

A score for decision making during percutaneous coronary intervention in acute myocardial infarction patients with multivessel disease

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Background/Aims: The optimal percutaneous coronary intervention (PCI) strategy in patients with acute myocardial infarction (AMI) with multivessel disease (MVD) is uncertain. This study was designed to develop a novel and simple tool for assessing an individualized and optimized PCI strategy in AMI patients with MVD.

Methods: In total, 5,025 patients with AMI from nine centers at two universities were enrolled in the prospective Convergent Registry of Catholic and Chonnam University for Acute Myocardial Infarction (COREA-AMI) registry from January 2004 through December 2009. From among them, we selected 2,630 patients with MVD who were treated by culprit-only or multivessel (MV) PCI. We investigated major adverse cardiac events (MACEs) during a 1-year clinical follow-up. Using a subgroup analysis, we extracted variables for use in the culprit only versus multivessel revascularization (CONVERSE) score, which showed a preference for MV PCI rather than culprit-only PCI for treating MVD.

Results: The CONVERSE score was constructed using eight independent variables (1 point for each variable): age > 65 years, hypertension, diabetes mellitus, high Killip class (III or IV), low left ventricular ejection fraction ($\leq 50\%$), low creatinine clearance (≤ 60 mL/min), high level of high-sensitivity C-reactive protein (≥ 2.0 mg/L), and left anterior descending artery or left main as the nonculprit vessel. The incidence of MACEs increased linearly with the CONVERSE score. The receiver operating characteristic curve showed that the cutoff value was 3 points.

Conclusions: The results suggest that patients with a CONVERSE score of 3 or more should undergo MV PCI.

Keywords: Percutaneous coronary intervention; Myocardial infarction; Prognosis

INTRODUCTION

In the field of acute myocardial infarction (AMI), primary percutaneous coronary intervention (PCI) is the main treatment modality, and diagnostic and therapeutic interventional techniques have progressed remarkably

over the past few decades [1,2]. Numerous coronary artery angiographic findings have shown that nearly 40% to 70% of myocardial infarction (MI) patients have multivessel disease (MVD) [3,4]. MVD can have more serious clinical manifestations and a relatively poorer prognosis than single-vessel disease [5]. Many previous studies

have been conducted to determine the optimal management of MVD. The 2013 American College of Cardiology Foundation/American Heart Association (ACCF/AHA) guidelines suggested that multivessel (MV) PCI not be performed in hemodynamically stable patients with ST-segment elevation myocardial infarction (STEMI) [1]. The 2012 European Society of Cardiology (ESC) guidelines also suggested that primary PCI be performed in the culprit vessel only in STEMI patients, unless the patient presents with cardiogenic shock or ischemia persists after PCI [6]. However, recent clinical data from the preventive angioplasty in AMI (PRAMI) trial and Complete Versus Lesion-Only Primary PCI (CvLPRIT) trial showed that MV PCI has beneficial effects in cases of STEMI [7,8]. Based on these randomized clinical trials, the latest 2015 ACCF/AHA guidelines were modified and upgraded to include a recommendation for MV PCI in MVD STEMI patients with class III to class IIB disease [9]. Despite these changes, the impact of the guideline recommendations is weak. Thus, accurate guidelines for the optimal management of AMI patients with MVD disease are still lacking.

Comparing the efficacy of culprit-only PCI and MV PCI is not simple because the characteristics of AMI patients, including age, sex, risk factors, and STEMI or non-ST-segment elevation myocardial infarction (NSTEMI) status, are heterogeneous [1,10]. These characteristics can influence clinical outcomes, and thus the PCI strategy should be selected with patient characteristics in mind. Therefore, an individualized approach is required. This study was designed to establish a novel and simple scoring system that could help guide decisions on developing individualized and optimized PCI strategies, particularly when MV PCI is considered as a treatment modality, in Korean AMI patients with MVD and either STEMI or NSTEMI.

METHODS

The Convergent Registry of Catholic and Chonnam University for Acute Myocardial Infarction (COREA-AMI) is a Korean retrospective multicenter registry that was designed to investigate the real-world outcomes of patients with AMI, including both STEMI and NSTEMI [11]. All consecutive patients diagnosed with AMI between Jan-

uary 2004 and December 2009 at nine major cardiovascular centers were retrospectively registered in this registry. The participating centers are located throughout the country and perform a large number of PCI procedures (> 500 PCIs/year). This large observational registry includes demographic, clinical, and angiographic data as well as short-term and long-term clinical outcome data. The study protocols were approved by the ethics committee at each participating center and adhered to the principles of the Declaration of Helsinki. This registry has been registered on ClinicalTrials.gov (study ID: NCT02385682). All patients provided written informed consent for participation in the registry. Trained study coordinators at each center collected data according to a standardised format. Standardised definitions of all variables were determined by the steering committee board of COREA-AMI.

