



Acute Coronary Syndrome With Unprotected Left Main Coronary Artery Culprit

— An Observation From the AOI-LMCA Registry —

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Background: Data on the clinical outcomes of percutaneous coronary intervention (PCI) for unprotected left main coronary artery (LMCA) in patients with acute coronary syndrome (ACS) are limited. Therefore, this study aimed to assess the clinical outcome of patients with ACS who underwent PCI for LMCA culprit lesion.

Methods and Results: Of 1,809 patients enrolled in the Assessing Optimal Percutaneous Coronary Intervention for the LMCA (AOI-LMCA) registry (a retrospective 6-center registry of consecutive patients undergoing LMCA stenting in Japan), the current study population consisted of 1,500 patients with unprotected LMCA stenting for LMCA ACS (ACS with shock: 115 patients, ACS without shock: 281 patients) and stable CAD (1,104 patients). The cumulative 180-day incidence of death was markedly higher in the ACS with shock group than in the other groups (49.5%, 8.6%, and 3.3%, respectively; $P<0.0001$), but mortality beyond 180-day was not significantly different among the 3 groups (30.2%, 20.4%, and 19.5%, respectively; $P=0.65$). In the ACS with shock group, the initial TIMI flow grade did not affect 5-year mortality (57.1% and 62.2%, $P=0.99$), but in the ACS without shock group, 5-year mortality was significantly higher in patients with initial TIMI flow grade ≤ 1 than in patients with TIMI flow grade ≥ 2 (44.4% and 23.7%, respectively; $P=0.008$).

Conclusions: In patients with LMCA ACS, survival correlates with baseline hemodynamic and coronary flow status.

Key Words: Acute coronary syndrome; Cardiogenic shock; Coronary stenting; Left main coronary artery

Acute coronary syndrome (ACS) caused by left main coronary artery (LMCA) disease often presents as cardiogenic shock and is associated with a subsequent high mortality rate.^{1–4} Acute occlusion involving the LMCA is a clinically severe adverse event causing cardiogenic shock, and fatal arrhythmias because of the large area of myocardium in jeopardy. The current clinical guidelines for ST-elevation myocardial infarction (MI) and non-ST-elevation ACS recommend primary percutaneous

coronary intervention (PCI) in patients with cardiogenic shock,^{5,6} because emergency coronary reperfusion is the current evidence-based therapeutic intervention;^{7,8} however, data on the long-term clinical outcomes of PCI for unprotected LMCA in patients with ACS are limited. This study aimed to evaluate the long-term clinical outcomes of patients with ACS who underwent PCI for LMCA culprit lesion.

Received August 7, 2018; revised manuscript received September 10, 2018; accepted October 2, 2018; J-STAGE Advance Publication released online November 9, 2018 Time for primary review: 28 days

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Clinical Trial Registration: Assessing Optimal Percutaneous Coronary Intervention for Left Main Coronary Artery Stenting Registry (AOI-LMCA Stenting Registry). [<http://www.umin.ac.jp/ctr/index/htm/>] Unique Identifier: UMIN000014706

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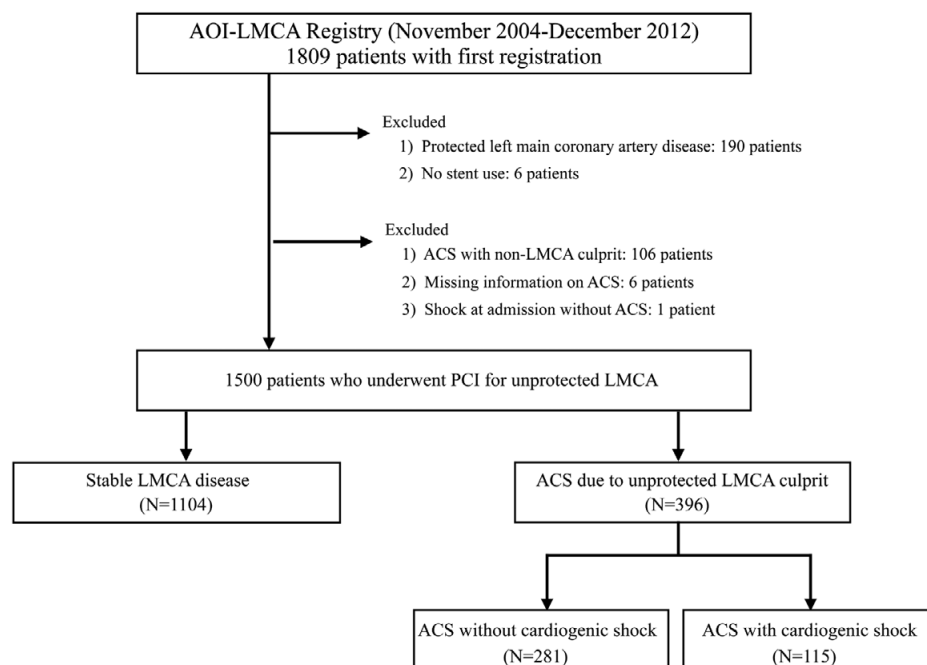


Figure 1. Study flow chart. ACS, acute coronary syndrome; AOI-LMCA, Assessing Optimal Percutaneous Coronary Intervention for the LMCA; LMCA, left main coronary artery.

Methods

Study Design and Patient Population

The Assessing Optimal Percutaneous Coronary Intervention for the LMCA (AOI-LMCA) registry is a physician-directed, non-company-sponsored and retrospective multi-center registry that enrolls consecutive patients undergoing PCI using coronary stents, either drug-eluting (DES) or bare metal (BMS) for LMCA disease in Japan. From November 2004 to December 2012, 1,809 patients underwent LMCA stenting for the first time at 6 tertiary hospitals in Japan. The study design, patient enrollment, and main outcomes from the AOI-LMCA registry have been reported elsewhere.⁹ All procedures, including stent choice, stenting technique, and the duration of dual antiplatelet therapy, were left to the discretion of individual centers.

In the present analysis, we compared the baseline characteristics and clinical outcomes among 3 groups of patients undergoing unprotected LMCA stenting (ACS with shock, ACS without shock and stable coronary artery disease [CAD]). The diagnosis of shock was made at hospital admission. The study population consisted of 1,500 patients (ACS with shock: 115 patients, ACS without shock: 281 patients, stable CAD: 1,104 patients), after excluding 190 patients with protected LMCA disease, 6 patients who underwent LMCA PCI without stent use, 106 ACS patients with non-LMCA culprit lesion, 6 patients with missing information on ACS, and 1 patient with shock vital at admission without ACS (**Figure 1**).

The research protocol was approved by the local ethics committee of all 6 participating medical centers, which waived the requirement of obtaining informed consent from patients because of the retrospective nature of the

study. However, we excluded those patients who declined to participate in this study when contacted for follow-up. All patient records were anonymized and de-identified before the analysis.

Definitions and Clinical Outcomes

We collected demographic, angiographic, and procedural data from hospital charts based on prespecified definitions. The details of the definitions used in this study were reported previously.⁹ We defined unprotected LMCA disease as angiographically significant stenosis of the LMCA without patent surgical grafts to the left coronary artery system. We defined cardiogenic shock as Killip class 4 at presentation, indicating systolic blood pressure <90 mmHg and manifestations of hypoperfusion such as oliguria, cyanosis and diaphoresis. ACS includes ST-segment elevation MI, non-ST-segment elevation MI on the basis of myocardial enzyme elevation, and unstable angina, which was defined as myocardial ischemia at rest or on minimal exertion in the absence of cardiomyocyte necrosis.

The primary outcome measure in this study was all-cause death. The secondary outcome measures included cardiac death, sudden death, MI, definite stent thrombosis, target lesion revascularization (TLR), any coronary revascularization, and major bleeding. We defined stent thrombosis according to the Academic Research Consortium definition.¹⁰ In addition, TLR was defined as either PCI or coronary artery bypass grafting (CABG) for restenosis or thrombosis of the target lesion, which involved the proximal and distal edge segments as well as the ostium of any side branches originating from the LMCA. Major bleeding was defined as Bleeding Academic Research Consortium categorization types 3 and 5.¹¹

