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Clinical Characteristics and Cardiovascular Outcomes of Hemodialysis Patients with Atrial Fibrillation: A Prospective Follow-Up Study

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Abstract

Background/Aims

Among the cardiovascular complications in dialysis patients, atrial fibrillation (AF) is the most common arrhythmia. The purpose of this study was to clarify the characteristics and mortality of hemodialysis patients with AF, which are not completely elucidated.

Methods

The prevalence of AF in patients undergoing hemodialysis in our institutions was assessed. Patients with AF (AF group) and without AF (control group) were included in this study. Patients in the control group were matched for several important clinical risk factors. For further analysis, AF patients were divided into 2 groups on the basis of the type of AF (chronic AF [CAF] and paroxysmal AF [PAF] groups). These patients were evaluated for their clinical characteristics, laboratory data and echocardiographic parameters and prospectively followed up for 48 months.

Results

Among 328 study patients, 30 patients had AF (9.1%). Left atrial diameter (LAD) and the left ventricular mass index were significantly greater in the AF group than in the

control group. Furthermore, cardiovascular and all-cause mortality and cumulative incidence of cardiovascular events were significantly higher in the AF group than in the control group and tended to be higher in the CAF group.

Conclusions

Our findings demonstrated that the prevalence of AF as 9.1% in hemodialysis patients, and that AF, especially CAF, was associated with high mortality.

Keywords: atrial fibrillation, mortality, hemodialysis patients

Introduction

Many recent reports have demonstrated that chronic kidney disease (CKD) is closely associated with cardiovascular disease (CVD), and the importance of recognizing this association between CKD and CVD has been increasingly emphasized [1-3]. Among CKD patients, those undergoing renal replacement therapy have an especially higher risk of developing CVD. The number of such patients is increasing annually all over the world. In addition, mortality from CVD is 30 times higher in dialysis patients than in the general population [4].

Arrhythmia is one of the most major cardiovascular complications in dialysis patients, and atrial fibrillation (AF) is the most frequently clinically encountered arrhythmia in these patients. Moreover, the major complications of AF are thromboembolic events, and the rate of stroke is remarkably higher in AF patients. AF independently increases the risk of stroke 5-fold and that of death up to 1.9-fold [5].

Although some studies have reported on hemodialysis patients with AF, most of these studies were retrospective and not prospective. In addition, the details of association between end stage renal disease (ESRD) and AF remain unclear. Therefore, the purpose of our study was to assess the characteristics and mortality of hemodialysis patients with AF.

Materials and Methods

Study population

A total of 335 ESRD patients underwent dialysis twice or thrice a week at our institutions in October 2005. Patients for whose duration of dialysis was less than 3 months and who had been diagnosed with rheumatic valvular disease were excluded from the present study. This study also included some patients who had participated in our previous study [6]. Electrocardiogram (ECG) was performed for all the patients at least once a month and some patients who had any symptoms that suggested the presence of arrhythmia underwent ECG monitoring during a dialysis session. AF was considered when the arrhythmia was permanent or had been documented by these examinations. Among the remaining 328 patients enrolled in the present study, we cross-sectionally assessed the prevalence of AF. In addition, from the remaining patients, we chose the same number of patients without AF matched for various clinical risk factors including age, gender, duration of hemodialysis, and presence of hypertension, diabetes mellitus, coronary artery disease, and history of stroke. Furthermore, we compared these AF patients on the basis of types of AF (paroxysmal AF [PAF] or chronic AF [CAF]). Our study was conducted in accordance with the Declaration of Helsinki Principles. Our experimental protocols were approved by the

appropriate institutional review committee; informed consent was obtained from all study participants.

Anticoagulants or antiplatelet drugs included aspirin, ticlopidine and warfarin. Coronary artery disease was defined as having a history of percutaneous coronary intervention and/or coronary artery bypass graft or positive findings on exercise stress electrocardiogram, exercise stress scintigraphy, or coronary angiography. Valvular heart disease was determined as the presence of echocardiographic documentation of moderate or severe mitral or aortic stenosis and/or regurgitation. According to the guidelines of the American College of Cardiology/American Heart Association and the European Society of Cardiology (ACC/AHA/ESC) guidelines, AF was defined as chronic when it was permanent, and as paroxysmal when it was paroxysmal or persistent.