In total, 5,025 patients with acute STEMI or NSTEMI were included in the COREA-AMI registry. Of this study population, 3,042 had MVD. Of these 3,042 patients, the following patients were excluded: 61 patients who failed PCI and 351 patients who lacked a 1-year follow-up. In total, 2,630 patients were ultimately included in this study. We further divided the population into the culprit-only PCI group ($n = 1,029$) and the MV PCI group ($n = 1,601$) (Fig. 1).

AMI was diagnosed according to clinical presentation, 12-lead electrocardiogram findings, and change in cardiac biomarkers (troponin I, creatine kinase-MB). The culprit-only PCI group included patients with MVD who underwent PCI of the infarct-related artery only during an initial treatment. The MV PCI group included patients with MVD who underwent a one-time complete revascularization during their initial treatment or underwent staged PCI during the admission periods included in the registry. Blood samples for baseline laboratory tests were collected in the emergency room before PCI. Two-dimensional echocardiography was performed on all patients, and the left ventricular ejection fraction (LVEF) was evaluated.

In our study, the primary end point was the incidence rate of major adverse cardiac events (MACEs) over 12 months. Total MACEs was defined as the composite of cardiac death, nonfatal MI, and repeated PCI or coronary artery bypass grafting. All deaths were considered cardiac deaths if noncardiac death could be excluded. Recur-

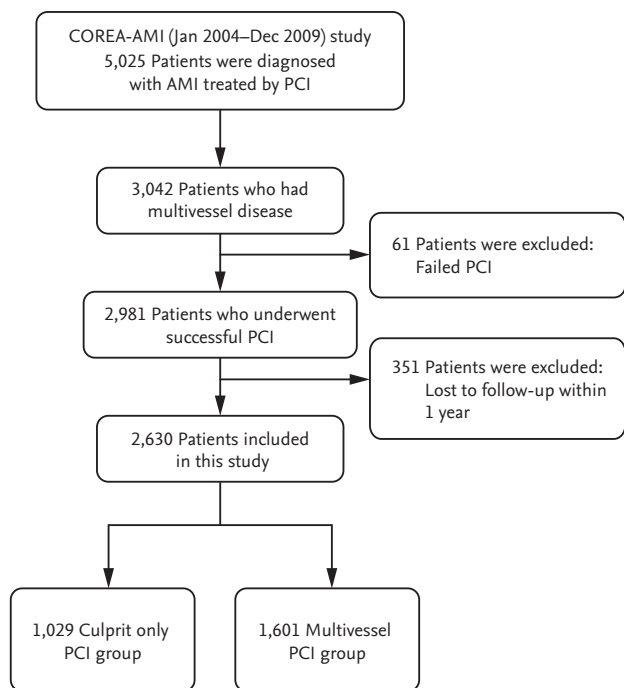


Figure 1. Study flow chart. COREA-AMI, Convergent Registry of Catholic and Chonnam University for Acute Myocardial Infarction; AMI, acute myocardial infarction; PCI, percutaneous coronary intervention.

rent MI was defined as recurrent symptoms with new ST-segment elevation or re-elevation of cardiac markers to at least twice the upper limit of normal. Target lesion revascularization (TLR) was defined as ischemia-induced PCI of the target lesion resulting from restenosis or re-occlusion within the stent or in the 5 mm adjacent to the distal or proximal segment. All patients were administered loading doses of 300 mg aspirin and 300 to 600 mg clopidogrel before PCI. A bolus of 50 to 70 IU/kg unfractionated heparin was administered before the procedure to maintain activated clotting time at 250 to 300 seconds. Coronary angiography was performed through either the radial or the femoral artery using a standard technique. The structure of the coronary angiogram, including the lesion type, was determined according to American College of Cardiology/AHA criteria. Degree of coronary flow was classified according to thrombolysis in myocardial infarction (TIMI) flow. Interventional strategies such as the use of glycoprotein IIb/IIIa inhibitors and the use of thrombectomy devices and the performance of post-dilation, intravascular ultrasound, or MV stenting were chosen by the individ-

ual surgeons. Bare metal stents and drug-eluting stents were used at the discretion of the individual surgeons. Successful PCI was defined as TIMI grade 3 flow with residual stenosis $\leq 20\%$ in the infarct-related artery [12]. After the PCI, the patients were maintained on 100 to 200 mg aspirin with 75 mg clopidogrel daily.