Table 1. Baseline Characteristics of the ACS Patients

Variable	ACS with shock (n=115)	ACS without shock (n=281)	Stable CAD (n=1,104)	P value
Age (years)	70.2±11.7	72.0±11.1	72.0±9.8	0.18
≥80*	26 (23%)	74 (26%)	263 (24%)	0.61
Male	89 (77%)	205 (73%)	834 (76%)	0.63
Hypertension	62 (54%)	194 (69%)	853 (77%)	<0.0001
Dyslipidemia	37 (33%)	122 (43%)	631 (57%)	<0.0001
Current smoker	31 (27%)	68 (24%)	151 (14%)	<0.0001
Diabetes mellitus*	39 (34%)	104 (37%)	478 (43%)	0.03
Treated with insulin	7 (6.1%)	24 (8.6%)	121 (11%)	0.14
Familial history of CAD	19 (18%)	36 (13%)	179 (18%)	0.16
eGFR ≤30 without HD*	15 (13%)	19 (6.8%)	49 (4.4%)	0.0004
ESRD on HD*	6 (5.2%)	11 (3.9%)	69 (6.3%)	0.28
Atrial fibrillation	11 (9.6%)	19 (6.8%)	85 (7.7%)	0.66
Prior PCI*	19 (17%)	76 (27%)	555 (50%)	<0.0001
Prior CABG	0	2 (0.7%)	52 (4.7%)	<0.0001
Prior MI	16 (14%)	51 (18%)	350 (32%)	<0.0001
Prior stroke*	13 (11%)	38 (14%)	144 (13%)	0.81
Prior HF*	15 (13%)	38 (14%)	140 (13%)	0.89
COPD	3 (2.6%)	6 (2.1%)	36 (3.3%)	0.57
Malignancy*	14 (12%)	24 (8.5%)	109 (9.9%)	0.56
Aortic disease	5 (4.4%)	11 (3.9%)	82 (7.4%)	0.047
PAD*	14 (12%)	26 (9.3%)	158 (14%)	0.06
LVEF (%)†	42.3±14.6	54.5±13.8	58.1±12.9	<0.0001
EURO SCORE	10.9±4.01	7.9±3.6	4.7±2.8	<0.0001
EURO SCORE >6.0	96 (84%)	173 (62%)	267 (24%)	<0.0001
Clinical presentation of ACS				<0.0001
UA/NSTEMI	28 (24%)	226 (80%)		
STEMI	87 (76%)	55 (20%)		
Laboratory data				
WBC (×10 ³ /μL)	10.5±5.9 (n=102)	8.2±3.9 (n=273)	6.1±1.8 (n=1,073)	<0.0001
Hemoglobin (g/dL)	12.9±2.9 (n=102)	12.8±2.5 (n=273)	12.7±4.3 (n=1,073)	0.84
Creatinine (mg/dL)	1.52±1.44 (n=104)	1.38±1.67 (n=274)	1.38±1.79 (n=1,087)	0.74
LDL-C (mg/dL)	112.6±39.0 (n=37)	105.8±30.1 (n=97)	110.2±39.0 (n=691)	0.99
HbA1c (%)	5.8±0.96 (n=28)	6.0±1.2 (n=77)	6.0±1.02 (n=650)	0.70
BNP (pg/mL)	554.7±1,713.1 (n=65)	375.6±534.0 (n=136)	247.8±497.4 (n=261)	0.02
Albumin (g/dL)	3.5±0.68 (n=101)	3.8±0.5 (n=269)	3.9±0.46 (n=947)	<0.0001
CRP (mg/L)	1.4±3.0 (n=102)	1.5±3.0 (n=250)	0.59±1.3 (n=806)	<0.0001
Max CPK after PCI	10,225±13,640 (n=86)	2,539±4,490 (n=180)		<0.0001
Medications at discharge				
Aspirin	66 (96%, n=69)	261 (98%, n=266)	1,084 (99%, n=1,095)	<0.0001
Thienopyridine	63 (91%, n=69)	256 (96%, n=266)	1,076 (98%, n=1,095)	<0.0001
Warfarin	12 (17%, n=69)	25 (9.4%, n=266)	101 (9.2%, n=1,095)	0.76
Statins	38 (55%, n=69)	191 (72%, n=266)	699 (64%, n=1,095)	<0.0001
β-blockers	24 (35%, n=69)	84 (32%, n=266)	301 (28%, n=1,095)	0.23
ACEI/ARB	41 (59%, n=69)	167 (63%, n=266)	599 (55%, n=1,095)	0.003
PPI	42 (61%, n=69)	148 (56%, n=266)	423 (39%, n=1,095)	<0.0001

Data are presented as number (%) or mean±SD unless otherwise noted. *Risk-adjusting variables selected for Cox proportional hazards models. †Calculated in 883 patients in the stable CAD group, in 64 patients in the ACS with shock group, and 217 patients in the ACS without shock group. ACEI, angiotensin-converting enzyme inhibitor; ACS, acute coronary syndrome; ARB, angiotensin II receptor blocker; BNP, B-type natriuretic polypeptide; CABG, coronary artery bypass grafting; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CPK, creatine phosphokinase; CRP, C-reactive protein; eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease; HbA1c, hemoglobin A1c; HD, hemodialysis; HF, heart failure; LDL-C, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; MI, myocardial infarction; PAD, peripheral artery disease; PCI, percutaneous coronary intervention; PPI, proton pump inhibitor; NSTEMI, non-ST-segment elevation MI; STEMI, ST-segment elevation MI; UA, unstable angina; WBC, white blood cell.

Variable	ACS with shock (n=115)	ACS without shock (n=281)	Stable CAD (n=1,104)	P value
Extent of CAD				0.03
Left main only	23 (20%)	36 (13%)	115 (10%)	
1-vessel disease	27 (24%)	70 (25%)	347 (31%)	
2-vessel disease*	43 (37%)	107 (38%)	428 (39%)	
3-vessel disease*	22 (19%)	68 (24%)	214 (19%)	
CTO	25 (22%)	44 (16%)	191 (17%)	0.42
RCA-CTO	10 (8.7%)	10 (3.6%)	75 (6.8%)	0.06
Stenosis (%)				<0.0001
Total occlusion	25 (22%)	9 (3.2%)	11 (1.0%)	
Non-occlusive stenosis	90 (78%)	271 (97%)	1,093 (99%)	
TIMI grade				<0.0001
≤1	25 (22%)	9 (3.2%)	11 (1.0%)	
2	32 (28%)	38 (14%)	29 (2.6%)	
3	58 (50%)	234 (83%)	1,064 (96%)	
AHA/ACC classification (B2/C lesion)	92 (80%)	223 (83%)	997 (91%)	
Emergency PCI	114 (99%)	264 (94%)	20 (1.8%)	
De novo lesion	113 (98%)	269 (96%)	1,071 (97%)	0.34
Moderate/severe calcification*	16 (14%)	41 (15%)	167 (15%)	0.91
Trifurcation	12 (11%)	29 (10%)	131 (12%)	0.74
2-stent procedure				0.34
Culotte	18/23 (78%)	45/62 (73%)	131/189 (69%)	
T-stenting	3/23 (13%)	16/62 (26%)	52/189 (28%)	
V-stenting	0/23 (0%)	0/62 (0%)	1/189 (0.5%)	
Crush	0/23 (0%)	2/62 (0%)	3/189 (1.6%)	
Mini-crush	2 (8.7%)	1 (1.6%)	2/189 (1.1%)	
Stenting ostial LMCA	92 (80%)	231 (82%)	899 (81%)	0.83
POT	12 (10%)	39 (14%)	143 (13%)	0.62
Final kissing balloon technique	71 (62%)	204 (73%)	737 (67%)	0.10
Stent type*				<0.0001
BMS	60 (52%)	76 (27%)	150 (14%)	
G1-DES	22 (19%)	117 (42%)	576 (52%)	
G2-DES	33 (29%)	88 (31%)	378 (34%)	
No. of implanted stents	1.25±0.05	1.21±0.03	1.26±0.016	0.43
Stent length (main branch) (mm)	22.4±1.16	22.9±0.74	23.9±0.37	0.27
Stent diameter (main branch) (mm)	3.31±0.03	3.28±0.02	3.28±0.01	0.69
Stent length (side branch) (mm)	19.6±1.41	18.4±0.87	20.7±0.50	0.07
Stent diameter (side branch) (mm)	2.88±0.08	2.93±0.05	2.88±0.03	0.07
Stent length (main branch) ≥30 mm*	21 (18%)	56 (20%)	223 (20%)	0.86
Stent diameter (main branch) ≥3.5 mm*	75 (65%)	158 (56%)	689 (62%)	0.14
IVUS*	69 (60%)	192 (68%)	731 (66%)	0.32
Rotablator	3 (2.6%)	6 (2.1%)	89 (8.1%)	<0.0001
IABP	98 (85%)	67 (24%)	30 (2.7%)	<0.0001
PCPS	30 (26%)	5 (1.8%)	3 (0.3%)	<0.0001
No-reflow/slow flow during procedure	31 (27%)	17 (6.1%)	30 (2.7%)	<0.0001
Approach site				0.73
Radial artery	18 (16%)	55 (20%)	209 (19%)	
Brachial artery	11 (9.6%)	32 (11%)	133 (12%)	
Femoral artery	86 (75%)	194 (69%)	759 (69%)	

Data are presented as number (%) or mean±SD unless otherwise noted. *Potential independent risk-adjusting variables selected for Cox proportional hazards models. ACC, American College of Cardiology; AHA, American Heart Association; BMS, bare metal stent; CTO, chronic total occlusion; G1-DES, 1st-generation drug-eluting stent; G2-DES, 2nd-generation drug-eluting stent; IABP, intra-aortic balloon pumping; IVUS, intravascular ultrasound; PCPS, percutaneous cardiopulmonary support; POT, proximal optimization technique; RCA, right coronary artery. Other abbreviations as in Table 1.

