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Original Article

Prognostic impact of atrial fibrillation in patients with acute myocardial infarction

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ABSTRACT

Background: Atrial fibrillation (AF) is the most common supraventricular tachyarrhythmia in patients with acute myocardial infarction (AMI). However, little is known about the impact of AF on in-hospital and long-term mortalities in patients with AMI in the era of primary percutaneous coronary intervention (PCI).

Methods: Six hundred ninety-four consecutive patients with AMI admitted within 48 h after symptom onset were analyzed. All patients successfully underwent primary PCI at the acute phase of AMI. Patients were divided into 2 groups according to the presence of AF at admission or during index hospitalization. We retrospectively evaluated the in-hospital and long-term all-cause mortalities between patients with and those without AF.

Results: AF was detected in 38 patients (5.5%) at admission and in 51 patients (7.3%) during hospitalization. Patients with AF were older and had a higher heart rate, lower ejection fraction, higher prevalence of hypertension, worse renal function, higher peak level of creatine phosphokinase, and lower rate of final TIMI flow grade 3 than those without AF. Although patients with AF had a more complicated clinical course and higher in-hospital mortality (11.2% vs. 4.0%, $P=0.009$), there was no significant association between presenting AF and in-hospital death after adjustment for baseline confounders (odds ratio, 2.63; 95% confidence interval [CI], 0.91–5.47; $P=0.076$). During the follow-up period of 3.0 ± 1.7 years, patients with AF had a higher all-cause mortality than those without AF (30.3% vs. 22.1%, $P=0.004$ by log-rank test). However, after adjustment for clinical characteristics, presenting AF was not an independent predictor of all-cause mortality (hazard ratio, 1.15; 95% CI, 0.67–1.88; $P=0.588$).

Conclusions: AF is a common complication of AMI and associated with a more complicated clinical course. However, AF is not an independent predictor of both in-hospital and long-term mortalities in the PCI era.

1. Introduction

Atrial fibrillation (AF) is the most common supraventricular tachyarrhythmia seen in patients with acute myocardial infarction (AMI). It has been reported that AF occurs in 5–23% of patients with AMI [1–4]. AF is triggered by many different conditions, including left ventricular dysfunction with hemodynamic impairment [5,6], atrial ischemia or infarction [7], pericarditis, chronic lung disease, acute hypoxia, or electrolyte abnormalities [8,9]. AF occurring during the acute phase of AMI may adversely affect the left ventricular function and exacerbate ongoing myocardial ischemia. The bidirectional interaction between AF and myocardial dysfunction or ischemia may lead to a vicious circle in a patient with AF complicating AMI. Some studies have shown an association between increased in-hospital and long-term mortalities and AF [1,10–13], although others have found no independent effect [2,3,14–17]. Most studies on AF complicated with AMI were performed in the prethrombolytic or thrombolytic era. Current treatments for AMI include not only aspirin, β-blockers, and thrombolytic therapy, but also angiotensin-converting enzyme inhibitors (ACE-I), angiotensin II receptor blockers (ARB), statin, and percutaneous coronary intervention (PCI) [18]. PCI has been shown to be a more effective treatment strategy in patients with AMI than thrombolytic therapy [19,20], and use of primary PCI has dramatically increased [21]. However, little is known about the in-hospital and long-term mortalities in patients with AMI and AF in the PCI era. We examined the impact of AF on in-hospital and long-term mortalities in patients with AMI.

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2. Methods

2.1. Study patients

The study protocol was approved by the ethical committee on human research of our institution. Six hundred ninety-four consecutive AMI patients who were transferred to Hirosaki University Hospital within 48 h after symptom onset and underwent primary PCI at the acute phase of AMI from February 2006 to April 2010 were enrolled. The diagnosis of AMI was made in the presence of chest pain lasting $\geq$20 min and/or electrocardiographic (ECG) changes suggestive of myocardial infarction (MI) or ischemia ($\geq$0.1 mV ST-segment elevation or depression in $\geq$2 contiguous leads and/or appearance of a new Q-wave), accompanied by an increase of creatine phosphokinase myocardial isoform (CPK-MB) and/or a cardiac troponin T-value greater than the upper reference limit. AF was defined electrocardiographically as the absence of P-waves, coarse or fine fibrillation waves, and completely irregular R-R interval, and was diagnosed by 12-lead ECG or ECG monitoring by at least 2 cardiologists.