Statistical analysis

The baseline clinical and angiographic characteristics of the two groups were analyzed. Continuous variables are presented as means \pm standard deviations and were compared using an unpaired Student *t* test. Discrete variables are expressed as percentages and frequencies and were compared using chi-square statistics. In addition, multivariable subgroup analyses were performed to assess odds ratios (ORs) of the impact of MV PCI on the 1-year incidence of MACEs. The variables included in the analysis were age, sex, body mass index, Killip class on admission, cardiovascular risk factors (hypertension, dyslipidemia, smoking, diabetes mellitus, and family history of coronary heart disease), prior MI, chronic heart failure, prior cerebrovascular disease, peripheral arterial disease, LVEF, laboratory findings (total cholesterol, low density lipoprotein cholesterol [LDL-C], and high density lipoprotein cholesterol), final diagnosis (STEMI and NSTEMI), location of infarct-related artery, number of diseased vessels, stent type, stent size, stent diameter, success rate of PCI, use of glycoprotein IIb/IIIa during PCI, and cardiovascular medications (aspirin, clopidogrel, β -blockers, statins). Adjusted ORs were calculated using multivariable logistic regression analysis.

All analyses were performed using SPSS for Windows version 19.0 (IBM Co., Armonk, NY, USA). All statistical tests were two-tailed, with statistical significance defined as a $p \leq 0.05$.

RESULTS

As shown in Table 1, the baseline clinical characteristics of the patients were generally similar between the two groups. However, the MV PCI group tended to have a greater number of male patients. The proportion of Killip class III and IV on presentation was higher in the culprit-only PCI group. There were more STEMI patients

in the culprit-only PCI group, and there were more NSTEMI patients in the MV PCI group. LVEF was lower in the culprit-only PCI group. In terms of laboratory findings, the MV PCI group had higher concentrations of total cholesterol, triglycerides, and LDL-C. The levels of maximum creatine kinase-MB fraction, high-sensitivity C-reactive protein (hs-CRP), and N-terminal pro B-type natriuretic peptide were higher in the culprit-only PCI group. The use of discharge medications

was similar between the two groups. However, clopidogrel, statins, and renin angiotensin system blockade were prescribed less frequently in the culprit-only PCI group.

Coronary angiographic and procedural characteristics are presented in Table 2. The most common infarct-related artery in both groups was the left anterior descending (LAD) artery. The culprit-only PCI group had a greater percentage of initial TIMI flow 0. The use

Table 1. Baseline characteristics of the study population

Variable	Culprit-only PCI group (n = 1,029)	Multivessel PCI group (n = 1,601)	p value
Age, yr	64.5 ± 12.4	63.9 ± 11.7	0.214
Male sex	690 (67.1)	1,133 (70.8)	0.044
Killip class III–IV	165 (16.0)	165 (10.3)	< 0.001
Hypertension	568 (55.2)	878 (54.8)	0.857
Diabetes mellitus	363 (35.3)	583 (36.4)	0.553
Family history of CAD	53 (5.2)	96 (6.0)	0.360
Previous myocardial infarction	44 (4.3)	70 (4.4)	0.906
Smoking	548 (53.3)	912 (57.0)	0.062
STEMI	638 (62.0)	884 (55.2)	0.001
NSTEMI	391 (38.0)	717 (44.8)	0.001
Left ventricular ejection fraction, %	52.2 ± 11.8	53.7 ± 12.1	0.003
Laboratory findings			
Maximum troponin I, ng/L	35.1 ± 55.0	34.9 ± 58.4	0.933
Maximum creatine kinase-MB fraction, IU/L	108.1 ± 157.6	81.3 ± 114.7	< 0.001
Serum creatine, mg/dL	1.2 ± 1.0	1.2 ± 1.0	0.338
Total cholesterol, mg/dL	178.2 ± 42.9	182.4 ± 43.2	0.018
Triglyceride, mg/dL	115.8 ± 76.3	123.0 ± 86.3	0.034
LDL-C, mg/dL	115.3 ± 37.2	119.30 ± 37.8	0.004
HDL-C, mg/dL	41.3 ± 11.1	42.7 ± 11.6	0.013
hs-CRP, mg/L	3.1 ± 4.9	2.1 ± 3.7	< 0.001
NT-proBNP, pg/mL	3,917.1 ± 7,791.7	2,949.2 ± 6,440.4	0.010
Discharge medication			
Aspirin	1,023 (99.4)	1,598 (99.8)	0.090
Clopidogrel	1,018 (98.9)	1,598 (99.8)	0.002
Renin angiotensin system blockade	782 (76.0)	1,287 (80.4)	< 0.001
β-Blocker	766 (74.4)	1,242 (77.6)	0.065
Statin	865 (84.1)	1,400 (87.4)	0.014

Values are presented as mean ± SD or number (%).