All study patients were followed up for 48 months. Death due to any cause and cardiovascular disease and occurrence of cardiovascular events during the follow-up period was defined as end points for each patient. Cardiovascular events included acute myocardial infarction, angina pectoris, congestive heart failure, arrhythmia and stroke, which were diagnosed by experienced cardiologists and neurologists. The diagnosis of myocardial infarction was based on a combination of symptoms, electrocardiographic

findings, and levels of cardiac biomarkers. Patients with episodes of chest discomfort during exercise, during several minutes of rest, or during dialysis session and with effective prescriptions for sublingual nitroglycerine and/or with positive findings on electrocardiography, scintigraphy or coronary angiography were defined as angina pectoris in the present study. Heart failure was diagnosed based on the presence of the clinical criteria: symptoms and signs of heart failure including dyspnea, general fatigue, raised jugular venous pressure, pulmonary rales, and radiographic evidence of pulmonary venous congestion or interstitial edema. Stroke was defined as the presence of a focal neurologic deficit of rapid onset, confirmed by imaging techniques (computerized axial tomography or nuclear magnetic resonance).

Echocardiogrphic examination

Echocardiography was performed on the interdialysis day. Two-dimensional guided M-mode echocardiography was performed to measure left ventricular wall mass. Left ventricular diastolic and systolic diameter (LVDd/LVDs), in addition to the diastolic thickness of the left ventricular posterior wall (LVPWT) and interventricular septum (IVST), were assessed on M-mode images in the parasternal longitudinal-axis view. M-mode analysis was performed according to the American Society of

Echocardiography guidelines. The left ventricular mass index (LVMI) (g/m^2) and relative wall thickness (RWT) were calculated using these parameters [7].

All measurements were performed by four trained investigators who were unaware of the subjects' clinical data. We recorded echocardiographic images, and data were analyzed precisely from the retrieved images.

Blood sampling, BP measurement and change in body weight and potassium levels

BP was measured by trained personnel using a calibrated mercury sphygmomanometer and appropriate cuffs, maintaining the subject in a supine position, and ensuring standardized conditions before and after each dialysis session.

Change in body weight at 2-day intervals between dialysis sessions and change in serum potassium levels before and after dialysis sessions at 2-day intervals between these sessions were defined as ⊿BW and ⊿K, respectively. These were calculated using the following formulas:

⊿BW (%) = [increase in body weight at 2-day intervals between dialysis sessions (kg) / dry weight (kg)] × 100

⊿K (mEq/l) = [serum potassium levels before dialysis sessions - serum potassium levels after dialysis sessions]

According to Japanese society of dialysis therapy (JSDT) guidelines, blood samples were collected from patients in the supine position after overnight fasting before and immediately after each dialysis session at 2-day intervals. Laboratory tests were performed using standardized clinical laboratory methods.

Study data used were the average of 2 (intact parathyroid hormone and brain natriuretic peptide) or 4 (other data) measurements.

Statistical analysis

We used the computer software application StatView 5.0 (SAS Institute, Cary, NC, USA) for all statistical analyses. Values are presented as mean ± SD. The significance of differences between the 2 groups was analyzed by the Student's t-test for continuous variables and by the χ^2 test for categorical variables. Kaplan-Meier survival analysis was performed to examine the difference in all-cause and cardiovascular mortality and cumulative incidence of cardiovascular events between the 2 groups on the basis of the presence and type of AF. Moreover, a Cox regression model was used to evaluate the factors that influenced the overall hazard of death and cardiovascular events and the cause-specific hazard of all-cause and cardiovascular deaths and cardiovascular events. A p value of less than 0.05 was considered statistically significant.

Results

Patient characteristics

Table 1 shows patients' characteristics in the control and AF groups. Other than matched clinical risk factors (age, sex, duration of dialysis, and percentage of diabetes, hypertension, coronary artery disease, and history of stroke), body mass index and use of an anticoagulation/antiplatelet drug were comparable between the control and AF groups (control group; aspirin, n = 15, AF group; aspirin, n=13; ticlopidine, n = 7; warfarin, n = 3). Use of an angiotensin converting enzyme inhibitor (ACE-I) or angiotensin II receptor blocker (ARB) was significantly less, and the number of patients with valvular disease tended to be higher in the AF group than in the control group. The causes of ESRD did not significantly differ between the 2 groups. Increase in body weight at 2-day intervals between dialysis sessions and duration of dialysis were comparable between the 2 groups. BP and serum potassium levels before and after dialysis sessions were also comparable between the 2 groups. The cardiothoracic ratio was significantly higher in the AF group than in the control group.