The study population was divided into 2 groups: patients who had AF at admission or developed AF during hospitalization (any-AF group) and those without AF (non-AF group). The any-AF group was further divided into 2 subgroups: patients who had AF at admission (AF at admission) and those who did not have AF at admission but developed AF during the index hospitalization (AF during hospitalization). Patients with a history of paroxysmal or transient AF but without a recurrence of AF during the index hospitalization were categorized into the non-AF group.

2.2. Primary PCI

Primary PCI was performed in accordance with the ACC/AHA/SCAI Practice Guidelines for Percutaneous Coronary Intervention [22]. Patients admitted within 12 h of symptom onset were indicated for primary PCI. Those admitted within 36 h of AMI onset and complicated with cardiogenic shock, or those admitted after 12 h but within 24 h and complicated with severe heart failure, hemodynamic or electrical instability, or evidence of persistent ischemia also underwent primary PCI. Patients who were admitted >12 h after AMI onset and were hemodynamically and electrically stable were not submitted to primary PCI. A bare metal stent was used for PCI when stenting was indicated.

2.3. Endpoints

The primary endpoint of the study was all-cause death. We retrospectively evaluated the in-hospital and long-term all-cause mortalities. We also examined the association of AF with in-hospital events, including congestive heart failure (CHF), cardiogenic shock, ventricular tachycardia/fibrillation (VT/VF), stroke, and length of hospitalization. Follow-up started from the day of admission. The patients were followed for 3.0 $\pm$ 1.7 years. After hospital discharge, follow-up data were obtained from the following 3 ways: reviewing patients' hospital records, interviewing the patients through telephone, and examining the patients in outpatient clinics.

2.4. Statistical analysis

Continuous parameters were expressed as mean $\pm$ SD, and categorical variables as number and percentage. Comparative analysis among groups was performed with Student's *t* test or ANOVA for continuous variables and chi-square test for categorical variables. For comparison of non-AF, AF at admission, and AF during hospitalization, Tukey's honest significant difference test multiple-comparison procedure was used to identify where the differences among the 3 groups occurred after the significant ANOVA. A multivariate logistic regression model was used to analyze factors that influenced the prevalence of AF. The following variables were entered into the model: age >65 years, male sex, heart rate at admission >100/min, left ventricular ejection fraction (LVEF) <40%, anterior MI, peak level of CPK >3000 IU/L, final TIMI flow grade 3, and Killip class at admission >I. The prognostic impact of AF on in-hospital mortality was examined using a multivariate logistic regression model, adjusting for age >65 years, LVEF <40%, and final TIMI flow grade 3. Kaplan–Meier curves for long-term all-cause mortality among the groups were constructed and compared using the log-rank test. Univariate and multivariate Cox proportional hazard analyses were performed to identify hazard ratios (HR) and 95% confidence intervals (CI). All AF categories (any-AF, AF at admission, and AF during hospitalization) were tested in a univariate model and furthermore in a multivariate model adjusted for clinical prognostic factors, including age >65 years, male sex, LVEF <40%, estimated glomerular filtration rate (eGFR) <60 mL min^{-1} 1.73 m^{-2}, anterior MI, peak level of CPK >3000 IU/L, heart rate at admission >100/min, and final TIMI flow grade 3. All statistical analyses were done using JMP 10.0.2 (SAS Institute Inc., Cary, NC, USA). A *P* value of <0.05 was considered significant.