PCI, percutaneous coronary intervention; CAD, coronary artery disease; STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; hs-CRP, high-sensitivity C-reactive protein; NT-proBNP, N-terminal pro B-type natriuretic peptide.

Table 2. Baseline coronary angiographic and procedural characteristics of the study population

Variable	Culprit-only PCI group (n = 1,029)	Multivessel PCI group (n = 1,601)	p value
Infarct-related coronary artery			0.028
Left anterior descending artery	442 (43.0)	656 (41.0)	
Right coronary artery	362 (35.2)	598 (37.4)	
Left circumflex artery	176 (17.1)	302 (18.9)	
Left main	49 (4.8)	45 (2.8)	
Three vessel disease	402 (39.1)	628 (39.2)	0.989
Initial TIMI flow grade	455 (44.2)	607 (37.9)	0.001
Drug-eluting stent	942 (91.5)	1,478 (92.3)	0.062
Stent size, mm	29.6 ± 14.0	28.7 ± 13.7	0.093
Stent diameter, mm	3.2 ± 0.4	3.2 ± 0.4	0.948
Number of stents	1.1 ± 0.6	2.1 ± 1.2	< 0.001
GP IIb/IIIa inhibitor use during PCI	140 (13.6)	308 (19.2)	< 0.001
Success rate of PCI	689 (97.4)	1,661 (95.1)	0.080

Values are presented as number (%) or mean ± SD.

PCI, percutaneous coronary intervention; TIMI, thrombolysis in myocardial infarction; GP, glycoprotein.

Table 3. Clinical outcomes at 1 year

Variable	Culprit-only PCI group (n = 1,029)	Multivessel PCI group (n = 1,601)	p value
Cardiac death	146 (14.2)	109 (6.8)	< 0.001
Nonfatal re-MI	25 (2.4)	43 (2.7)	0.686
Total stent thrombosis	19 (1.8)	43 (2.7)	0.166
Re-PCI	166 (16.1)	272 (17.2)	0.459
TLR	84 (8.2)	182 (11.4)	0.008
TVR	22 (2.1)	59 (3.7)	0.025
Non-TVR	85 (8.3)	86 (5.4)	0.003
CABG	9 (0.9)	2 (0.1)	0.004
HF requiring hospitalization	79 (62.0)	85 (5.3)	0.014
Stroke	22 (2.1)	30 (1.9)	0.635

Values are presented as number (%).

PCI, percutaneous coronary intervention; MI, myocardial infarction; TLR, target lesion revascularization; TVR, target vessel revascularization; CABG, coronary artery bypass graft; HF, heart failure.

of glycoprotein IIb/IIIa inhibitors during PCI was more frequent in the MV PCI group. The size, diameter, and type of stent and the use of drug-eluting stents were not significantly different between the two groups.

Table 3 shows the primary outcome: the incidence of total MACEs in 12 months. The incidences of nonfatal re-MI, stent thrombosis, and stroke were not signifi-

cantly different between the two groups. Both groups were similar in terms of the re-PCI rate, but target vessel revascularization (TVR) and TLR were higher in the MV PCI group. Accordingly, the incidence of non-TVR was higher in the culprit-only PCI group. In addition, more patients in the culprit-only PCI group underwent coronary artery bypass grafting. The major differences

between the two groups were in the incidences of cardiac death and heart failure requiring hospitalization. Both events occurred more often in the culprit-only PCI group.

The adjusted ORs for total MACEs over 12 months by

strategy in various subgroups, analyzed by multivariable subgroup analysis and multivariable logistic regression analysis, are presented in Fig. 2. Among patients with older age, hypertension, diabetes mellitus, decreased LV systolic function, high Killip class, decreased renal func-

Table 4. Culprit only versus multivessel revascularization (CONVERSE) score

Variable	Adjusted OR	Points
Age ≥ 65 years	1.610	1 point
Hypertension	1.642	1 point
Diabetes mellitus	1.543	1 point
Killip class III or IV	1.587	1 point
LVEF ≤ 50%	1.934	1 point
Creatinine clearance ≤ 60 mL/min	1.760	1 point
hs-CRP ≥ 2 mg/L	1.915	1 point
Nonculprit vessel: LAD or LM	1.733	1 point

Adjusted OR was calculated by multivariable logistic regression analysis.