Table 3. Crude Clinical Outcomes				
	No. of patients with event (cumulative incidence, %)			P value
	ACS with shock (n=115)	ACS without shock (n=281)	Stable CAD (n=1,104)	
30-day				
All-cause death	42 (36.6%)	8 (2.9%)	13 (1.2%)	
Cardiac death	38 (33.3%)	13 (5.4%)	12 (1.1%)	
Sudden death	1 (1.0%)	0	3 (0.3%)	
MI	1 (1.1%)	2 (0.7%)	8 (0.7%)	
Definite ST	3 (3.2%)	3 (1.1%)	6 (0.5%)	
TLR	3 (3.2%)	6 (2.2%)	5 (0.5%)	
Any CR	5 (6.0%)	15 (5.5%)	12 (1.1%)	
Major bleeding	6 (6.7%)	3 (1.1%)	8 (0.7%)	
180-day				
All-cause death	54 (48.5%)	17 (8.6%)	36 (3.3%)	
Cardiac death	49 (44.1%)	7 (2.5%)	18 (1.6%)	
Sudden death	1 (1.0%)	2 (0.8%)	7 (0.6%)	
MI	3 (4.4%)	3 (1.1%)	10 (0.9%)	
Definite ST	4 (5.0%)	3 (1.1%)	8 (0.7%)	
TLR	5 (6.9%)	24 (9.2%)	40 (3.7%)	
Any CR	10 (14.8%)	47 (18%)	83 (7.8%)	
Major bleeding	7 (8.5%)	9 (3.4%)	16 (1.4%)	
5-year				
All-cause death	65 (61.3%)	55 (24.4%)	179 (20.3%)	<0.0001
Cardiac death	51 (46.4%)	3 (9.5%)	55 (6.5%)	<0.0001
Sudden death	2 (3.0%)	3 (1.2%)	19 (2.2%)	0.63
MI	4 (9.0%)	9 (4.7%)	23 (2.8%)	0.04
Definite ST	5 (7.1%)	3 (1.1%)	8 (0.73%)	<0.0001
TLR	8 (12.9%)	38 (16.2%)	140 (15.0%)	0.58
Any CR	17 (29.6%)	89 (41.2%)	304 (32.5%)	0.08
Major bleeding	11 (17.2%)	18 (8.4%)	68 (8.2%)	0.0007

CI, confidence interval; CR, coronary revascularization; HR, hazard ratio; ST, stent thrombosis; TLR, target lesion revascularization. Other abbreviations as in Table 1.

Statistical Analysis

We show continuous variables as the mean and standard deviation unless otherwise noted, and they were compared using Student's t-test or the Wilcoxon rank-sum test based on their distributions. Categorical variables are presented as numbers and percentages, and were compared using the χ^2 or Fisher's exact test, as appropriate. Cumulative incidences of clinical events were estimated using the Kaplan-Meier method, and compared with log-rank test. We estimated the adjusted risks of the ACS with and without shock groups relative to the stable CAD group for individual endpoints using multivariable Cox proportional hazard models. We used 20 clinically relevant factors as the risk-adjusting variables (Table 1). Furthermore, we also conducted a landmark analysis evaluating the risks within and beyond 180 days after PCI. We also evaluated the influence of initial Thrombolysis in Myocardial Infarction (TIMI) flow grade on mortality in the 2 ACS groups with and without shock.

The statistical analysis in this study was conducted by a physician (H.H.), using JMP10.0 (SAS Institute Inc., Cary, NC, USA) software. All statistical analyses were two-tailed, and we considered $P < 0.05$ as statistically significant. The authors had full access to and take full responsibility for the integrity of the data.

Results

Baseline Characteristics

The study cohort mainly comprised elderly patients without any significant differences among the 3 groups. We observed some significant differences among the groups in the baseline clinical characteristics. The prevalence of hypertension, dyslipidemia, diabetes mellitus, prior PCI, and prior CABG were significantly lower in the ACS groups than in the stable CAD group. In contrast, the Euro Score was higher in the ACS with shock group than others (Table 1).

Regarding lesion characteristics, isolated LMCA disease was significantly more common in the ACS with shock group than in the other groups. Total occlusion of the LMCA was more often observed in the ACS with shock (21.9%) and ACS without shock groups (3.2%) than in the stable CAD group. Intra-aortic balloon pumping (IABP) and percutaneous cardiopulmonary support (PCPS) were significantly more frequently used in the ACS groups than in the stable CAD group. In the ACS with shock group, IABP and PCPS were used in 85% and 26% of patients, respectively. There were no significant differences among the 3 groups in the stenting strategies, such as a 2-stenting strategy for LMCA bifurcation lesion, final kissing technique, post-optimization technique, using intravascular

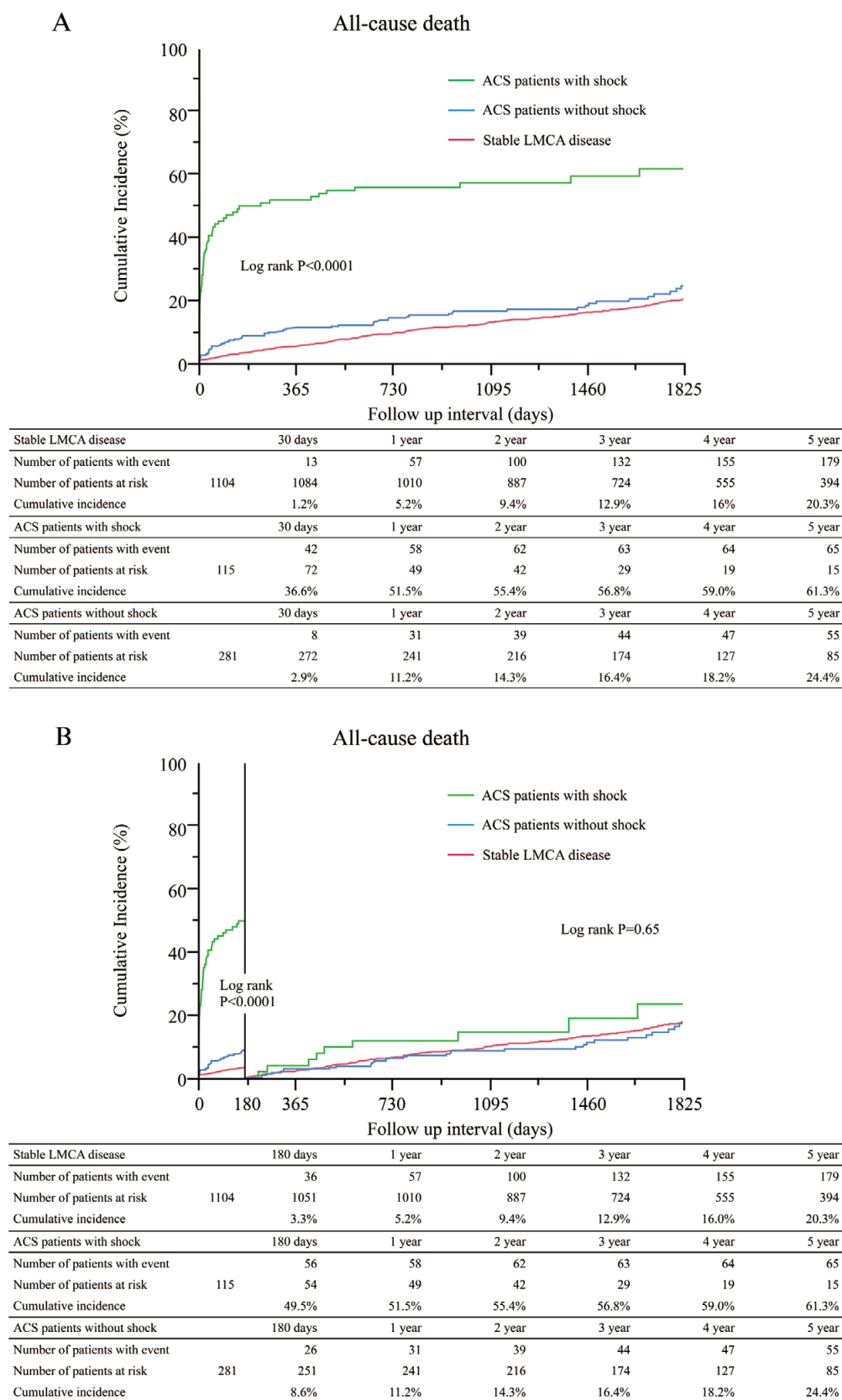


Figure 2. Kaplan-Meier curves for all-cause death, (A) throughout the entire follow-up period, and (B) in landmark analysis within 80 days and beyond 180 days after LMCA stenting. ACS, acute coronary artery syndrome; LMCA, left main coronary artery.