3. Results

3.1. Baseline characteristics and relation to AF

The baseline characteristics of the patients are summarized in Table 1. Of the 694 patients, AF was diagnosed in 89 (12.8%, any-AF group) at admission (38 patients, 5.5%) or during hospitalization (51 patients, 7.3%). Of the 89 patients with AF, AF was terminated spontaneously in 31 (34.8%), by electrical cardioversion in 17 (19.1%), with intravenous or oral administration of amiodarone in 29 (32.6%), with intravenous β-blocker in 7 (10.8%), and was not terminated during index hospitalization in 23 (25.8%). Patients with any-AF were older and had a higher heart rate, lower LVEF, lower eGFR, higher prevalence of hypertension, higher peak level of CPK, lower rate of final TIMI flow grade 3, and higher prevalence of previous AF than those without AF. Particularly, patients with AF at admission had a significantly higher heart rate at admission and a higher prevalence of previous AF. Patients with AF during hospitalization had a higher prevalence of hypertension than those without AF. No significant difference was found in sex, body mass index, left atrial dimension, diabetes mellitus, anterior MI, time from symptom onset to presentation, Killip class at admission, history of MI, stroke, and previous PCI. Multivariate logistic regression analysis revealed that age >65 years, male sex, heart rate >100/min, and peak level of CPK >3000 IU/L were independent predictive factors of the prevalence of AF (Table 2).

The medication at discharge is shown in Table 3. Patients with AF were more commonly treated with warfarin and β-blockers, but were less administered thienopyridine. There were no significant difference in the treatments with ACE-I, ARB, and statin between the non-AF and any-AF groups. Eighty-four patients (12.7%) were treated with aspirin, thienopyridine, and warfarin (triple antithrombotic therapy). Triple antithrombotic therapy was more frequently administered in patients with AF than in those without AF. Neither use of warfarin nor use of antiplatelet drugs had a significant relation to long-term mortality.

3.2. Impact of AF on in-hospital events

CHF, cardiogenic shock, and VT/VF occurred more often in patients in the any-AF group than in those in the non-AF group, and hospitalization was also longer in patients with than in those without AF. There was no significant difference in the incidence of in-hospital stroke (Table 4). Of the 34 patients (4.9%) who died

Table 1
Baseline characteristics at presentation.

	All ($n=694$)	Non-AF ($n=605$, 87.2%)	Any-AF ($n=89$, 12.8%)	AF at admission ($n=38$, 5.5%)	AF during hospitalization ($n=51$, 7.3%)	P value[a]
Age (years)	66 ± 12	65 ± 13	72 ± 9	72 ± 10[b]	72 ± 8[b]	< 0.001
Male, *n* (%)	525 (75.6)	454 (75.0)	71 (79.8)	30 (79.0)	41 (80.4)	0.323
Median follow-up (days)	1095 ± 626	1113 ± 620	978 ± 657	834 ± 627[b]	1084 ± 664	0.058
Body mass index (kg/m^2)	24.1 ± 3.6	24.2 ± 3.6	23.7 ± 3.5	23.3 ± 3.9	24.0 ± 3.2	0.228
Heart rate at admission (/min)	78 ± 20	78 ± 19	84 ± 28	91 ± 31[b]	79 ± 23	0.003
LVEF (%)	46.2 ± 10.3	46.9 ± 9.8	41.9 ± 12.3	41.8 ± 13.7[b]	42.0 ± 11.2[b]	< 0.001
Left atrial dimension (mm)	36.0 ± 5.7	35.9 ± 5.8	36.5 ± 5.5	34.8 ± 2.5	37.1 ± 6.2	0.616
Diabetes mellitus, *n* (%)	267 (38.5)	227 (37.5)	40 (44.9)	16 (42.1)	24 (47.1)	0.182
Hypertension, *n* (%)	465 (67.0)	397 (65.6)	68 (76.4)	26 (68.4)	42 (82.4) [b]	0.038
eGFR (mL min^{-1} 1.73 m^{-2})	59.3 ± 22.7	60.3 ± 22.2	52.8 ± 24.8	52.2 ± 21.6[b]	53.3 ± 27.1[b]	0.004
Anterior MI, *n* (%)	337 (48.6)	297 (49.1)	40 (44.9)	15 (39.5)	25 (49.0)	0.464
Peak CPK (IU/L)	3238 ± 3053	2995 ± 2689	4886 ± 4541	4517 ± 5121[b]	5160 ± 4087[b]	< 0.001
Final TIMI flow grade 3, *n* (%)	560 (80.7)	496 (82.0)	64 (71.9)	27 (71.1)	37 (72.6)	0.031
Time from symptom onset to presentation, *n* (%)						
≦6 h	455 (65.6)	396 (65.5)	59 (66.3)	27 (71.1)	32 (62.8)	0.091
6–12 h	126 (18.2)	108 (17.9)	18 (20.2)	8 (21.1)	10 (19.6)	
12–24 h	82 (11.8)	77 (12.7)	5 (5.6)	0 (0.0)	5 (9.8)	
24–48 h	31 (4.5)	24 (4.0)	7 (7.9)	3 (7.9)	4 (7.8)	
Killip class at admission, *n*(%)						
I	557 (80.3)	493 (81.5)	64 (71.9)	30 (79.0)	34 (66.7)	0.236
II	52 (7.5)	42 (6.9)	10 (11.2)	2 (5.3)	8 (15.7)	
III	47 (6.8)	39 (6.5)	8 (9.0)	2 (5.3)	6 (11.8)	
IV	38 (5.5)	31 (5.1)	7 (7.9)	4 (10.5)	3 (5.9)	
History of, *n* (%)						
AF	16 (2.3)	3 (0.5)	13 (14.6)	11 (29.0)[b]	2 (3.9)	< 0.001
MI	40 (5.8)	37 (6.1)	3 (3.4)	1 (2.6)	2 (3.9)	0.267
Stroke	44 (6.3)	42 (6.9)	2 (2.3)	0 (0.0)	2 (3.9)	0.056
PCI	32 (4.6)	29 (4.8)	3 (3.4)	1 (2.6)	2 (3.9)	0.534