OR, odds ratio; LVEF, left ventricular ejection fraction; hs-CRP, high-sensitivity C-reactive protein; LAD, left anterior descending artery; LM, left main.

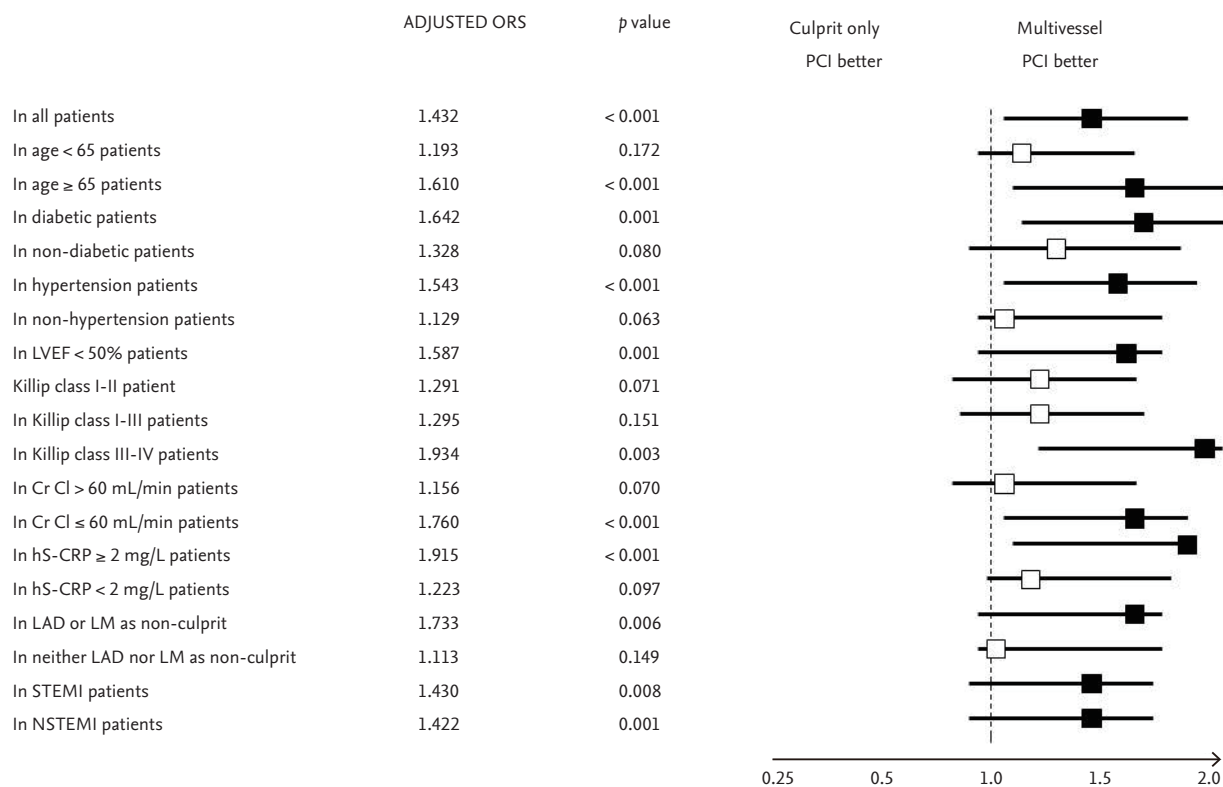


Figure 2. Adjusted odd ratios (ORs) in subgroup analysis. Adjusted ORs for the incidence of major adverse cardiac events (MACEs) associated with culprit-only percutaneous coronary intervention (PCI) or multivessel PCI. LVEF, left ventricular ejection fraction; CrCl, creatinine clearance; hs-CRP, high-sensitivity C-reactive protein; LAD, left anterior descending; LM, left main; STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction.

tion, high hs-CRP, and left main (LM) or LAD artery as the nonculprit vessel, both STEMI and NSTEMI patients showed significantly better outcomes with MV PCI. The culprit only versus multivessel revascularization (CONVERSE) score is composed of the following factors: age (≥ 65 years), hypertension, diabetes mellitus, LVEF ($< 50\%$),

Killip class (III–IV), creatine clearance (IV), hs-CRP (≥ 2 mg/L), and LAD or LM artery as the nonculprit vessel (Table 4). The type of diagnosis was excluded because the patients were diagnosed with either STEMI or NSTEMI. Each of the eight factors was assigned 1 point, and thus the total CONVERSE score ranged from 0 to 8 points.