Table 4. Adjusted Clinical Outcomes: Overall Results and Landmark Analysis

	ACS with shock vs. Stable CAD			ACS without shock vs. Stable CAD		
	No. of patient with event (crude incidence rate)	Adjusted HR (95% CI)	P value	No. of patient with event (crude incidence rate)	Adjusted HR (95% CI)	P value
Entire follow-up period						
All-cause death	66 (57.4%) vs. 217 (19.7%)	5.29 (3.85–7.19)	<0.0001	68 (24.2%) vs. 217 (19.7%)	0.98 (0.48–1.77)	0.95
Cardiac death	51 (44.3%) vs. 71 (6.4%)	12.16 (7.86–18.80)	<0.0001	30 (10.7%) vs. 71 (6.4%)	1.20 (0.36–2.95)	0.74
Sudden death	2 (1.7%) vs. 25 (2.3%)	NA		4 (1.4%) vs. 25 (2.3%)	NA	
MI	5 (4.3%) vs. 31 (2.8%)	5.15 (1.58–14.33)	0.009	10 (3.6%) vs. 31 (2.8%)	2.39 (0.56–6.99)	0.21
Definite ST	5 (4.3%) vs. 8 (0.7%)	NA		4 (1.4%) vs. 8 (0.7%)	NA	
TLR	9 (7.8%) vs. 155 (10.4%)	0.98 (0.45–1.87)	0.95	41 (14.6%) vs. 155 (10.4%)	0.63 (0.22–1.42)	0.30
Any CR	17 (14.8%) vs. 335 (30.3%)	1.19 (0.70–1.91)	0.50	92 (32.7%) vs. 335 (30.3%)	1.14 (0.67–1.81)	0.62
Major bleeding	12 (10.4%) vs. 82 (7.4%)	3.32 (1.62–6.33)	0.0017	23 (8.2%) vs. 82 (7.4%)	1.26 (0.44–2.87)	0.64
Within 180 days						
All-cause death	56 (44.7%) vs. 36 (3.3%)	11.13 (6.90–18.20)	<0.0001	26 (9.3%) vs. 36 (3.3%)	1.62 (0.39–4.56)	0.46
Cardiac death	49 (42.6%) vs. 18 (1.6%)	30.99 (16.78–59.56)	<0.0001	7 (2.5%) vs. 18 (1.6%)	1.79 (0.28–6.40)	0.47
Sudden death	1 (0.9%) vs. 7 (0.6%)	NA		2 (0.7%) vs. 7 (0.6%)	NA	
MI	3 (2.6%) vs. 10 (0.9%)	4.43 (1.37–12.04)	0.015	3 (1.1%) vs. 10 (0.9%)	1.80 (0.28–6.42)	0.47
Definite ST	4 (3.5%) vs. 8 (0.7%)	9.73 (2.03–42.68)	0.0058	3 (1.1%) vs. 8 (0.7%)	NA	
TLR	5 (4.3%) vs. 35 (3.2%)	1.45 (0.48–3.62)	0.48	24 (8.5%) vs. 35 (3.2%)	0.92 (0.22–2.57)	0.89
Any CR	10 (8.7%) vs. 81 (7.3%)	1.58 (0.74–3.06)	0.22	47 (16.7%) vs. 81 (7.3%)	1.80 (0.83–3.44)	0.13
Major bleeding	7 (6.1%) vs. 16 (1.4%)	6.13 (2.87–12.64)	<0.0001	9 (3.2%) vs. 16 (1.4%)	0.90 (0.05–4.34)	0.91
Beyond 180 days						
All-cause death	10 (17.9%) vs. 181 (17.2%)	1.30 (0.63–2.39)	0.45	42 (16.7%) vs. 181 (17.2%)	0.81 (0.34–1.61)	0.57
Cardiac death	2 (4.1%) vs. 53 (5.0%)	1.11 (0.18–3.80)	0.89	23 (9.2%) vs. 53 (5.0%)	0.77 (0.12–2.61)	0.72
Sudden death	1 (2.3%) vs. 18 (1.9%)	NA		2 (1.0%) vs. 18 (1.9%)	NA	
MI	2 (3.9%) vs. 21 (2.0%)	4.31 (0.61–19.06)	0.13	7 (2.8%) vs. 21 (2.0%)	2.42 (0.37–9.0)	0.3
Definite ST	1 (2.0%) vs. 0	NA		1 (0.4%) vs. 0	NA	
TLR	4 (8.0%) vs. 120 (11.8%)	0.74 (0.22–1.82)	0.55	17 (7.4%) vs. 120 (11.8%)	0.43 (0.07–1.37)	0.18
Any CR	7 (15.9%) vs. 254 (26.1%)	0.83 (0.35–1.67)	0.63	45 (22.1%) vs. 254 (26.1%)	0.87 (0.39–1.65)	0.69
Major bleeding	5 (6.9%) vs. 66 (6.1%)	2.07 (0.69–5.05)	0.18	34 (12.5%) vs. 66 (6.1%)	1.19 (0.36–2.97)	0.75

Abbreviations as in Tables 1,3.

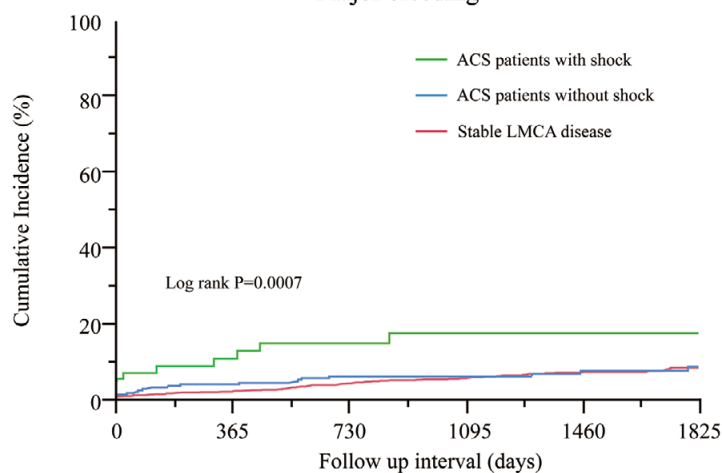
ultrasound (IVUS), and approach site. Furthermore, BMS were more frequently used in the ACS groups, especially in the ACS with shock group. No-reflow or slow flow of the left coronary artery during the procedure was more frequent in the ACS with shock (27.0%) and ACS without shock groups (6.1%) than in the stable CAD group (2.7%) (Table 2).

Clinical Outcomes

The median follow-up duration was 1,467 (IQR: 851–2,222) days in the stable CAD group, 95 (IQR: 13–1,117) days in the ACS with shock group, and 1,319 (IQR: 784–1,942) days in the ACS without shock group. The cumulative 5-year incidence of death was significantly higher in the ACS with shock group than in the other groups (Table 3, Figure 2A). The cumulative incidence of death at 180-day

A

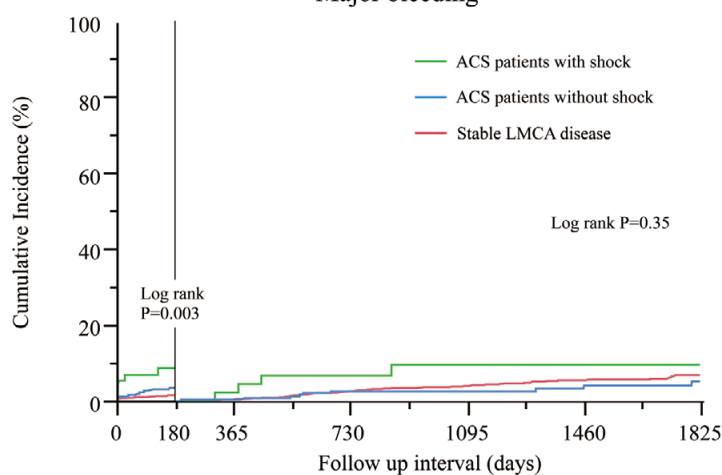
Major bleeding



Stable LMCA disease	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	8	20	41	52	62	68
Number of patients at risk	1104	1067	988	857	696	526
Cumulative incidence	0.7%	1.9%	4.1%	5.4%	6.9%	8.2%
ACS patients with shock	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	6	8	10	11	11	11
Number of patients at risk	115	64	44	37	26	17
Cumulative incidence	6.7%	10.5%	14.6%	17.2%	17.2%	17.2%
ACS patients without shock	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	3	10	15	15	17	18
Number of patients at risk	281	267	237	209	168	120
Cumulative incidence	1.1%	3.8%	5.9%	5.9%	7.3%	8.4%

B

Major bleeding



Stable LMCA disease	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	16	20	41	52	62	68
Number of patients at risk	1104	1084	988	857	696	526
Cumulative incidence	1.4%	1.9%	4.1%	5.4%	6.9%	8.2%
ACS patients with shock	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	7	8	10	11	11	11
Number of patients at risk	115	72	44	37	26	17
Cumulative incidence	8.5%	10.5%	14.6%	17.2%	17.2%	17.2%
ACS patients without shock	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	9	10	15	15	17	18
Number of patients at risk	281	272	237	209	168	120
Cumulative incidence	3.4%	3.8%	5.9%	5.9%	7.3%	8.4%

Figure 3. Kaplan-Meier curves for major bleeding, (A) throughout the entire follow-up period, and (B) in landmark analysis within 180 days and beyond 180 days after LMCA stenting. ACS, acute coronary artery syndrome; LMCA, left main coronary artery.

all-cause death and cardiac death beyond 180 days among the 3 groups, suggesting that preventing short-term mortality is crucial in patients with ACS and culprit LMCA disease. This study suggested that the cause of most deaths within 180 days of the index PCI for LMCA in patients with ACS was refractory heart failure. In particular, 42 of 115 patients in the ACS with shock group died within 180 days from heart failure, suggesting that initial myocardial damage could be directly connected to short-term mortality.