Duration of dialysis was significantly longer, the number of patients with valvular disease was significantly higher and Kt/V was significantly lower in the CAF group than in the PAF group (Table 2).

Echocardiographic parameters between the two groups

Table 3 shows the echocardiographic parameters in the control and AF groups. Left atrial dimension (LAD) was significantly greater in the AF group than in the control group. Wall thickness, systolic function, and inferior venous cava diameter were similar between the two groups. LVMI was significantly greater in the AF group than in the control group.

With regard to echocardiographic parameters in the CAF and PAF groups, only LAD was significantly greater in the CAF groups than in the PAF group (Table 4).

Patient survival and cardiovascular events

Table 4 indicated the details of newly diagnosed cardiovascular events during the follow-up period. As shown in Figure 1A, cardiovascular mortality was significantly higher in the AF group than in the control group (log rank test, $p = 0.001$). Cumulative cardiovascular mortality rates were 40.0% for patients with AF and 10.0% for those

without AF. Furthermore, all-cause mortality and cumulative incidence of cardiovascular events were significantly higher in the AF group than in the control group (Figure 1B: control group, 16.7%: AF group, 53.3%; log rank test, p = 0.002, Figure 1C: control group, 20.0%: AF group, 43.3%; log rank test, p = 0.018). In addition, further analysis showed that cardiovascular and all-cause mortality and cumulative incidence of cardiovascular events tended to be higher in the CAF group than in the PAF group (Figure 2A, B and C). Thus, these results indicate that most of the deaths in our study were due to CVD.

Clinical risk factors associated with cardiovascular and all-cause mortality and cardiovascular events

Analysis of clinical risk factors for cardiovascular mortality showed that the presence of AF and valvular disease and increased LAD were significantly associated with increased cardiovascular mortality. In addition to these factors, decreased serum albumin level was also significantly associated with increased all-cause mortality and cardiovascular events. As shown in table 6, even after adjusted for dialysis duration, Kt/V and EF, the presence of AF tended toward an increased risk for all-cause and cardiovascular mortality and significant association between other risk factors and these

clinical outcomes remained. No significant association was observed between use of ACE-I/ARB and mortality and cardiovascular events in our study patients.

Effect of antiarrhythmic therapy on the control of sinus rhythm in the TAF group

Among 17 patients in the PAF group, 8 patients took antiarrhythmic drugs (disopyramide, 4 patients; pilsicainide, 3 patients; aprindine, 3 patients; propafenone, 1 patient; bepridil, 1 patient). Although electrocardiogram readings and serum levels of these drugs were closely monitored in these patients, 6 patients (75%) experienced an episode of AF during a dialysis session or at home.

Discussion

Our study demonstrated that (1) the prevalence of AF was 9.1% in our hemodialysis patients; (2) AF, especially CAF, was associated with high mortality during the 4-year follow-up period; and (3) duration of dialysis was significantly longer and the number of patients with valvular disease was significantly higher in the CAF group than in the PAF groups.

Many studies have demonstrated a remarkably increased frequency of AF in hemodialysis patients. The estimated prevalence of AF in these patients is reported to be

in the range of 7.0 to 27.0 % [8, 9]. Ananthapanyasut et al. [10] reported a 21.2% (n = 214) incidence of AF among 1,010 nondialysis CKD patients. In addition, according to the Dialysis Outcomes and Practice Patterns Study (DOPPS), 12.5% (n = 2,188) of 17,513 dialysis patients had preexisting AF at baseline [11]. DOPPS showed a 5.6% prevalence of AF in Japan, which is much lower than that in other countries; this result consists with that of the present study in which a relatively less prevalence of AF (9.2%) was observed. This may contribute to the fact that the prevalence of stroke in hemodialysis patients of Japan is lower than that in hemodialysis patients of other countries [12]. Furthermore, we speculated that this decreased prevalence of AF in Japan is probably because of the better conditioning of Japanese hemodialysis patients. The reason seems to be that the number of patients receiving kidney transplantation is markedly lower in Japan [13] than in other countries and that relatively well conditioned patients are included among Japanese hemodialysis patients.