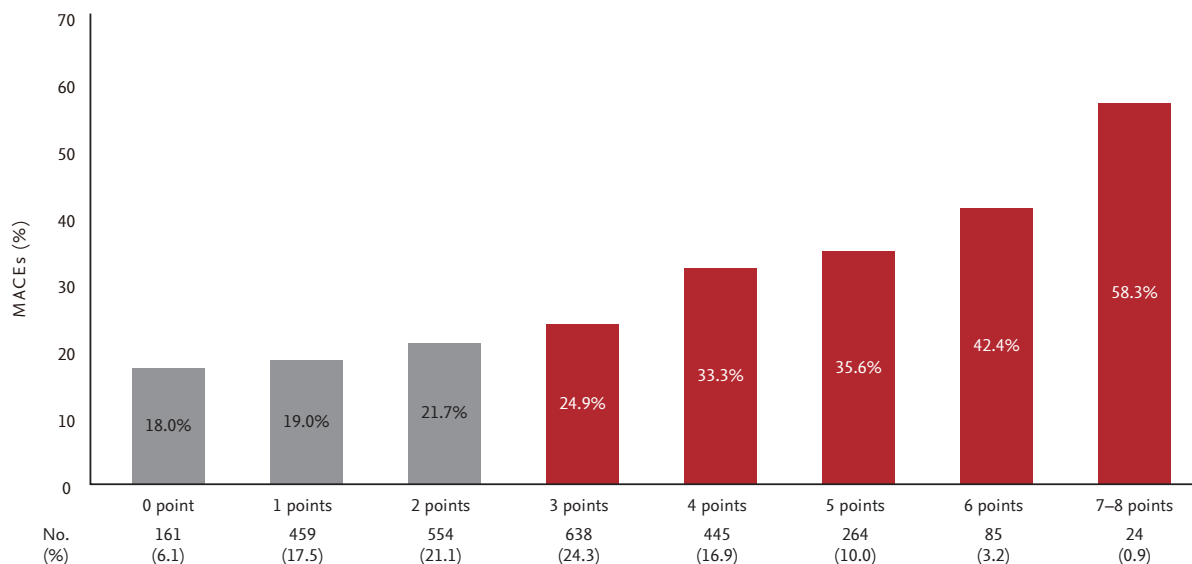


Figure 3. Total major adverse cardiac events (MACEs) according to the culprit only versus multivessel revascularization (CONVERSE) score. Total incidence of MACEs according to CONVERSE score ranging from 0 to 8 points.

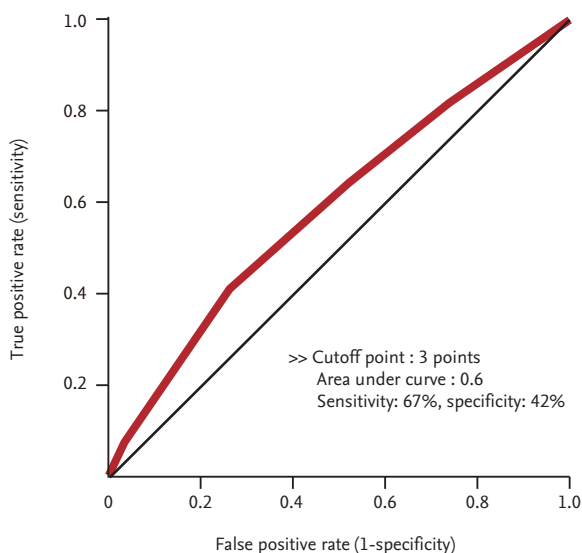


Figure 4. Receiver operating characteristic curve of culprit only versus multivessel revascularization (CONVERSE) score. The cutoff point for the CONVERSE score was 3 points

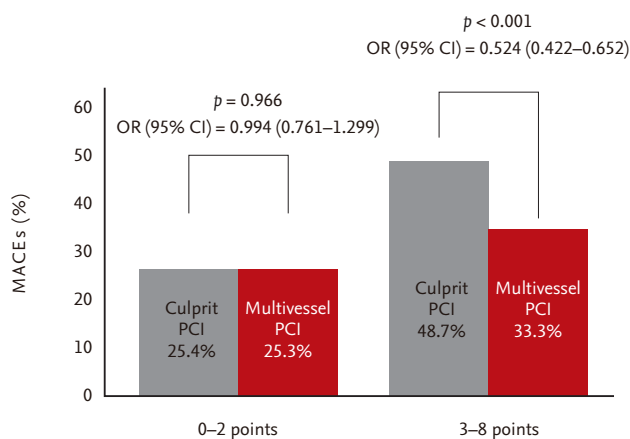


Figure 5. Total major adverse cardiac events (MACEs) of culprit versus multivessel percutaneous coronary intervention (PCI) according to culprit only versus multivessel revascularization (CONVERSE) score.