The current clinical guidelines for ST-segment elevation MI and non-ST-segment elevation ACS recommend primary PCI in hemodynamically unstable patients,^{5,6} because emergency coronary reperfusion is the current evidence-based therapeutic intervention for patients with cardiogenic shock.^{7,8} In the ACS without shock group, patients with initial TIMI flow grade ≤ 1 had a similarly high mortality rate to patients in the ACS with shock group. We classified the hemodynamic status only at admission and not at time of PCI. It is plausible that for patients with initial TIMI flow grade ≤ 1 in the ACS without shock group their hemodynamics had deteriorated by the time of PCI. It seems crucial to achieve adequate revascularization by PCI before cardiogenic shock develops. The hemodynamics of patients with LMCA ACS can deteriorate rapidly, so in patients with LMCA ACS, PCI should be performed immediately to prevent cardiogenic shock even in patients initially not presenting with shock and without flow limitation in the LMCA.

The main reason for the increased early mortality in the ACS with shock group was refractory heart failure. In the present study, hemodynamic support devices such as IABP and PCPS were used in 85% and 26% of patients, respectively, in the ACS with shock group. The role of these conventional hemodynamic support devices has not been established.^{18–20} We also do not know the role of newer hemodynamic support devices such as IMPELLA.^{21–23} Nevertheless, all catheterization laboratory staff, including operators, should be well prepared for instituting hemodynamic support devices when treating LMCA ACS patients. In this study, the incidence of major bleeding within 180 days was significantly higher in the ACS with shock group than in the stable CAD group. The higher bleeding risk of the ACS with shock group could be explained by the higher prevalence of IABP and PCPS use, and the anticoagulant therapy associated with use of these hemodynamic support devices.

Study Limitations

First, there could be several unmeasured differences in patient and lesion backgrounds, making it difficult to draw definitive conclusions on the comparison across the 3 groups. In particular, regarding the prognosis of ACS, the door-to-balloon time, onset-to-balloon time and Rentrop grade may severely affect the short- and long-term clinical outcomes.^{24,25} However, we did not have these data. Second, this study did not have data of patients with LMCA disease who underwent CABG as a comparison group. Third, as the rate of BMS use was relatively high in the ACS groups, we could not assess the efficacy of DES for ACS with LMCA culprit lesion. Finally, the multivariable adjustment was not incorporated for assessment of the mortality rate according to the degree of stenosis of the LMCA culprit lesion because of the small number of patients with ACS. Also, we did not evaluate the hemodynamic status at the time of PCI.

In conclusion, in patients LMCA ACS, survival correlates with baseline hemodynamic and coronary flow status.

Disclosures

T.K. serves as an advisory board member for Abbott Vascular. The other authors report no conflicts of interest with regard to this manuscript.

Acknowledgments

We thank the staff of the catheterization laboratories and physicians at the participating centers.

Conflict of Interest Statement

None of the authors has any potential conflict of interest to declare with respect to this study.

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Supplementary Files

Supplementary File 1

Figure S1. Kaplan-Meier curves for in-hospital death.

Please find supplementary file(s);

<http://dx.doi.org/10.1253/circj.CJ-18-0896>



Acute Coronary Syndrome With Unprotected Left Main Coronary Artery Culprit

— An Observation From the AOI-LMCA Registry —

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on behalf of the AOI-LMCA Stenting Registry Investigators

The authors apologize for the errors in the original manuscript. Corrections are shown below.

Table 1. Baseline Patient Characteristics (**Corrected**)

Table 2. Lesion and Procedural Characteristics (**Corrected**)

Table 3. Crude Clinical Outcomes (**Corrected**)

Table 4. Adjusted Clinical Outcomes: Overall Results and Landmark Analysis (**Corrected**)

Parameters corrected in the previous corrigendum were written in **red** and additional corrections in the current corrigendum were written in underlined red.

Figure 2. Kaplan-Meier curves for all-cause death, (A) throughout the entire follow-up period, and (B) in landmark analysis within **180** days and beyond 180 days after LMCA stenting.

Figure 3. Kaplan-Meier curves for major bleeding, (A) throughout the entire follow-up period, and (B) in landmark analysis within 180 days and beyond 180 days after LMCA stenting.

We amended the parameters those were shown in the chart below the figures (number of patients with event and cumulative incidence) after 180 days. Kaplan-Meier curves and Log rank P values do not change.

Original article: *Circ J* 2019; **83**: 198–208 doi:10.1253/circj.CJ-18-0896

Previous corrigendum: *Circ J* 2020; **84**: 1199–1206 doi:10.1253/circj.CJ-66-0178

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ISSN-1346-9843



Table 1. Baseline Characteristics of the ACS Patients

Variable	ACS with shock (n=115)	ACS without shock (n=281)	Stable CAD (n=1,104)	P value
Age (years)	70.2±11.7	72.0±11.1	72.0±9.8	0.19
≥80*	26 (23%)	74 (26%)	263 (24%)	0.62
Male	89 (77%)	205 (73%)	834 (76%)	0.57
Hypertension	62 (54%)	194 (69%)	853 (77%)	<0.0001
Dyslipidemia	37 (32%)	122 (43%)	631 (57%)	<0.0001
Current smoker	31 (27%)	68 (24%)	151 (14%)	<0.0001
Diabetes mellitus*	39 (34%)	104 (37%)	478 (43%)	0.038
Treated with insulin	7 (6.1%)	24 (8.5%)	121 (11%)	0.16
Familial history of CAD	19 (17%)	36 (13%)	179 (16%)	0.36
eGFR ≤30 without HD*	15 (13%)	19 (6.8%)	49 (4.4%)	0.0004
ESRD on HD*	6 (5.2%)	11 (3.9%)	69 (6.3%)	0.31
Atrial fibrillation	11 (9.6%)	19 (6.8%)	85 (7.7%)	0.63
Prior PCI*	19 (17%)	76 (27%)	555 (50%)	<0.0001
Prior CABG	0	2 (0.7%)	52 (4.7%)	0.0006
Prior MI	16 (14%)	51 (18%)	350 (32%)	<0.0001
Prior stroke*	13 (11%)	38 (14%)	144 (13%)	0.83
Prior HF*	15 (13%)	38 (14%)	140 (13%)	0.93
COPD	3 (2.6%)	6 (2.1%)	36 (3.3%)	0.59
Malignancy*	14 (12%)	24 (8.5%)	109 (9.9%)	0.54
Aortic disease	5 (4.3%)	11 (3.9%)	82 (7.4%)	0.064
PAD*	14 (12%)	26 (9.3%)	158 (14%)	0.078
LVEF (%)†	42.3±14.6	54.5±13.8	58.1±12.9	<0.0001
EURO SCORE	10.9±4.01 (n=114)	7.9±3.6 (n=278)	4.7±2.8 (n=1,099)	<0.0001
EURO SCORE >6.0	96 (84%) (n=114)	173 (62%) (n=278)	267 (24%) (n=1,099)	<0.0001
Clinical presentation of ACS				<0.0001
UA/NSTEMI	28 (24%)	226 (80%)		
STEMI	87 (76%)	55 (20%)		
Laboratory data				
WBC (×10 ³ /μL)	10.5±5.9 (n=102)	8.2±3.9 (n=273)	6.1±1.8 (n=1,073)	<0.0001
Hemoglobin (g/dL)	12.9±2.9 (n=102)	12.8±2.5 (n=273)	12.7±4.3 (n=1,073)	0.81
Creatinine (mg/dL)	1.52±1.44 (n=104)	1.38±1.67 (n=274)	1.38±1.79 (n=1,087)	0.71
LDL-C (mg/dL)	111.5±39.0 (n=38)	105.4±29.8 (n=96)	110.4±287.0 (n=691)	0.98
HbA1c (%)	5.8±0.96 (n=28)	6.0±1.2 (n=77)	6.0±1.02 (n=650)	0.68
BNP (pg/mL)	554.7±1,713.1 (n=65)	375.6±534.0 (n=136)	247.8±497.4 (n=261)	0.02
Albumin (g/dL)	3.5±0.68 (n=101)	3.8±0.5 (n=269)	3.9±0.46 (n=947)	<0.0001
CRP (mg/L)	1.4±3.0 (n=102)	1.5±3.0 (n=250)	0.59±1.3 (n=806)	<0.0001
Max CPK after PCI	10,225±13,640 (n=86)	2,539±4,490 (n=180)		<0.0001
Medications at discharge				
Aspirin	66 (96%, n=69)	261 (98%, n=266)	1,084 (99%, n=1,095)	0.043
Thienopyridine	63 (91%, n=69)	256 (96%, n=266)	1,067 (98%, n=1,089)	0.018
Warfarin	12 (17%, n=69)	25 (9.4%, n=266)	101 (9.2%, n=1,095)	0.083
Statins	38 (55%, n=69)	191 (72%, n=266)	699 (64%, n=1,095)	0.011
β-blockers	24 (35%, n=69)	84 (32%, n=266)	301 (27%, n=1,095)	0.21
ACEI/ARB	41 (59%, n=69)	167 (63%, n=266)	599 (55%, n=1,095)	0.05
PPI	42 (61%, n=69)	148 (56%, n=266)	423 (39%, n=1,089)	<0.0001