AF, atrial fibrillation; LVEF, left ventricular ejection fraction; eGFR, estimate glomerular filtration rate; MI, myocardial infarction; CPK, creatine phosphokinase; and PCI, percutaneous coronary intervention.

[a] Any-AF vs. non-AF.
[b] $P < 0.05$ vs. non-AF.

Table 2
Predictors of atrial fibrillation.

	OR	95% CI	P value
Age > 65 years	3.26	1.94–5.66	< 0.001
Male	1.90	1.05–3.60	0.033
Heart rate at admission > 100/min	6.42	1.86–6.20	< 0.001
LVEF < 40%	1.08	0.62–1.84	0.788
Anterior MI	1.43	0.86–2.39	0.171
Peak CPK > 3000 IU/L	1.81	1.08–3.03	0.023
Final TIMI flow grade 3	0.74	0.42–1.34	0.321
Killip class at admission > 1	1.61	0.92–2.74	0.094

OR, odds ratio; 95% CI, 95% confidence interval; LVEF, left ventricular ejection fraction; MI, myocardial infarction; and CPK, creatine phosphokinase.

Table 3
Baseline treatment at discharge.

	All ($n=660$)	Non-AF ($n=581$, 88.0%)	Any-AF ($n=79$, 12.0%)	P value
Aspirin, *n* (%)	653 (98.9)	575 (99.0)	78 (98.7)	0.853
Thienopyridine, *n* (%)	622 (94.2)	555 (97.5)	67 (84.8)	< 0.001
ACE-I or ARB, *n* (%)	606 (91.8)	532 (91.6)	74 (93.7)	0.508
β-Blocker, *n* (%)	562 (85.2)	488 (84.0)	74 (93.7)	0.013
Statin, *n* (%)	531 (80.5)	471 (81.1)	60 (76.0)	0.293
Warfarin, *n* (%)	97 (14.7)	52 (9.0)	45 (57.0)	< 0.001
Triple antithrombotic therapy, *n* (%)	84 (12.7)	46 (7.9)	38 (48.1)	< 0.001

AF, atrial fibrillation; ACE-I, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; and Triple antithrombotic therapy, aspirin, thienopyridine, and warfarin.

Table 4
In-hospital events.

