accuracy of the results. Mortality was compared using the Kaplan–Meier method and the Cox proportional hazards regression model. Using the Cox proportional hazards regression model, variables were evaluated by univariate and multivariate analyses at a significance of $p<0.10$ on univariate analysis results. In multivariate analysis, we used the backward regression method and included the following parameters: old age (≥65 years); male sex; high heart rate (HR, >100 beat/min); hypertension; low systolic blood pressure (SBP, <90 mm Hg); high body mass index (BMI, >25 kg/m^2); diabetes mellitus and dyslipidemia; history of heart failure, myocardial infarction, dyspnea and angina; low left ventricular ejection fractions (LVEFs, <40%); smoking; low hemoglobin level (<12 g/dL); high triglyceride (TG) level (≥150 mg/dL); low high-density lipoprotein (HDL) cholesterol level (≤40 mg/dL); high low-density lipoprotein (LDL) cholesterol level (≥70 mg/dL); high HbA1c level (>6.5%); American College of Cardiology/American Heart Association (ACC/AHA) type B2/C lesions, final TIMI score (0/1); and no PCI. In the adjusted survival analysis, HRs and 95% confidence intervals (CIs) were obtained using multivariate Cox regression analysis.

All statistical analyses were performed using the IBM-SPSS Statistics for Windows software (ver. 25.0; IBM Corp., Armonk, NY, USA) and R project version 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria). All analyses were two-tailed. In the present study, p-values<0.05 were considered significant.

RESULTS

A total of 12271 patients with AMI were enrolled in the final study population. All baseline clinical and laboratory characteristics are summarized in Table 1. The NSTEMI and STEMI groups included 6443 (52.5%) and 5828 (47.5%) patients, respectively. The mean patient age in the NSTEMI group was higher than that in the STEMI group (62.78±12.29 years vs. 62.07±12.58 years, $p<0.001$), and 52.9% and 43.1% of the patients were aged ≥65 years in NSTEMI and STEMI groups, respectively. The NSTEMI group had a lower proportion of male than the STEMI group (70.7% vs. 78.8%, $p<0.001$), and the patients in the NSTEMI group had lower BMI than those in the STEMI group (23.98±3.39 kg/m^2 vs. 24.13±3.27 kg/m^2, respectively, $p=0.017$). The mean SBP, diastolic blood pressure (DBP), and HR were higher in the NSTEMI group than in the STEMI group (135.11±27.09 mm Hg vs. 127.34±29.61 mm Hg, $p<0.001$; 80.99±16.03 mm Hg vs. 77.82±18.73 mm Hg, $p<0.001$; 79.82±18.13 beat/min vs. 76.57±19.38 beat/min, $p<0.001$; respectively). The number of patients currently smoking or those with typical chest pain was lower in the NSTEMI group than in the STEMI group. Furthermore, compared to those in the NSTEMI group, more patients in the STEMI group had a Killip class IV disease, whereas LVEF was more predominant in the NSTEMI group than in the STEMI group (53.88±11.40% vs. 50.52±10.17%, $p<0.001$) (Table1).

On coronary angiography, a lower number of left anterior descending arteries (35.1% vs. 49.9%) and right coronary arteries (RCA; 24.2% vs. 37.6%), and a higher number of left circumflex (LCX) arteries (22.0% vs. 9.0%) and left main arteries (2.5% vs. 1.1%), were observed among patients in the NSTEMI group compared to those in the STEMI group. The proportion of multivessel lesions was higher in the NSTEMI group than in the STEMI group (44.9% vs. 42.6%). A less number of ACC/AHA type B2 or C lesions was examined in the NSTEMI group than in the STEMI group (70.1% vs. 86.5%). Regarding PCI procedures, the proportion of multivessel PCI procedures was higher in the NSTEMI group than in the STEMI group (21.7% vs. 12.3%), whereas the proportion of patients who underwent PCI procedures was lower in the NSTEMI group than in the STEMI group (76.6% vs. 92.0%); approximately ~80% of patients underwent dual eluting stent (DES) implantation. The NSTEMI group had less patients with an initial TIMI score of 0/1 compared to the STEMI group (33.3% vs. 72.4%), while the NSTEMI group had less patients with a final TIMI score of 3 compared to the STEMI group (81.8% vs. 93.8%). Moreover, the NSTEMI group included a higher proportion of patients who underwent coronary artery bypass graft surgery compared to the STEMI group (2.1% vs. 0.5%) (Table 2). Medications after discharge, including aspirin (99.5% vs. 99.9%), ticagrelor or prasugrel (18.0% vs. 25.8%), statins (92.3% vs. 94.9%), angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers (78.4% vs. 81.3%), and beta-blockers (80.9% vs. 87.2%), were used less often in the NSTEMI group than in the STEMI group; however, clopidogrel (82.0% vs. 74.2%) and calcium channel blocker (CCB; 12.4% vs. 4.3%) were used more commonly in the NSTEMI group than in the STEMI group (Table 2).