Data are presented as number (%) or mean±SD unless otherwise noted. *Risk-adjusting variables selected for Cox proportional hazards models. †Calculated in 883 patients in the stable CAD group, in 64 patients in the ACS with shock group, and 217 patients in the ACS without shock group. ACEI, angiotensin-converting enzyme inhibitor; ACS, acute coronary syndrome; ARB, angiotensin II receptor blocker; BNP, B-type natriuretic polypeptide; CABG, coronary artery bypass grafting; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; CPK, creatine phosphokinase; CRP, C-reactive protein; eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease; HbA1c, hemoglobin A1c; HD, hemodialysis; HF, heart failure; LDL-C, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; MI, myocardial infarction; PAD, peripheral artery disease; PCI, percutaneous coronary intervention; PPI, proton pump inhibitor; NSTEMI, non-ST-segment elevation MI; STEMI, ST-segment elevation MI; UA, unstable angina; WBC, white blood cell.

Variable	ACS with shock (n=115)	ACS without shock (n=281)	Stable CAD (n=1,104)	P value
Extent of CAD				0.013
Left main only	23 (20%)	36 (13%)	115 (10%)	
1-vessel disease	27 (23%)	70 (25%)	347 (31%)	
2-vessel disease*	43 (37%)	107 (38%)	428 (39%)	
3-vessel disease*	22 (19%)	68 (24%)	214 (19%)	
CTO	25 (22%)	44 (16%)	191 (17%)	0.35
RCA-CTO	10 (8.7%)	10 (3.6%)	75 (6.8%)	0.077
Stenosis (%)				<0.0001
Total occlusion	25 (22%)	9 (3.2%)	11 (1.0%)	
Non-occlusive stenosis	90 (78%)	272 (97%)	1,093 (99%)	
TIMI grade				<0.0001
≤1	25 (22%)	9 (3.2%)	11 (1.0%)	
2	32 (28%)	38 (14%)	29 (2.6%)	
3	58 (50%)	234 (83%)	1,064 (96%)	
AHA/ACC classification (B2/C lesion)	92 (80%)	233 (83%)	997 (90%)	<0.0001
Emergency PCI	114 (99%)	264 (94%)	20 (1.8%)	<0.0001
De novo lesion	113 (98%)	269 (96%)	1,071 (97%)	0.37
Moderate/severe calcification*	16 (14%)	41 (15%)	167 (15%)	0.93
Trifurcation	12 (10%)	29 (10%)	131 (12%)	0.72
2-stent procedure				0.24
Culotte	18/23 (78%)	45/62 (73%)	131/189 (69%)	
T-stenting	3/23 (13%)	16/62 (26%)	52/189 (28%)	
V-stenting	0/23 (0%)	0/62 (0%)	1/189 (0.5%)	
Crush	0/23 (0%)	0/62 (0%)	3/189 (1.6%)	
Mini-crush	2/23 (8.7%)	1/62 (1.6%)	2/189 (1.1%)	
Stenting ostial LMCA	92 (80%)	231 (82%)	899 (81%)	0.88
POT	12 (10%)	39 (14%)	143 (13%)	0.65
Final kissing balloon technique	71 (62%)	204 (73%)	737 (67%)	0.069
Stent type*				<0.0001
BMS	60 (52%)	76 (27%)	150 (14%)	
G1-DES	22 (19%)	117 (42%)	576 (52%)	
G2-DES	33 (29%)	88 (31%)	378 (34%)	
No. of implanted stents	1.25± 0.54	1.21± 0.49	1.26± 0.56	0.41
Stent length (main branch) (mm)	22.9±10.4	23.3±11.3	24.1±13.2	0.45
Stent diameter (main branch) (mm)	3.31± 0.38	3.28± 0.36	3.28± 0.36	0.72
Stent length (side branch) (mm)	19.4±4.9	18.4± 6.4	20.8±7.1	0.06
Stent diameter (side branch) (mm)	2.88± 0.37	2.93± 0.37	2.88± 0.41	0.70
Stent length (main branch) ≥30mm*	21 (18%)	56 (20%)	223 (20%)	0.88
Stent diameter (main branch) ≥3.5mm*	75 (65%)	158 (56%)	689 (62%)	0.11
IVUS*	69 (60%)	192 (68%)	731 (66%)	0.28
Rotablator	3 (2.6%)	6 (2.1%)	89 (8.1%)	0.0003
IABP	98 (85%)	67 (24%)	30 (2.7%)	<0.0001
PCPS	30 (26%)	5 (1.8%)	3 (0.3%)	<0.0001
No-reflow/slow flow during procedure	31 (27%)	17 (6.0%)	30 (2.7%)	<0.0001
Approach site				0.77
Radial artery	18 (16%)	55 (20%)	209 (19%)	
Brachial artery	11 (9.6%)	32 (11%)	133 (12%)	
Femoral artery	86 (75%)	194 (69%)	759 (69%)	

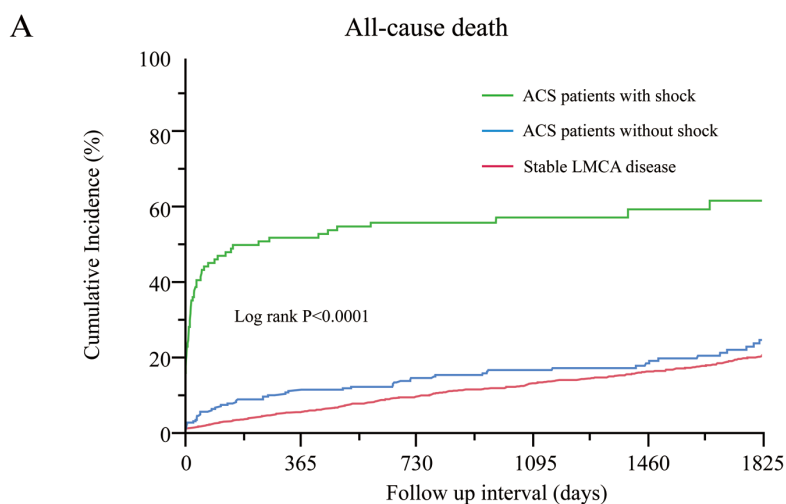
Data are presented as number (%) or mean±SD unless otherwise noted. *Potential independent risk-adjusting variables selected for Cox proportional hazards models. ACC, American College of Cardiology; AHA, American Heart Association; BMS, bare metal stent; CTO, chronic total occlusion; G1-DES, 1st-generation drug-eluting stent; G2-DES, 2nd-generation drug-eluting stent; IABP, intra-aortic balloon pumping; IVUS, intravascular ultrasound; PCPS, percutaneous cardiopulmonary support; POT, proximal optimization technique; RCA, right coronary artery. Other abbreviations as in Table 1.

Table 3. Crude Clinical Outcomes				
	No. of patients with event (cumulative incidence, %)			P value
	ACS with shock (n=115)	ACS without shock (n=281)	Stable CAD (n=1,104)	
30-day				
All-cause death	42 (36.6%)	8 (2.9%)	13 (1.2%)	
Cardiac death	38 (33.3%)	7 (2.5%)	12 (1.1%)	
Sudden death	1 (1.0%)	0	3 (0.3%)	
MI	1 (1.1%)	2 (0.7%)	8 (0.7%)	
Definite ST	3 (3.2%)	3 (1.1%)	6 (0.5%)	
TLR	3 (3.2%)	6 (2.2%)	5 (0.5%)	
Any CR	5 (6.0%)	15 (5.5%)	11 (1.0%)	
Major bleeding	6 (6.7%)	3 (1.1%)	8 (0.7%)	
180-day				
All-cause death	56 (49.5%)	24 (8.6%)	36 (3.3%)	
Cardiac death	49 (44.1%)	15 (5.4%)	18 (1.6%)	
Sudden death	1 (1.0%)	2 (0.8%)	7 (0.6%)	
MI	3 (4.4%)	3 (1.1%)	10 (0.9%)	
Definite ST	4 (5.0%)	3 (1.1%)	8 (0.7%)	
TLR	5 (6.9%)	24 (9.2%)	40 (3.7%)	
Any CR	10 (14.8%)	47 (18%)	82 (7.7%)	
Major bleeding	7 (8.5%)	9 (3.4%)	16 (1.4%)	
5-year				
All-cause death	65 (61.3%)	55 (24.4%)	179 (20.3%)	<0.0001
Cardiac death	51 (46.4%)	23 (9.5%)	55 (6.5%)	<0.0001
Sudden death	2 (3.0%)	3 (1.2%)	19 (2.2%)	0.63
MI	4 (9.0%)	9 (4.7%)	23 (2.8%)	0.04
Definite ST	5 (7.1%)	3 (1.1%)	8 (0.73%)	<0.0001
TLR	8 (12.9%)	38 (16.2%)	140 (15.0%)	0.58
Any CR	17 (29.6%)	89 (41.2%)	303 (32.4%)	0.08
Major bleeding	11 (17.2%)	18 (8.4%)	68 (8.2%)	0.0007