Currently, the CHADS2 score is often used to perform risk stratification in AF patients [14]. Thus, history of congestive heart failure, hypertension, age, diabetes and history of stroke are considered to be important risk factors. However, most CKD patients have such traditional and many nontraditional risk factors including anemia, hypoalbuminemia, uremic toxin, volume overload and mineral disorders such as

hyperphosphatemia and hyperkalemia. Several previous studies have reported that these factors are independently associated with AF in ESRD patients [5, 8-10]. Vazquez et al. reported that female gender, increased LAD, and age were independently associated with AF at the start of dialysis [9]. In addition, age, pulse pressure, valvular disease, left ventricular hypertrophy, anemia, decreased left ventricular systolic function and calcification were suggested to be correlated with newly diagnosed AF. Although the present study is a matched cohort study, the number of patients with valvular disease was higher the number of AF patients treated with ACE-I/ARB was significantly lower in the control group than in the AF group. Recent reports have suggested that ACE-I/ARB suppresses the occurrence of AF by preventing both structural and electrical cardiac remodeling [15-20]. Although we did not perform a prospective interventional study on the prevention of AF, we too speculated the influence of ACE-I/ARB on AF.

Studies investigating mortality in hemodialysis patients with AF are limited, and only a few of them are prospective studies. Data about Japanese hemodialysis patients are limited. Studies by Genovesi et al. [21] and Vazquez et al. [9] demonstrated that AF was associated with increased mortality in hemodialysis patients. In our present study, during the 4-year follow-up period, the cumulative probability of cardiovascular

mortality was 43% and that of all-cause mortality was 53% in the AF group. Consist with the results of previous studies, mortality was significantly higher in the AF group than in the control group. Moreover, our data indicated that cause of death in most cases was CVD. Since our study patients were matched for several important clinical risk factors at enrollment, we speculated that presence of AF may reflect an unexpected, high-risk condition for CVD.

AF is classified into 2 major types: CAF and PAF. Chou et al. reported that patient survival did not differ between dialysis patients with PAF and those with CAF [22]. On the other hand, in the present study, the prognosis of CAF patients was poorer than that of PAF patients. The number of patients with valvular disease was significantly higher and duration of dialysis was significantly longer in the CAF group than in the PAF group. Since presence of valvular disease and increased LAD were independent risk factors for mortality, we postulated that left atrial dilatation and deterioration of valvular disease associated with longer duration of dialysis might transform PAF into CAF. With complete treatment of PAF patients, we may be able to prevent the progression of this unfavorable cycle and improve the prognosis of these patients.

In AF patients, the most important problem in a clinical setting is a thromboembolism event. However, whether guidelines for nonrenal disease patients

should apply to CKD patients is unclear. Especially in hemodialysis patients, the risk of bleeding is believed to be much higher than that in nonrenal disease patients because of the use of anticoagulants during each dialysis session. Chan et al. have recently reported that use of anticoagulants and/or antiplatelet drugs was significantly associated with high mortality in hemodialysis patients [23]. They also reported that warfarin use was significantly associated with an increased risk of not only hemorrhagic but also ischemic stroke [24]. Considering these results, several investigators recommend possible treatment of these patients with oral anticoagulants and/or antiplatelet drugs after risk stratification. In the present study, although only 50% of AF patients recieved anticoagulants and/or antiplatelet drugs, no patient with newly diagnosed ischemic stroke was observed. Only 1 AF patient had hemorrhagic stroke during the follow-up period. Similar to the previous studies, the prevalence of AF and stroke are much lower in Japanese hemodialysis patients [25]. In addition, Wiesholzer et al. demonstrated that AF was not associated with an increased risk of stroke in hemodialysis patients [26]. Taken together, clinicians should carefully consider the use of anticoagulants and/or antiplatelet drugs when treating hemodialysis patients with AF.

In a clinical setting, hemodialysis patients with PAF are sometimes administered antiarrhythmic drugs because of chest pain or decrease in BP during a dialysis session.