Kaplan-Meier curves and multivariate Cox proportional hazards regression model showed that the cumulative rate of all-cause mortality was higher in the NSTEMI group (n=703)

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Table 1. Baseline Clinical and Laboratory Characteristics of Patients with STEMI and NSTEMI

Variables	All (n=12271)	STEMI (n=5828)	NSTEMI (n=6443)	*p* value
Demographic				
Age (yr)	63.49±12.50	62.07±12.58	62.78±12.29	<0.001
Age ≥65	5918 (48.2)	2511 (43.1)	3407 (52.9)	<0.001
Male sex	9146 (74.5)	4592 (78.8)	4554 (70.7)	<0.001
BMI (kg/m^2)	24.05±3.34	24.13±3.27	23.98±3.39	0.017
Clinical symptoms				
Dyspnea	2794 (22.8)	1120 (19.2)	1674 (26.0)	<0.001
Typical chest pain	10747 (87.6)	5427 (93.1)	5320 (82.6)	<0.001
Cardiovascular risk factors				
Hypertension	6215 (50.6)	2688 (46.1)	3527 (54.7)	<0.001
Diabetes mellitus	3433 (28.0)	1405 (24.1)	2028 (31.5)	<0.001
Dyslipidemia	1421 (11.6)	637 (10.9)	784 (12.2)	0.035
Current smoking	4884 (39.8)	2646 (45.4)	2238 (34.7)	<0.001
Medical history				
Myocardial infarction	948 (7.7)	341 (5.9)	607 (9.4)	<0.001
Angina	1176 (9.6)	371 (6.4)	805 (12.5)	<0.001
Heart failure	182 (1.5)	43 (0.7)	139 (2.2)	<0.001
Cerebrovascular accident	783 (6.4)	275 (4.7)	508 (7.9)	<0.001
Vital sign on admission				
SBP (mm Hg)	131.42±28.58	127.34±29.61	135.11±27.09	<0.001
DBP (mm Hg)	79.49±17.44	77.82±18.73	80.99±16.03	<0.001
HR (beat/min)	78.28±18.80	76.57±19.38	79.82±18.13	<0.001
High Killip class (III/IV)	1362 (11.1)	721 (12.4)	641 (10.0)	<0.001
LVEF (%)	52.28±10.96	50.52±10.17	53.88±11.40	<0.001
Laboratory findings				
WBC (10^3/uL)	10.40±4.48	11.38±4.01	9.50±4.70	<0.001
Neutrophil	66.26±15.01	66.02±16.11	66.48±13.94	0.100
Lymphocyte	24.85±12.91	25.66±14.21	24.12±11.56	<0.001
Platelet	232.55±66.24	236.06±64.75	229.37±67.41	<0.001
Hb (g/dL)	13.86±2.09	14.24±1.94	13.50±2.16	<0.001
Total cholesterol (mg/dL)	178.76±45.68	182.12±45.07	175.68±46.01	<0.001
Triglyceride (mg/dL)	134.31±114.83	140.91±124.40	128.14±104.76	<0.001
HDL-cholesterol (mg/dL)	42.94±11.80	42.78±11.53	43.09±12.04	0.153
LDL-cholesterol (mg/dL)	112.28±39.40	114.90±39.36	109.87±39.28	<0.001
Glucose	166.25±77.23	173.80±74.85	159.49±78.69	<0.001
Creatinine (mg/dL)	1.09±1.05	1.00±0.69	1.16±1.28	<0.001
GFR (mL/min/1.73 m^2)	88.92±41.00	90.06±41.92	87.88±40.11	0.003
Hs-CRP (mg/dL)	1.40±5.72	1.21±3.90	1.61±7.12	0.002
Peak CK-MB (ng/mL)	106.83±146.27	163.26±173.56	55.65±89.31	<0.001
Peak Troponin-I (ng/mL)	44.69±101.89	73.53±135.33	20.31±48.77	<0.001
NT-pro-BNP	2283.91±7171.72	1306.49±6808.18	3214.11±7382.98	<0.001
HbA1c (%)	6.47±1.45	6.45±1.49	6.50±1.42	0.119
PRU	198.12±109.94	179.82±108.57	216.72±108.22	<0.001
ARU	459.59±73.91	456.74±75.25	462.05±72.67	0.064