	All ($n=694$)	Non-AF ($n=605$, 87.2%)	Any-AF ($n=89$, 12.8%)	P value
In-hospital death, *n* (%)	34 (4.9)	24 (4.0)	10 (11.2)	0.009
CHF, *n* (%)	136 (19.6)	105 (17.4)	31 (34.8)	< 0.001
Cardiogenic shock, *n* (%)	39 (5.6)	28 (4.6)	11 (12.4)	0.008
VT/VF, *n* (%)	31 (4.5)	22 (3.6)	9 (10.1)	0.014
Stroke, *n* (%)	12 (1.7)	9 (1.5)	3 (3.4)	0.250
Hospitalization, days	17 ± 9	17 ± 7	20 ± 15	< 0.001

AF, atrial fibrillation; CHF, congestive heart failure; VT, ventricular tachycardia; and VF, ventricular fibrillation.

Table 5
Multivariate analysis (in-hospital death).

	OR	95% CI	P value
Any-AF	2.31	0.91–5.47	0.076
Age > 65 years	1.85	0.80–4.66	0.156
LVEF < 40 %	4.55	2.02–10.91	< 0.001
Final TIMI flow grade 3	0.34	0.15–0.78	0.011

OR, odds ratio; 95% CI, 95% confidence interval; AF, atrial fibrillation; and LVEF, left ventricular ejection fraction.

during index hospitalization, most deaths (91.2%) were of cardiovascular causes. The unadjusted in-hospital mortality was significantly higher in the any-AF group than in the non-AF group (11.2% vs. 4.0%, $P=0.009$) (Table 4). However, there was no significant

association between AF and in-hospital mortality (odds ratio [OR], 2.31; 95% CI, 0.91–5.47; $P=0.076$) after adjustment for baseline confounders (Table 5). Furthermore, when stratified by AF subgroups, neither AF at admission nor AF during hospitalization was an independent predictor of in-hospital mortality.

3.3. Impact of AF on long-term mortality

During a follow-up period of 3.0 ± 1.7 years, a total of 114 patients (16.4%) died. Most deaths (47.4%) were of cardiovascular causes. The Kaplan–Meier survival curves showed that the unadjusted long-term mortality was significantly higher in the any-AF group than in the non-AF group (Fig. 1). When comparing the AF subgroups with the non-AF group, both the AF at admission and AF during hospitalization groups had a higher mortality than the non-AF group (Fig. 1). There was no significant difference in long-term mortality between the 2 any-AF subgroups (Fig. 1).