As shown in Fig. 3, the incidence of 1-year MACEs tended to increase with a higher CONVERSE score. Through receiver operating characteristic curve analysis of the CONVERSE score, the cutoff value was determined to be 3 points (sensitivity 67%, specificity 42%) (Fig. 4).

We further divided the patients into groups with a low CONVERSE score (0 to 2 points) or a high CONVERSE score (3 to 8 points) and compared the incidence of 12-month total MACEs in the culprit-only PCI and MV PCI groups (Fig. 5). The analysis showed that in patients with a relatively low CONVERSE score (0 to 2 points), 12-month total MACEs did not differ significantly between the culprit-only PCI group and the MV PCI group (OR, 0.994; 95% confidence interval [CI], 0.761 to 1.299; $p = 0.966$). However, in patients with a high CONVERSE score (3 to 8 points), the incidence of 12-month total MACEs was lower in the MV PCI group than in the culprit-only PCI group (OR, 0.524; 95% CI, 0.422 to 0.652; $p < 0.001$).

DISCUSSION

MVD accounts for more than half of all cases of AMI according to many registries, including data from the Korean AMI registry [13]. Two main types of PCI are used to treat MV AMI: culprit-only PCI and MV PCI. The 2012 ESC guidelines recommended that primary PCI be limited to the culprit vessel, with the exception of cardiogenic shock and persistent ischemia after PCI of the supposed culprit lesion [6]. The 2011 ACCF/AHA/SCAI (Society for Cardiovascular Angiography and Interventions) PCI guidelines also suggested that PCI not be performed in a nonculprit vessel at the time of primary PCI in patients with STEMI without hemodynamic compromise [12]. The classes and levels of evidence for these two recommendations were IIB and IIIb, respectively. However, several recent randomized clinical trials, including the PRAMI and CvLPRIT trials, showed that MV PCI resulted in better clinical outcomes than culprit-only PCI [7,8]. As a result, both the ACCF/AHA and ESC guidelines have been altered to favor MV PCI for treating MV AMI patients [9,14]. However, this change is still controversial because of a lack of strong evidence, despite many clinical studies [13,15-17]. The main factors supporting culprit-only PCI are complications related to nonculprit

vessel PCI, overvalued stenosis, renal insufficiency, and low success rates [18-20]. Comparing the effectiveness of each PCI strategy is not easy, because the characteristics of AMI patients, including age, sex, risk factors, laboratory results, and angiographic findings, are heterogeneous. An individualized approach is required that accounts for the characteristics of each patient. Therefore, we designed this study to evaluate an individualized PCI strategy based on patients' clinical characteristics. The incidence of MACEs, particularly cardiac deaths and heart failure requiring hospitalization, was higher in the culprit-only PCI group than the MV PCI group. However, MV PCI was no better than culprit-only PCI in some subgroups. Therefore, we selected the subgroups that showed superiority for MV PCI. The CONVERSE score was developed using these clinical variables.

The CONVERSE score, which reveals a preference for MV PCI rather than culprit-only PCI, is composed of the following factors: age (≥ 65 years), hypertension, diabetes mellitus, LVEF ($< 50\%$), Killip class (III-IV), creatinine clearance (≤ 60 mL/min), hs-CRP (≥ 2 mg/L), and LAD or LM artery as the nonculprit vessel. All variables are well-known predictors of poor prognosis in AMI [5]. Therefore, MV PCI was more effective than culprit-only PCI in AMI patients suspected of having a worse prognosis with many risk factors.

These findings are consistent with other studies, except for the concern of renal dysfunction. In a meta-analysis, MV PCI increased the risk of renal dysfunction because of the high dose of contrast agent [21]. However, in this study, MV PCI improved clinical outcomes in the renal dysfunction subgroup. Although procedures using a large amount of contrast media could aggravate renal dysfunction, MV PCI with a staged procedure could improve clinical outcomes in patients with renal dysfunction. In addition, MV PCI was more effective for the subgroup of patients with high levels of hs-CRP. The hs-CRP, an inflammatory biomarker, independently predicts future vascular events and poor prognosis in AMI patients [22]. Thus, we believe that MV revascularization may have improved clinical outcomes in AMI patients with high levels of hs-CRP. In addition, the LM and LAD arteries are the most important vessels for maintaining left ventricular systolic function [23]. Coronary artery disease involving the LM or LAD artery is associated with worse clinical outcomes owing to sys-

toxic dysfunction and severe arrhythmia [24]. Therefore, revascularization of the LM or LAD artery should be performed even if it is the nonculprit vessel.