ARU, aspirin reaction units; BMI, body mass index; CK, creatine kinase; DBP, diastolic blood pressure; GFR, glomerular filtration rate; HDL, high-density lipoprotein; HR, heart rate; Hb, hemoglobin; Hs-CRP, high-sensitivity C-reactive protein; LDL, low-density lipoprotein; LVEF, left ventricular ejection fraction; NT-pro-BNP, N-terminal pro-brain natriuretic peptide; NSTEMI, non-ST-elevation myocardial infarction; PRU, P2Y12 reaction units; SBP, systolic blood pressure; STEMI, ST-elevation myocardial infarction; WBC, white blood cell.
Data are expressed as n (%) or mean±SD.

Table 2. Characteristics of Coronary Angiography and Medication in Patients with STEMI and NSTEMI

Variables	All (n=12271)	STEMI (n=5828)	NSTEMI (n=6443)	*p* value
Angiography and PCI				
Infarct-related artery				<0.001
Left main	224 (1.8)	66 (1.1)	158 (2.5)	
Left anterior descending	5163 (42.1)	2905 (49.9)	2258 (35.1)	
Left circumflex	1943 (15.8)	527 (9.0)	1416 (22.0)	
Right coronary artery	3753 (30.6)	2192 (37.6)	1561 (24.2)	
ACC/AHA B2/C lesion	9560 (77.9)	5042 (86.5)	4518 (70.1)	<0.001
Multivessel lesion	5376 (43.8)	2484 (42.6)	2892 (44.9)	<0.001
Multivessel PCI	2112 (17.2)	714 (12.3)	1398 (21.7)	<0.001
Underwent PCI	10295 (83.9)	5360 (92.0)	4935 (76.6)	<0.001
Implanted DES	9998 (81.5)	5219 (89.6)	4779 (74.2)	<0.001
TIMI flow grade				
Initial TIMI flow 0/1	6366 (51.9)	4218 (72.4)	2148 (33.3)	<0.001
Final TIMI flow 3	10742 (87.5)	5469 (93.8)	5273 (81.8)	<0.001
Coronary artery bypass graft	165 (1.3)	30 (0.5)	135 (2.1)	<0.001
Medical treatment of discharge				
Aspirin	12230 (99.7)	5821 (99.9)	6409 (99.5)	<0.001
P2Y12 receptor inhibitor				
Clopidogrel	9607 (78.3)	4322 (74.2)	5285 (82.0)	<0.001
Ticagrelor or Prasugrel	2664 (21.7)	1506 (25.8)	1158 (18.0)	<0.001
Statin	11479 (93.5)	5531 (94.9)	5948 (92.3)	<0.001
ACEI/ARB	9787 (79.8)	4739 (81.3)	5048 (78.4)	<0.001
Beta-blocker	10290 (83.9)	5080 (87.2)	5210 (80.9)	<0.001
Calcium channel blocker	1053 (8.6)	252 (4.3)	801 (12.4)	<0.001

ACC, American College of Cardiology; AHA, American Heart Association; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; DES, dual eluting stent; PCI, percutaneous coronary intervention; STEMI, ST-elevation myocardial infraction; NSTEMI, non-ST-elevation myocardial infarction; TIMI, Thrombolysis In Myocardial Infarction.
Data are expressed as n (%) unless indicated otherwise.

than in the STEMI group (n=340) (10.9% vs. 5.8%, log-rank test, $p<0.001$; HR, 0.615; 95% CI, 0.528–0.716; p<0.001) (Fig. 2A). Cardiac mortality was also higher in the NSTEMI group (n=427) than in the STEMI group (n=202) (6.6% vs. 3.5%, log-rank test, $p<0.001$; HR, 0.541; 95% CI, 0.444–0.660; $p<0.001$) (Fig. 2B).