However, maintenance of sinus rhythm despite treatment by such drugs seems difficult. Our data also showed that AF occurred during a dialysis session in 6 of 8 patients (75%) in spite of taking antiarrhythmic drugs. Even in nondialysis patients, whether rhythm control is better than rate control is controversial. The Atrial Fibrillation Follow-up Investigation of Rhythm Management (AFFIRM) study demonstrated that rate control is not inferior to rhythm control for the prevention of death and morbidity from CVD [27]. Several other studies have also attempt to determine which therapy is better: most of these studies reported that both therapies were comparable [28-30]. A previous report demonstrated that the number of deaths and cardiac arrests was significantly higher in patients recieving antiarrhythmic drugs than in those not receiving such drugs [31]. Especially in hemodialysis patients, most drugs tend to accumulate, with an easy elevation of their levels. Therefore, severe side effects may occur in these hemodialysis patients. Taken together, rate control therapy seems to be better for hemodialysis patients. However, patients with markedly decreased cardiac function, angina-like chest pain or decreased BP during a dialysis session may be more effectively treated with antiarrhythmic drugs or by catheter ablation because maintenance of sinus rhythm leads to a stable hemodynamic state.

The main limitation of our study was that the number of study patients was small.

However, our 2 groups were well matched and carefully and appropriately treated. Moreover, we observed our study patients prospectively and longitudinally. We believe this is important because there are few prospective and longitudinal studies on this topic. Although we determined the clinical risk factors for CVD and mortality, prospective interventions were not performed to improve or prevent CVD. Although the detailed mechanisms were not completely elucidated in this study, our results indicated a statistically significant incidence of AF in CKD patients. Therefore, we consider the results of the present study to be valuable for the management of CVD associated with CKD.

Conclusions

Our data revealed that the prevalence of AF was 9.1% in our hemodialysis patients and that AF, especially CAF, was associated with high mortality. In addition, our results suggested that the duration of dialysis and presence of valvular disease may be associated with AF in dialysis patients.

Further study is required to clarify the mechanisms of AF and explore specific strategies for the prevention of AF in hemodialysis patients.

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Table 1 Baseline characteristics of patients (1)

	Control (n = 30)	AF (n = 30)	*P*
Age (year)	64 ± 10	68 ± 7	n. s.
Sex (male) (%)	12 (40)	9 (30)	n. s.
Duration of dialysis (months)	91.4 ± 47.8	108.2 ± 91.4	n. s.
Smoking (%)	18 (60)	20 (67)	n. s.
HT (%)	26 (87)	24 (80)	n. s.
DM (%)	12 (40)	8 (27)	n. s.
CAD (%)	7 (23)	8 (27)	n. s.
Stroke (%)	7 (23)	11 (36)	n. s.
BMI (kg/m^2)	21.1 ± 2.9	21.0 ± 3.6	n. s.
Causes of ESRD			
Chronic glomerulonephritis	17 (57)	18 (60)	n. s.
Diabetic nephropathy	7 (23)	7 (23)	n. s.
Nephrosclerosis	5 (17)	2 (7)	n. s.
Others	1 (3)	3 (10)	n. s.
Blood access			
A-V fistula	28 (93)	30 (100)	n. s.
Graft	2 (7)	0 (0)	n. s.
Anticoagulant/platelet drug (%)	15 (50)	15 (50)	n. s.
ACE-I/ARB (%)	15 (50)	3 (10)	0.001
β-blocker (%)	5 (17)	7 (23)	n. s.
Valvular disease (%)	3 (10)	10 (33)	0.054
Hematocrit (%)	31.9 ± 4.7	34.8 ± 3.8	0.009
Albumin (mg/dl)	3.8 ± 0.5	3.7 ± 0.4	n. s.
T-Chol (mg/dl)	163.1 ± 37.3	160.5 ± 35.8	n. s.

Hemoglobin A1c (%)	5.9 ± 0.7	6.1 ± 1.0	n. s.
Ca (mg/dl)	9.5 ± 0.9	9.0 ± 0.1	0.004
P (mg/dl)	5.3 ± 1.2	5.4 ± 1.2	n. s.
Ca × P (mg^2/dl^2)	51.0 ± 12.7	48.7 ± 11.0	n. s.
Intact PTH(pg/ml)	280.8 ± 275.2	176.7 ± 157.0	n. s.
Kt/V	1.30 ± 0.16	1.36 ± 0.26	n. s.
Pre-systolic BP (mmHg)	149.2 ± 23.0	151.9 ± 21.0	n. s.
Pre-diastolic BP (mmHg)	81.6 ± 11.9	76.1 ± 10.9	n. s.
Post-systolic BP (mmHg)	140.8 ± 17.5	134.5 ± 20.2	n. s.
Post-diastolic BP (mmHg)	76.4 ± 9.2	75.1 ± 12.0	n. s.
Pre-K (mEq/L)	4.9 ± 0.4	5.0 ± 0.6	n. s.
Post-K (mEq/L)	3.6 ± 0.3	3.7 ± 0.5	n. s.
⊿K (mEq/L)	1.3 ± 0.4	1.3 ± 0.4	n. s.
⊿BW (%)	4.7 ± 1.8	4.8 ± 1.4	n. s.
CTR (%)	48.9 ± 4.2	52.7 ± 5.3	0.013