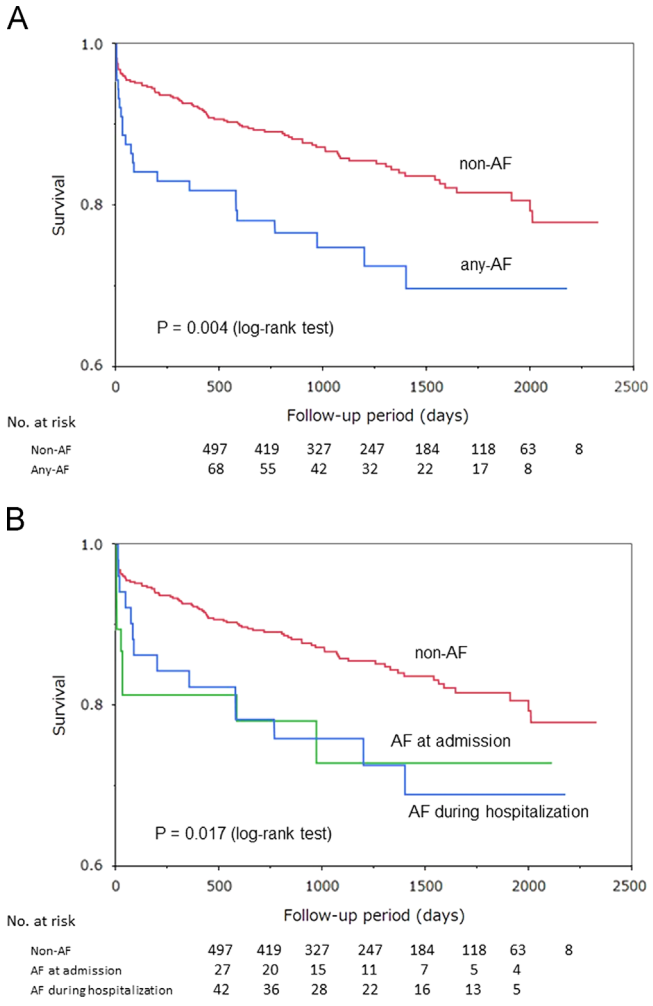

Fig. 1. Kaplan–Meier curves for unadjusted long-term mortality. (A) Kaplan–Meier curves for unadjusted long-term mortalities of patients with atrial fibrillation (any-AF) and those without atrial fibrillation (non-AF). (B) Kaplan–Meier curves for unadjusted long-term mortalities of patients with atrial fibrillation at admission (AF at admission), those who developed atrial fibrillation during hospitalization (AF during hospitalization), and those without atrial fibrillation (non-AF).

In the univariate Cox proportional hazard model, the hazard ratios (95% CI) of any-AF, AF at admission (vs. non-AF), and AF at hospitalization (vs. non-AF) were 1.93 (1.19–3.00), 1.96 (0.92–3.69), and 1.91 (1.04–3.24), respectively (Table 6). The multivariate analysis by the Cox proportional hazard model revealed that age >65 years (HR, 3.20; 95% CI, 1.97–5.41; $P<0.001$), LVEF $<40\%$ (HR, 1.76; 95% CI, 1.14–2.72; $P=0.012$), eGFR <60 mL min^{-1} 1.73 m^{-2} (HR, 3.76; 95% CI, 2.32–6.41; $P<0.001$), heart rate at admission >100/min (HR, 1.85; 95% CI, 1.10–2.99; $P=0.021$), and final TIMI flow grade 3 (HR, 0.62; 95% CI, 0.39–0.99; $P=0.046$) were independent predictors of long-term mortality. However, presenting AF (HR, 1.15; 95% CI, 0.67–1.88; $P=0.588$) was not significantly associated with long-term mortality (Table 7). Furthermore, when comparing the AF subgroups with the non-AF group, neither AF at admission (HR, 1.05; 95% CI, 0.45–2.13; $P=0.901$) nor AF during hospitalization (HR, 1.22; 95% CI, 0.64–2.17; $P=0.530$) was an independent predictor of long-term mortality (Table 6). When limited to 1-year mortality, patients with AF had a higher mortality rate (18.1% vs. 7.8%, $P=0.001$ by log-rank test), and presenting AF was an independent predictor (HR, 1.91; 95% CI, 1.03–3.36; $P=0.040$) for 1-year mortality even after adjustment for age >65 years, male sex, anterior MI, previous MI, and final TIMI flow grade 3.

4. Discussion

In patients with AMI in the present study, presenting AF was associated with higher in-hospital events, including all-cause death, CHF, cardiogenic shock, and ventricular arrhythmias. Furthermore, patients with AF had a higher long-term mortality than those without AF. However, multivariate analysis revealed that presenting AF was not an independent predictor of both

Table 7
Cox proportional hazards model for long-term mortality.

	HR	95% CI	*P* value
Any-AF	1.15	0.67–1.88	0.588
Age >65 years	3.20	1.97–5.41	<0.001
Male	0.62	0.37–1.01	0.055
LVEF $<40\%$	1.76	1.14–2.72	0.012
eGFR <60 mL min^{-1} 1.73 m^{-2}	3.76	2.32–6.41	<0.001
Anterior MI	1.18	0.48–1.80	0.437
Peak CPK >3000 IU/L	1.02	0.66–1.56	0.934
Heart rate at admission >100/min	1.85	1.10–2.99	0.021
Final TIMI flow grade 3	0.62	0.39–0.99	0.046

HR, hazard ratio; 95% CI, 95% confidence interval; AF, atrial fibrillation; LVEF, left ventricular ejection fraction; eGFR, estimate glomerular filtration rate; MI, myocardial infarction; and CPK, creatine phosphokinase.

Table 6
Hazard ratio of atrial fibrillation for long-term mortality.