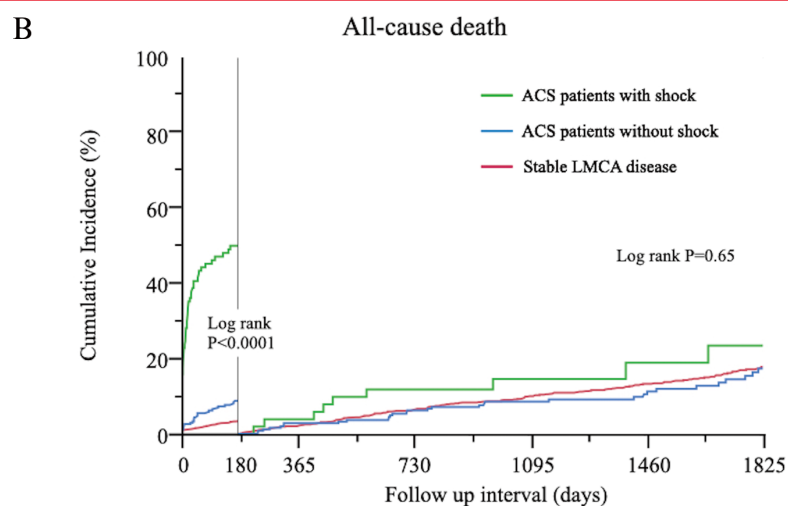
CI, confidence interval; CR, coronary revascularization; HR, hazard ratio; ST, stent thrombosis; TLR, target lesion revascularization. Other abbreviations as in Table 1.

	ACS with shock vs. Stable CAD			ACS without shock vs. Stable CAD		
	No. of patient with event (crude incidence rate)	Adjusted HR (95% CI)	P value	No. of patient with event (crude incidence rate)	Adjusted HR (95% CI)	P value
Entire follow-up period						
All-cause death	66 (57.4%) vs. 217 (19.7%)	5.29 (3.85–7.19)	<0.0001	68 (24.2%) vs. 217 (19.7%)	1.31 (0.98–1.74)	0.07
Cardiac death	51 (44.3%) vs. 71 (6.4%)	12.16 (7.86–18.80)	<0.0001	30 (10.7%) vs. 71 (6.4%)	1.92 (1.21–2.98)	0.007
Sudden death	2 (1.7%) vs. 25 (2.3%)	NA		4 (1.4%) vs. 25 (2.3%)	NA	
MI	5 (4.3%) vs. 31 (2.8%)	5.15 (1.58–14.33)	0.009	10 (3.6%) vs. 31 (2.8%)	NA	
Definite ST	5 (4.3%) vs. 8 (0.7%)	NA		4 (1.4%) vs. 8 (0.7%)	NA	
TLR	9 (7.8%) vs. 155 (10.4%)	0.98 (0.45–1.87)	0.95	41 (14.6%) vs. 155 (10.4%)	1.13 (0.78–1.61)	0.52
Any CR	17 (14.8%) vs. 335 (30.3%)	1.19 (0.70–1.91)	0.50	92 (32.7%) vs. 335 (30.3%)	1.38 (1.08–1.75)	0.012
Major bleeding	12 (10.4%) vs. 82 (7.4%)	3.32 (1.62–6.33)	0.0017	23 (8.2%) vs. 82 (7.4%)	1.20 (0.72–1.91)	0.47
Within 180 days						
All-cause death	56 (48.7%) vs. 36 (3.3%)	11.13 (6.90–18.20)	<0.0001	24 (8.5%) vs. 36 (3.3%)	2.35 (1.34–4.05)	0.003
Cardiac death	49 (42.6%) vs. 18 (1.6%)	30.99 (16.78–59.56)	<0.0001	15 (5.3%) vs. 18 (1.6%)	2.94 (1.40–6.13)	0.005
Sudden death	1 (0.9%) vs. 7 (0.6%)	NA		2 (0.7%) vs. 7 (0.6%)	NA	
MI	3 (2.6%) vs. 10 (0.9%)	4.43 (1.37–12.04)	0.015	3 (1.1%) vs. 10 (0.9%)	NA	
Definite ST	4 (3.5%) vs. 8 (0.7%)	9.73 (2.03–42.68)	0.0058	3 (1.1%) vs. 8 (0.7%)	NA	
TLR	5 (4.3%) vs. 40 (3.6%)	1.45 (0.48–3.62)	0.48	24 (8.5%) vs. 40 (3.6%)	2.24 (1.27–3.88)	0.006
Any CR	10 (8.7%) vs. 82 (7.4%)	1.58 (0.74–3.06)	0.22	47 (16.7%) vs. 82 (7.4%)	2.33 (1.58–3.40)	<0.0001
Major bleeding	7 (6.1%) vs. 16 (1.4%)	6.13 (2.87–12.64)	<0.0001	9 (3.2%) vs. 16 (1.4%)	1.57 (0.74–3.12)	0.23
Beyond 180 days						
All-cause death	10 (17.9%) vs. 181 (17.2%)	1.30 (0.63–2.39)	0.45	44 (17.5%) vs. 181 (17.2%)	1.07 (0.75–1.49)	0.72
Cardiac death	2 (4.1%) vs. 53 (5.0%)	1.11 (0.18–3.80)	0.89	15 (6.0%) vs. 53 (5.0%)	1.45 (0.76–2.59)	0.25
Sudden death	1 (2.3%) vs. 18 (1.9%)	NA		2 (1.0%) vs. 18 (1.9%)	NA	
MI	2 (3.9%) vs. 21 (2.0%)	4.31 (0.61–19.06)	0.13	7 (2.8%) vs. 21 (2.0%)	NA	
Definite ST	1 (2.0%) vs. 0	NA		1 (0.4%) vs. 0	NA	
TLR	4 (8.0%) vs. 115 (11.3%)	0.74 (0.22–1.82)	0.55	17 (7.4%) vs. 115 (11.3%)	0.70 (0.40–1.15)	0.16
Any CR	7 (15.9%) vs. 253 (26.0%)	0.83 (0.35–1.67)	0.63	45 (22.1%) vs. 253 (26.0%)	1.02 (0.72–1.40)	0.92
Major bleeding	5 (6.9%) vs. 66 (6.1%)	2.07 (0.69–5.05)	0.18	14 (5.1%) vs. 66 (6.1%)	0.94 (0.50–1.67)	0.85

Abbreviations as in Tables 1,3.



Stable LMCA disease	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	13	57	100	132	155	179
Number of patients at risk	1104	1084	1010	887	724	555
Cumulative incidence	1.2%	5.2%	9.4%	12.9%	16%	20.3%
ACS patients with shock	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	42	58	62	63	64	65
Number of patients at risk	115	72	49	42	29	19
Cumulative incidence	36.6%	51.5%	55.4%	56.8%	59.0%	61.3%
ACS patients without shock	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	8	31	39	44	47	55
Number of patients at risk	281	272	241	216	174	127
Cumulative incidence	2.9%	11.2%	14.3%	16.4%	18.2%	24.4%

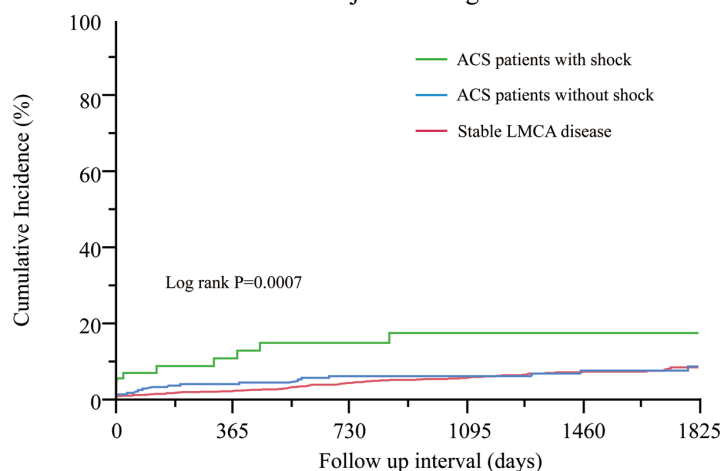


Stable LMCA disease	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	36	21	64	96	119	143
Number of patients at risk	1104	1051	1010	887	724	555
Cumulative incidence	3.3%	2.0%	6.3%	9.9%	13.2%	17.6%
ACS patients with shock	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	56	2	6	7	8	9
Number of patients at risk	115	54	49	42	29	19
Cumulative incidence	49.5%	3.9%	11.7%	14.5%	18.7%	23.3%
ACS patients without shock	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	24	7	15	20	23	31
Number of patients at risk	281	251	241	216	174	127
Cumulative incidence	8.6%	2.8%	6.2%	8.5%	10.5%	17.2%

Figure 2. Kaplan-Meier curves for all-cause death, (**A**) throughout the entire follow-up period, and (**B**) in landmark analysis within 180 days and beyond 180 days after LMCA stenting. ACS, acute coronary artery syndrome; LMCA, left main coronary artery.