Some aspects of our study should be considered relative to previous studies. First, the purpose of this study was not just to compare the PCI strategies but to also establish a patient-specific PCI strategy. To the best of our knowledge, this study is the first to identify an optimal individualized PCI strategy related to clinical characteristics in AMI patients with MVD. Second, this study did not consider the concept of staged PCI. Cases of one-time complete revascularization in an initial procedure and staged PCI during the index admission period were both included in the MV PCI group. Several recent studies have reported that a staged PCI strategy in AMI patients with MVD can improve clinical outcomes compared to a culprit-only PCI strategy. Marino et al. [25] showed that MV coronary artery disease STEMI patients who underwent staged MV PCI within 30 days had a significantly lower cardiac mortality rate than patients who underwent culprit vessel PCI only. Vlaar et al. [4] performed a meta-analysis that favored complete revascularization in patients with STEMI. Among the different interventional strategy groups in that study, staged PCI was associated with lower short- and long-term mortality compared to culprit-only PCI and MV PCI during the primary PCI [4]. Subgroup analysis in the HORIZONS-AMI (Harmonizing Outcomes With Revascularization and Stents in AMI) trial compared culprit-only PCI with staged PCI in patients with STEMI. The results indicated higher 1-year mortality, cardiac death, and stent thrombosis in the culprit-only PCI group than in the MV PCI group. Furthermore, there was a trend toward higher 1-year MACEs in the former group [17]. Jensen et al. [16] also reported that in patients with STEMI, staged PCI within 60 days of the index hospitalization can reduce 1-year mortality compared to patients who undergo culprit-only PCI during the primary PCI. Third, the CONVERSE score was calculated from eight factors that were each assigned 1 point. We imposed a score of 1 point for each variable to simplify the scoring system and because the OR for each variable were similar in the multivariable logistic regression analyses (Table 4). Fourth, patients with cardiogenic shock were excluded from the present study because the 2013 ACC/AHA guidelines for the management of STEMI recom-

mend PCI for the culprit and nonculprit vessels simultaneously in patients with cardiogenic shock [1].

This study has some limitations. First, this study was not a randomized controlled trial, and selection bias may have existed owing to the retrospective analysis. Although we adjusted for all possible confounding factors, other potent variables may have been associated with clinical outcomes. Furthermore, the definitive cause of unfavorable outcomes in delayed staged PCI is uncertain. Second, our study lacked data on the complexity of the coronary anatomy and myocardial viability before staged PCI. The SYNTAX score is designed to predict outcomes related to anatomical characteristics, such as the dominant artery, number of lesions, other lesion characteristics, and to a lesser extent the functional risk of occlusion of any segment of the coronary artery in patients with MVD. A high SYNTAX score indicates more complex disease and is associated with poorer cardiovascular outcomes [26-28]. According to previous studies, including the third DANish Study of Optimal Acute Treatment of Patients with ST-segment Elevation Myocardial Infarction PRIMARY PCI in MULTIVessel Disease (DANAMI3-PRIMULTI) trial, myocardial functional evaluation by fractional flow reserve could be a possible option before a second staged PCI is performed, but our registry did not contain this information [29,30]. Finally, the sensitivity and specificity for the cutoff value (3 points) were too low. We assume that this limitation has to do with the small study population. Therefore, a large-scale randomized controlled trial is needed to provide more accurate guidelines.

In conclusion, the CONVERSE score was designed to determine an optimal individualized PCI strategy in AMI patients with MVD. We constructed the score using eight independent variables that were identified in subgroup analysis, including clinical, laboratory, and angiographic characteristics. The CONVERSE score is a simple and reasonable method for choosing a PCI strategy and reflects the clinical outcomes of AMI patients with MVD. Overall, the results suggest that patients with a CONVERSE score of 3 or more would benefit from undergoing MV PCI.

KEY MESSAGE

1. The characteristics of acute myocardial infarction (AMI) patients are heterogeneous. Therefore,

an individualized and optimized percutaneous coronary intervention (PCI) strategy is required in Korean AMI patients with multivessel disease.

2. The culprit only versus multivessel revascularization (CONVERSE) score is constructed using baseline clinical characteristics, laboratory, echographic, angiographic findings.
3. The patients with a CONVERSE score of 3 or more are recommended to undergo multivessel PCI.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Acknowledgments

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