Table 3 summarizes the results of Cox regression multivariate analysis of the risk factors for 3-year mortality after discharge. In the NSTEMI group, low LVEF (<40%; HR, 4.696; 95% CI, 3.832–5.755; $p<0.001$), no PCI (HR, 3.086; 95% CI, 2.462–3.867; $p<0.001$), old age (≥65 years; HR, 1.750; 95% CI, 1.411–2.169; $p<0.001$), and low hemoglobin level (HR, 1.682; 95% CI, 1.358–2.084; $p<0.001$) were identified as independent risk factors for 3-year mortality after discharge. In the STEMI group, old age (≥65 years; HR, 4.498; 95% CI, 3.224–6.275; $p<0.001$), low glomerular filtration rate (GFR) (<60 mL/min/1.73 m^2; HR, 2.235; 95% CI, 1.722–2.901; $p<0.001$), low LVEF (<40%; HR, 2.065; 95% CI, 1.571–2.714; $p<0.001$), high HR (>100 beats/min; HR, 1.628; 95% CI, 1.167–2.271; $p=0.004$), no PCI (HR, 1.541; 95% CI, 1.012–2.348; $p=0.044$), and low hemoglobin level (HR, 1.542; 95% CI, 1.172–2.028; $p=0.002$) were identified as independent risk factors for 3-year mortality after discharge.

Supplemental material about outcomes in PSM and IPW analyses

After the PSM analysis, there were no significant differences between the two groups for any of the tested baseline clinical and laboratory findings, except Tn-I, N-terminal pro-brain natriuretic peptide (NT-pro-BNP), and P2Y12 reaction units (PRU) (Supplementary Table 1, only online). There were no significant differences between the groups for any medications or for angiography, except the infarct-related artery, multivessel PCI, and DES implantation (Supplementary Table 2, only online). The cumulative rates of both all-cause mortality and cardiac mortality were higher in the NSTEMI group than in the STEMI group (13.2% vs. 5.9%, log-rank test, $p<0.001$; HR, 0.464; 95% CI, 0.359–0.600; $p<0.001$; 8.5% vs. 3.8%, log-rank test, $p<0.001$; HR, 0.474; 95% CI, 0.344–0.654; $p<0.001$, respectively) (Supplementary Fig. 2, only online). Sensitivity analysis for mortality by means of multivariate Cox regression, PSM, and IPW analyses revealed significantly higher values in the NSTEMI group compared to the STEMI group (Supplementary Table 3, only online).

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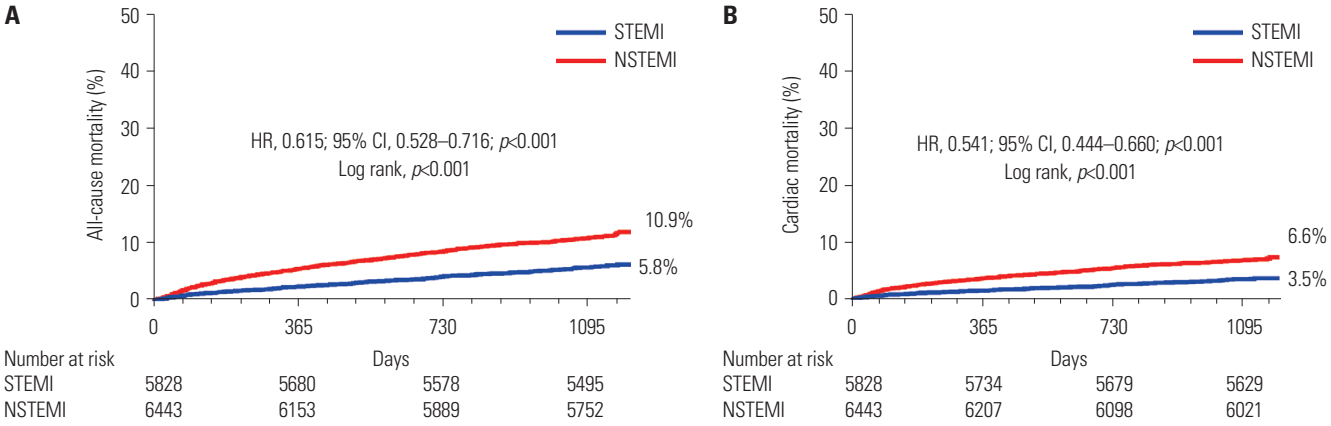

Fig. 2. Kaplan-Meier curves and Cox proportional hazards regression model for 3-year all-cause and cardiac mortality in the STEMI and NSTEMI groups. (A) Cumulative incidence of all-cause mortality in the two groups. (B) Cumulative incidence of cardiac mortality in the two groups. CI, confidence interval; HR, hazard ratio; NSTEMI, non-ST-elevation myocardial infarction; STEMI, ST-elevation myocardial infarction.