	Unadjusted HR	95% CI	*P* value	Adjusted HR[a]	95% CI	*P* value
Any-AF	1.93	1.19–3.00	0.009	1.15	0.67–1.88	0.588
AF at admission	1.96	0.92–3.69	0.078	1.05	0.45–2.13	0.901
AF during hospitalization	1.91	1.04–3.24	0.038	1.22	0.64–2.17	0.530

HR, hazard ratio; 95% CI, 95% confidence interval; and AF, atrial fibrillation.

[a] Adjusted for age >65 years, male sex, LVEF $<40\%$, eGFR <60 mL min^{-1} 1.73 m^{-2}, anterior MI, peak CPK >3000 IU/L, heart rate at admission >100/min, and final TIMI flow grade 3.

in-hospital and long-term mortalities. When comparing the AF subgroups to the non-AF group, neither AF at admission nor AF during hospitalization was an independent predictor of long-term mortality. To the best of our knowledge, this is the first long-term follow-up report evaluating the prognostic impact of AF in patients with AMI in the PCI era. These findings indicate the importance of presenting AF during the acute phase of MI even in the PCI era.

4.1. Prevalence of AF in AMI

AF is one of the most common supraventricular arrhythmias in the setting of AMI. In the present study, AF was a common complication of AMI, with a prevalence of 12.8%. This prevalence is slightly higher than has been observed in previous published studies (7–10%) [3,4,12]. In the GUSTO I trial [3], which included patients with AMI eligible for thrombolysis, an AF incidence of 10.4% was reported. Wong et al. [4] presented data from the GUSTO III study and reported a 7.0% incidence of AF. Eldar et al. [12] reported a 9.8% incidence of paroxysmal AF in patients with AMI. These were randomized controlled studies, and therefore high-risk patients were excluded. Moreover, these studies included only AMI patients with new-onset AF or paroxysmal AF. Our study included not only AMI patients with new-onset, transient, and paroxysmal AF but also those with persistent and permanent AF.

Old age has been reported to be the most important independent predictor of AF [3,11,23,24]. In the GUSTO I trial, baseline clinical characteristics, including age, heart rate, and Killip class at admission, were found to be significant independent predictors of new AF [3]. We found that patients with AF had worse baseline clinical characteristics, including advanced age, higher heart rate, lower LVEF, lower eGFR, higher peak level of CPK, and lower rate of final TIMI flow grade 3 than those without AF. The present study also showed that in addition to male sex, higher heart rate at admission, higher peak level of CPK, and previous AF, advanced age was independently associated with the incidence of AF. A retrospective analysis of a registry database that included 106,780 Medicare patients >65 years old with AMI showed that the incidence of AF was 22.1% [2]. This high incidence of AF in older patients with AMI is consistent with the generally higher prevalence of AF in elderly persons documented by several epidemiological studies [25].

4.2. In-hospital events

Consistent with previous reports [3,12,26], our current study showed that patients with AF had considerably more serious in-hospital complications than those without AF. The incidences of CHF, cardiogenic shock, and VT/VF were more frequently observed in patients with AF than in those without AF. In the GUSTO trial, patients with AF had a larger infarction size, more extensive coronary artery disease, poorer reperfusion, and lower LVEF than those without AF. Similarly, our study showed that patients with AF had worse baseline clinical characteristics, including advanced age, higher heart rate, lower LVEF, lower eGFR, higher peak level of CPK, and lower rate of final TIMI flow grade 3 than those without AF. Although we could not ascertain the precise etiology of AF, the observation that an increased heart rate and a lower LVEF were associated with AF suggests that hemodynamic compromise is the most likely mechanism.

In this study, in-hospital mortality was significantly higher in patients with AF than in those without AF. An adverse impact of AF on in-hospital mortality in patients with AMI has been reported by several clinical studies [4,14,26]. In these studies, AF was independently associated with in-hospital mortality even after adjustment for multiple confounders [4,14,26]. On the other hand, in some reports, the association of AF with mortality appeared to be related to CHF, cardiogenic shock, and ventricular arrhythmias, rather than AF itself [11–13,24]. In a recent analysis of AMI patients treated with PCI [13], Kinjo et al. showed that in-hospital fatal events occurred more frequently in patients with AF, although after adjustment for possible confounders, including age, sex, DM, hypertension, prior MI, prior cerebrovascular disease, systolic blood pressure <100 mm Hg, heart rate >100/min, Killip class IV, left anterior descending artery disease, multivessel disease, and final TIMI flow grade 3, AF was not independently associated with in-hospital mortality [13]. In our study, patients with AF had a higher in-hospital mortality in univariate analysis, but presenting AF was not an independent predictor (OR, 2.31; 95% CI, 0.91–5.47; $P=0.076$) of in-hospital mortality after adjustment for age >65 years, LVEF $<40\%$, and final TIMI flow grade 3. This result is consistent with the report of Kinjo et al. [13].