HT: hypertension; DM: diabetes mellitus; CAD: coronary artery disease; BMI: body mass index; ESRD: end stage renal disease; ACE-I/ARB: angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker; T-Chol: total cholesterol; Ca: calcium; P: phosphate; intact PTH: intact parathyroid hormone; BP: blood pressure; K: potassium; BW: body weight; CTR: cardiothoracic ratio; n. s.: not significant.

Values are the means±SD.

Table 2 Baseline characteristics of patients (2)

	CAF (n = 13)	PAF (n = 17)	*P*
Age (years)	70 ± 6	67 ± 8	n. s.
Sex (male) (%)	3 (23)	6 (35)	n. s.
Duration of dialysis (months)	139.6 ± 99.3	67.2 ± 61.9	0.028
Smoking (%)	9 (69)	11 (65)	n. s.
HT (%)	10 (77)	14 (82)	n. s.
DM (%)	4 (31)	4 (24)	n. s.
CAD (%)	5 (39)	3 (18)	n. s.
Stroke (%)	6 (46)	5 (29)	n. s.
BMI (kg/m^2)	21.4 ± 4.7	20.6 ± 2.6	n. s.
Anticoagulant/platelet drug (%)	13 (100)	9 (53)	0.003
ACE-I/ARB (%)	1 (8)	2 (11)	n. s.
β-blocker (%)	3 (23)	4 (24)	n. s.
Valvular disease (%)	7 (54)	2 (12)	0.011
Hematocrit (%)	33.9 ± 2.7	35.6 ± 4.4	n. s.
Albumin (mg/dl)	3.7 ± 0.5	3.8 ± 0.3	n. s.
T-Chol (mg/dl)	182.8 ± 38.0	144.8 ± 24.9	0.003
Hemoglobin A1c (%)	6.1 ± 1.0	5.7 ± 0.3	n. s.
Ca (mg/dl)	9.0 ± 0.6	9.0 ± 0.4	n. s.
P (mg/dl)	5.4 ± 1.3	5.4 ± 1.2	n. s.
Ca × P (mg^2/dl^2)	48.7 ± 11.6	48.7 ± 10.9	n. s.
Intact PTH(pg/ml)	166.7 ± 146.6	184.4 ± 168.5	n. s.
Kt/V	1.25 ± 0.31	1.44 ± 0.18	0.045
Pre-systolic BP (mmHg)	148.1 ± 22.6	154.8 ± 19.8	n. s.
Pre-diastolic BP (mmHg)	76.8 ± 10.7	77.2 ± 11.1	n. s.

Post-systolic BP (mmHg)	128.9 ± 25.6	138.8 ± 14.2	n. s.
Post-diastolic BP (mmHg)	71.0 ± 14.3	78.2 ± 8.6	n. s.
Pre-K (mEq/L)	5.0 ± 0.8	5.1 ± 0.6	n. s.
Post-K (mEq/L)	3.8 ± 0.6	3.7 ± 0.5	n. s.
⊿K (mEq/L)	1.2 ± 0.4	1.5 ± 0.5	n. s.
⊿BW (%)	4.9 ± 1.8	4.7 ± 1.2	n. s.
CTR (%)	54.4 ± 3.3	51.0 ± 5.6	0.053

HT: hypertension; DM: diabetes mellitus; CAD: coronary artery disease; BMI: body mass index; ACE-I/ARB: angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker; T-Chol: total cholesterol; Ca: calcium; P: phosphate; intact PTH: intact parathyroid hormone; BP: blood pressure; K: potassium; BW: body weight; CTR: cardiothoracic ratio; n. s.: not significant.

Values are the means±SD.