Table 3. Univariate and Multivariate Analyses for Predictors of 3-Year Mortality

	Univariate analysis		Multivariate analysis	
	HR (95% CI)	*p* value	HR (95% CI)	*p* value
Risk factor in STEMI				
Age ≥65 (yr)	5.642 (3.602–8.838)	<0.001	4.498 (3.224–6.275)	<0.001
GFR <60 (mL/min/1.73m^2)	2.169 (1.561–3.014)	<0.001	2.235 (1.722–2.901)	<0.001
LVEF <40 (%)	2.032 (1.462–2.826)	<0.001	2.065 (1.571–2.714)	<0.001
Heart rate >100 (beats/min)	1.524 (1.017–2.285)	0.041	1.628 (1.167–2.271)	0.004
No PCI	1.413 (0.084–2.479)	0.029	1.541 (1.012–2.348)	0.044
Hb <12 (g/dL)	1.572 (1.092–2.263)	0.015	1.542 (1.172–2.028)	0.002
Triglycerides ≥150 (mg/dL)	0.710 (0.474–1.064)	0.097	0.776 (0.566–1.066)	0.117
BMI ≥25 (kg/m^2)	0.648 (0.469–0.896)	0.009	0.663 (0.509–0.863)	0.002
Risk factor in NSTEMI				
LVEF <40 (%)	5.611 (4.305–7.315)	<0.001	4.696 (3.832–5.755)	<0.001
No PCI	2.978 (2.162–4.102)	<0.001	3.086 (2.462–3.867)	<0.001
Age ≥65 (yr)	1.863 (1.389–2.517)	<0.001	1.750 (1.411–2.169)	<0.001
Hb <12 (g/dL)	1.512 (1.090–2.097)	0.013	1.682 (1.358–2.084)	<0.001
Male	1.366 (1.002–1.861)	0.049	1.206 (0.966–1.505)	0.098
Smoker	1.233 (0.919–1.654)	0.062	1.133 (0.907–1.417)	0.272

BMI, body mass index; CI, confidence interval; GFR, glomerular filtration rate; HR, hazard ratio; Hb, hemoglobin; LVEF, left ventricular ejection fraction; NSTEMI, non-ST-elevation myocardial infarction; PCI, percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction.

DISCUSSION

The results from the KAMIR-NIH registry data analysis showed that there was a significant difference in mortality between the STEMI and NSTEMI groups after discharge. The NSTEMI group was associated with worse outcomes than the STEMI group. After PSM analysis, during the long-term clinical follow-up of 3 years, the all-cause mortality rate was 5.9% and 13.2% and the cardiac mortality rate was 3.8% and 8.5% in the STEMI and NSTEMI groups, respectively. The major risk factors for 3-year mortality after discharge in the NSTEMI group also included old age (≥65 years) and low LVEF (<40%). The major risk factors for 3-year mortality after discharge in the STEMI group included old age (≥65 years) and low GFR (<60 mL/min/1.73 m^2).

Short-term mortality studies have shown that the mortality rate of patients with NSTEMI is lower than that of patients with STEMI.[17-19] However, regarding long-term mortality, it is generally believed that the mortality rate in patients with NSTEMI is slightly higher compared to patients with STEMI.[20,21] These reports were consistent with our findings which showed that the mortality in the NSTEMI group was almost 2 times higher than that in the STEMI group (NSTEMI vs. STEMI: 10.9% vs. 5.8%). Our results indicate that the research involving STEMI is more comprehensive and elaborate than the research involving NSTEMI; due to this, more importance is attached to STEMI, thereby resulting in more active treatment for maintenance.

Pharmacotherapeutic agents have been developed over time, which have gradually improved the therapeutic management of STEMI. However, the therapeutic management of NSTEMI has not received the same attention. Many therapeutic options for NSTEMI are mere imitations of the treatments for STEMI, and this approach to treatment is probably appropriate. The number of patients who underwent PCI was significantly higher in the NSTEMI group than in the STEMI group, as shown in Table 2. Regarding medications, major drugs other than CCBs are widely used in the management of STEMI. In particular, the rate of use of ticagrelor or prasugrel was lower in the NSTEMI group than in the STEMI group, which may be attributed to ticagrelor's ability to reduce long-term mortality.[22] However, the NSTEMI group showed worse results than the STEMI group with regard to baseline characteristics, basic diseases, and laboratory findings, which might have affected the results pertaining to mortality.