4.3. Long-term mortality

Previous studies on the impact of AF on mortality in patients with AMI reported discrepant results, with some studies reporting no adverse effect on long-term mortality [1,10] and others reporting an increased risk of death with AF [2,3,11–17]. The present study demonstrates that AF with AMI was associated with long-term mortality but was not an independent predictor after adjustment for relevant predictors. Although the Kaplan–Meier curves clearly showed increased mortality in patients with AF regardless of the timing of AF, in multivariate analysis, either AF at admission or AF during hospitalization was not detected as an independent predictor of long-term mortality. In a previous study, patients with AF had a more complicated in-hospital clinical course; however, AF was not an independent risk factor in in-hospital and long-term mortalities after adjustment for baseline characteristics (HR, 1.26; 95% CI, 0.82–1.95; $P=0.283$) [10]. Goldberg et al. [1] also reported that patients discharged after developing AF had higher long-term death rates than those who did not develop AF, although these differences were attenuated after adjusting for other factors. Taken together, AF was associated with a more complicated clinical course, such as CHF or cardiogenic shock and VT/VF, although there was no significant association between presenting AF and worse long-term mortality after adjustment for relevant predictors. The presence of AF reflects the overall poor clinical status, and, consequently, might reflect the worse prognosis in previous studies. Kinjo et al. showed that patients with AF had significantly greater risk for mortality at 1 year even after adjustment for demographic characteristics and clinical factors [13]. Differences in the inclusion criteria, data adjustment, and follow-up period can at least partially account for the discrepant results between this study and the previous studies. In our study, when limited to 1-year mortality, patients with AF had a higher mortality rate (18.1% vs. 7.8%, $P=0.001$ by log-rank test), and presenting AF was an independent predictor (HR, 1.91; 95% CI, 1.03–3.36; $P=0.040$) of 1-year mortality even after adjustment for age >65 years, male sex, anterior MI, previous MI, and final TIMI flow grade 3. This result is consistent with the report of Kinjo et al. [13].

Although no significant statistical association was found, AF tended to be associated with higher in-hospital mortality (OR, 2.31; 95% CI, 0.91–5.47; $P=0.076$). Similarly, AF was an independent predictor of 1-year mortality. Therefore, AF seems to be closely associated with short- or mid-term mortality, but not with long-term mortality. In our study, most patients were treated with ACE-I or ARB, β-blockers, and statin. Appropriate treatment including not only early reperfusion therapy but also the above-mentioned drugs may be decreasing the prognostic impact of AF on long-term mortality.

4.4. Limitation

Our study has several limitations. All analyses were based on observational data, and the development or termination of AF during the postdischarge periods was not included in our database. Moreover, ECG was not continuously monitored during all periods of hospitalization, and, therefore, it might not have captured all of the AF episodes particularly in patients with asymptomatic transient or paroxysmal AF. We categorized patients with a history of paroxysmal or transient AF but without recurrence of AF during index hospitalization into the non-AF group; however, there might be patients incorrectly categorized into the non-AF group.

4.5. Conclusions

Even in the PCI era, AF remains a common and important complication of AMI. Patients with AF were older, were in worse health, and had more complicated clinical events. Patients with AF had higher in-hospital and long-term mortalities; however, the differences were attenuated after adjustment for baseline characteristics. Although the appropriate treatment, including early reperfusion therapy, may be decreasing the prognostic impact of AF in AMI patients, greater attention to the management of AF complicating AMI, particularly among high-risk patients, may be warranted.

Conflict of interest

None.

Acknowledgments

None.

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