A

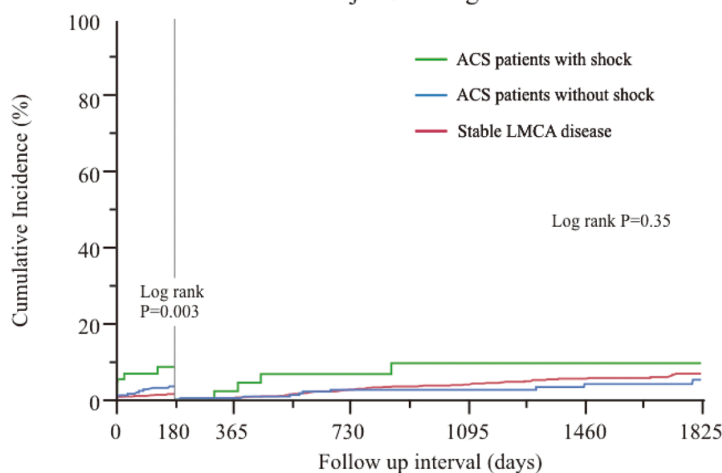
Major bleeding



Stable LMCA disease	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	8	20	41	52	62	68
Number of patients at risk	1104	1067	988	857	696	526
Cumulative incidence	0.7%	1.9%	4.1%	5.4%	6.9%	8.2%
ACS patients with shock	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	6	8	10	11	11	11
Number of patients at risk	115	64	44	37	26	17
Cumulative incidence	6.7%	10.5%	14.6%	17.2%	17.2%	17.2%
ACS patients without shock	30 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	3	10	15	15	17	18
Number of patients at risk	281	267	237	209	168	120
Cumulative incidence	1.1%	3.8%	5.9%	5.9%	7.3%	8.4%

B

Major bleeding



Stable LMCA disease	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	16	4	25	36	46	52
Number of patients at risk	1104	1084	988	857	696	526
Cumulative incidence	1.4%	0.4%	2.6%	4.0%	5.5%	6.8%
ACS patients with shock	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	7	1	3	4	4	4
Number of patients at risk	115	72	44	37	26	17
Cumulative incidence	8.5%	2.2%	6.7%	9.5%	9.5%	9.5%
ACS patients without shock	180 days	1 year	2 year	3 year	4 year	5 year
Number of patients with event	9	1	6	6	8	9
Number of patients at risk	281	272	237	209	168	120
Cumulative incidence	3.4%	0.4%	2.6%	2.6%	4.1%	5.2%

Figure 3. Kaplan-Meier curves for major bleeding, (A) throughout the entire follow-up period, and (B) in landmark analysis within 180 days and beyond 180 days after LMCA stenting. ACS, acute coronary artery syndrome; LMCA, left main coronary artery.

Parameters corrected in the previous corrigendum were written in red and additional corrections in the current corrigendum were written in underlined red.

Page 199, abstract

Incorrect:

The cumulative 180-day incidence of death was markedly higher in the ACS with shock group than in the other groups (49.5%, 8.6%, and 3.3%, respectively; $P<0.0001$), but mortality beyond 180-day was not significantly different among the 3 groups (30.2%, 20.4%, and 19.5%, respectively; $P=0.65$).

Correct:

The cumulative 180-day incidence of death was markedly higher in the ACS with shock group than in the other groups (49.5%, 8.6%, and 3.3%, respectively; $P<0.0001$), but mortality beyond 180-day was not significantly different among the 3 groups (23.3%, 17.2%, and 17.6%, respectively; $P=0.65$).

Page 202, left column, line 1

Incorrect:

We show continuous variables as the mean and standard deviation unless otherwise noted, and they were compared using Student's t-test or the Wilcoxon rank-sum test based on their distributions.

Correct:

We show continuous variables as the mean and standard deviation unless otherwise noted, and they were compared using one-way analysis of variance.

Page 202, left column, line 12

Incorrect:

We used 20 clinically relevant factors as the risk-adjusting variables (Table 1).

Correct:

We used 16 clinically relevant factors as the risk-adjusting variables (Table 1).

Page 204, left column, line 3

Incorrect:

No-reflow or slow flow of the left coronary artery during the procedure was more frequent in the ACS with shock (27.0%) and ACS without shock groups (6.1%) than in the stable CAD group (2.7%) (Table 2).

Correct:

No-reflow or slow flow of the left coronary artery during the procedure was more frequent in the ACS with shock (27.0%) and ACS without shock groups (6.0%) than in the stable CAD group (2.7%) (Table 2).

Page 206, left column, line 4

Incorrect:

After adjusting confounders, the excess mortality risk of the ACS with shock group relative to the stable CAD group remained significant, while the mortality risk of the ACS without shock group relative to the stable CAD group was not significant (Table 4).

Correct:

After adjusting confounders, the excess mortality risk of the ACS with shock group relative to the stable CAD group remained significant, while the mortality risk of the ACS without shock group trended to be higher than that of the stable CAD group with significant excess risk for cardiac death (Table 4).

Page 206, left column, line 22

Incorrect:

In the ACS with shock group, 56 of 115 patients died within 180 days of LMCA stenting; of these, 75% died of refractory heart failure, which was the most frequent cause of death, 7% of bleeding, and 7% of infection. In contrast, 26 of 281 patients died within 180 days in the ACS without shock group; of these, 50% died because of refractory heart failure, 15% of arrhythmia, and 12% of infection.

Correct:

In the ACS with shock group, 56 of 115 patients died within 180 days of LMCA stenting; of these, 75% died of refractory heart failure, which was the most frequent cause of death, 7% of bleeding, and 7% of infection. In contrast, 24 of 281 patients died within 180 days in the ACS without shock group; of these, 50% died because of refractory heart failure, 15% of arrhythmia, and 12% of infection.

Page 206, right column, line 7-

Incorrect:

The primary findings of this study were as follows. (1) Among the study patients undergoing LMCA stenting, ACS patients with shock had significantly higher mortality at 180 days than either ACS patients without shock or stable CAD patients, but mortality beyond 180 days was comparable across the 3 groups of patients. (2) In ACS patients with shock, the initial TIMI flow grade did not affect mortality, but in ACS patients without shock, initial TIMI flow grade ≤ 1 was associated with significantly higher mortality than TIMI flow grade ≥ 2 .

Correct:

The primary findings of this study were as follows: (1) Among the study patients undergoing LMCA stenting, ACS patients with shock had significantly higher mortality at 180 days than either ACS patients without shock or stable CAD patients, but mortality beyond 180 days was comparable across the 3 groups of patients; (2) The excess mortality risk of ACS patients without shock relative to stable CAD patients did not reach statistical significance, but there was a significant excess risk of ACS patients without shock relative to stable CAD patients for cardiac death; (3) In ACS patients with shock, the initial TIMI flow grade did not affect mortality, but in ACS patients without shock, initial TIMI flow grade ≤ 1 was associated with significantly higher mortality than TIMI flow grade ≥ 2 .

Page 206, right column, line 26-

Incorrect:

However, the 180-day mortality of the ACS without shock group was 8.6%, which was much lower than in the ACS with shock group.

Correct:

However, the 180-day mortality was 8.6% in the ACS without shock group, which was much lower than in the ACS with shock group, but significantly higher than in the stable CAD group. More than half of death within 180 days after primary PCI for LMCA in ACS without shock patients caused by cardiac death. Even LMCA ACS patients without cardiogenic shock on arrival easily fall into heart failure or/and cardiogenic shock during or just after PCI for LMCA and the unstable condition could lead to cardiac death. The 180-day risks of TLR and any coronary revascularization were significantly higher in ACS without shock group than in stable CAD group, while they were not significantly different between ACS with shock group and stable CAD group, although high 180-day mortality in ACS with shock group might cause underestimation for the true risk of TLR and any coronary revascularization. In LMCA ACS patients, PCI for LMCA is indicated even in complex LMCA disease with high SYNTAX score, which might be one of the reasons for the higher risk for repeat revascularization.

Page 207, right column, line 1-

Incorrect:

In conclusion, in patients LMCA ACS, survival correlates with baseline hemodynamic and coronary flow status.

Correct:

In conclusion, patients LMCA ACS had high mortality risk and survival correlated with baseline hemodynamic and coronary flow status.