The risk factors that affected mortality were also analyzed. Old age, low LVEF, anemia, and no PCI were the main factors associated with increased mortality. These parameters were also included as the risk factors for STEMI and NSTEMI patients in the GRACE and TIMI scoring systems.[4-6] A significant observation in the present study was that low LVEF and no PCI procedures were the top two risk factors in patients with NSTEMI. Patients with heart failure had a 4.696-times higher risk of mortality compared to those without heart failure. The mortality rate in patients who did not undergo PCI was 3.084-times higher compared to patients who underwent PCI. Although the reason for the aforementioned results remain ambiguous, patients in the NSTEMI group showed type 2 MI (T2MI) and other accompanying diseases more frequently compared to patients in the STEMI group.[23,24] For instance, the lack of oxygen supply to the myocardium caused by heart failure or low LVEF, which may be attributed to long-term atrial fibrillation and tachyarrhythmia, can induce the symptoms of T2MI. However, in the STEMI group, old age was the major risk factor associated with mortality, followed by renal dysfunction and heart failure. Sustained tachycardia and anemia are possible causes of chronic heart failure. Moreover, previous studies have reported that anemia may cause a graded increase in 1-year mortality on admission or discharge in patients with AMI.[25] Anemia can be attributed to several causative factors. However, in patients with AMI, the most common cause of anemia may be chronic visceral bleeding caused by dual antiplatelet therapy. In particular, a new P2Y12 inhibitor has been reported to be very unstable with regard to bleeding in elderly people, at least in the Asian population.[26] Renal dysfunction and water-sodium retention in the body, owing to decreased urine output, gradually increase the pressure on the heart, leading to heart failure.[27] To date, PCI procedures have been the mainstay of therapy for treating the root cause of AMI, and can greatly reduce the symptoms of persistent myocardial ischemia. Many studies have proven that a patent infarct-related artery, established as early as possible after coronary artery occlusion, is associated with low mortality in patients who have received fibrinolytic therapy.[28,29] These findings further confirm that PCI is an important factor affecting the prognosis.

In recent years, the number of patients with NSTEMI has gradually increased, warranting more attention.[13] In this study, low LVEF and no PCI procedures were the main risk factors associated with mortality in patients in the NSTEMI group. Consequently, long-term, regular follow-up is needed in this population to monitor this condition. The main reason or the underlying mechanism for the difference between the two groups in the present study may have been the increase in HR and the rapid decline in renal function after the occurrence of STEMI. However, the aforementioned events can be resolved by means of PCI, and easy recovery is possible. Additionally, NSTEMI involves coronary artery dissection, spasm, and other causes of myocardial ischemia. It is very likely that these factors will increase the mortality rate associated with NSTEMI.

There are several differences in the clinical profiles, baseline characteristics, risk factors, management, and prognosis of AMI patients in Korea compared to those of patients included in Western AMI registries.[11] For instance, the proportion of patients with STEMI in the Korean population is higher than those in populations from Western countries, and the prevalence of diabetes is high, but the prevalence of dyslipidemia and MI history are low. Among these factors, diabetes mellitus is associated with greater endothelial dysfunction, inflammation, and greater atherosclerotic burden, with a greater degree of diffuse and multivessel involvement.[11,30,31] Hence, ultimately, it may be related to the differences in prognosis after AMI between Asian and Western populations.

The results of this study indicate that TIMI and GRACE scores should be used during hospitalization to evaluate the conditions of patients with AMI and to select the PCI procedure. These findings also suggest that, after discharge, both clinicians and patients should pay careful attention to the recurrence and continued deterioration of renal and cardiac function. Furthermore, medical treatments should be standardized, especially for patients with NSTEMI, to control heart failure.

The current study had certain limitations. First, this study only involved data pertaining to patients with STEMI and NSTEMI obtained from major PCI centers in Korea. Second, the multivariate analysis of risk factors excluded the Killip class and cardiogenic shock. The aforementioned factors can have a huge impact on the prognosis. A previous study reported that the mortality risk increases by 6 to 10-fold in the presence of clinically recognized heart diseases.[32] Finally, this study would benefit from more long-term data (as well as real-time data) to strengthen its findings.

In summary, the NSTEMI group showed higher mortality after discharge over a 3-year clinical follow-up period compared to the STEMI group. Low LVEF and no PCI procedure were identified as the main risk factors for 3-year mortality af-

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ter discharge in the NSTEMI group; however, old age and renal dysfunction were identified as the major risk factors for long-term mortality in the STEMI group. These findings suggest that patients with NSTEMI should receive a more intensive medical treatment and undergo regular clinical follow-ups to prevent ischemic heart failure as compared to those with STEMI.

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