Table 3 Echocardiographic parameters in the control and AF group

	Control (n = 30)	AF (n = 30)	*P*
LAD (mm)	38.4 ± 5.4	44.6 ± 7.0	0.001
IVST (mm)	12.0 ± 2.1	12.2 ± 2.5	n. s.
LVPWT (mm)	11.7 ± 2.2	11.7 ± 2.1	n. s.
LVDd (mm)	48.8 ± 7.7	46.7 ± 7.1	n. s.
LVDs (mm)	31.8 ± 10.4	30.2 ± 6.7	n. s.
FS (%)	35.5 ± 10.1	35.8 ± 8.8	n. s.
EF (%)	71.7 ± 15.3	67.8 ± 13.6	n. s.
LVMI (g/m^2)	135.3 ± 68.7	174.5 ± 51.3	0.016
RWT (unitless)	0.50 ± 0.13	0.52 ± 0.16	n. s.
IVCD (mm)	13.6 ± 3.8	14.3 ± 4.5	n. s.

LAD: left atrial dimension; IVST: intraventricular septum thickness; LVPWT: left ventricular posterior wall thickness; LVDd: left ventricular diastolic diameter; LVDs: left ventricular systolic diameter; FS: fractional shortening; EF: ejection fraction; LVMI: left ventricular mass index; RWT: relative wall thickness; IVCD: inferior vena cava diameter; n. s.: not significant.

Values are the means±SD.

Table 4 Echocardiographic parameters in the CAF and TAF group

	CAF (n = 13)	TAF (n = 17)	*P*
LAD (mm)	47.9 ± 8.2	41.5 ± 4.1	0.034
IVST (mm)	11.6 ± 2.1	12.6 ± 2.7	n. s.
LVPWT (mm)	10.9 ± 2.0	12.2 ± 2.1	n. s.
LVDd (mm)	49.6 ± 5.6	44.6 ± 7.6	n. s.
LVDs (mm)	33.0 ± 5.3	28.2 ± 7.1	n. s.
FS (%)	34.0 ± 5.9	37.0 ± 10.4	n. s.
EF (%)	62.9 ± 11.1	71.2 ± 14.6	n. s.
LVMI (g/m^2)	177.8 ± 67.7	170.1 ± 79.2	n. s.
RWT (unitless)	0.57 ± 0.18	0.45 ± 0.10	0.069
IVCD (mm)	13.8 ± 4.6	15.1 ± 5.0	n. s.

LAD: left atrial diameter; IVST: intraventricular septum thickness; LVPWT: left ventricular posterior wall thickness; LVDd: left ventricular diastolic diameter; LVDs: left ventricular systolic diameter; FS: fractional shortening; EF: ejection fraction; LVMI: left ventricular mass index; RWT: relative wall thickness; IVCD: inferior vena cava diameter; n. s.: not significant.

Values are the means±SD.

Table 5 Cardiovascular events during the follow-up period

	Control	AF
Acute myocardial infarction	2	0
Angina pectoris	0	1
Congestive heart failure	0	5
Arrhythmia	3	6
Stroke	1	1

Table 6 Analysis for prognostic factors independently associated with cardiovascular and all-cause mortality and cardiovascular events

	HR	95% CI	*P*
Cardiovascular mortality			
AF	2.99	0.90 – 9.90	0.073
Valvular disease	3.39	1.10 - 10.4	0.033
LAD	1.14	1.04 – 1.25	0.007
Albumin	7.58	1.56 – 37.04	0.012
All-cause mortality			
AF	3.51	0.90 – 13.7	0.071
Valvular disease	6.67	1.74 - 25.6	0.005
LAD	1.46	1.03 – 1.27	0.009
Albumin	7.75	1.27 – 47.6	0.026
Cardiovascular events			
AF	2.29	0.72 - 7.25	0.160
Valvular disease	5.12	1.48 - 17.6	0.099
LAD	1.16	1.05 – 1.28	0.004
Albumin	4.78	0.88 – 26.3	0.069

HR: Hazard ratio; CI: confidence interval; AF: atrial fibrillation; LAD: left atrial diameter.

Adjusted for dialysis duration, Kt/V and EF.

Figure Legends

Figure 1. All-cause and cardiovascular mortality and cardiovascular events of hemodialysis patients with and without atrial fibrillation.

(A) All-cause mortality

(B) Cardiovascular mortality

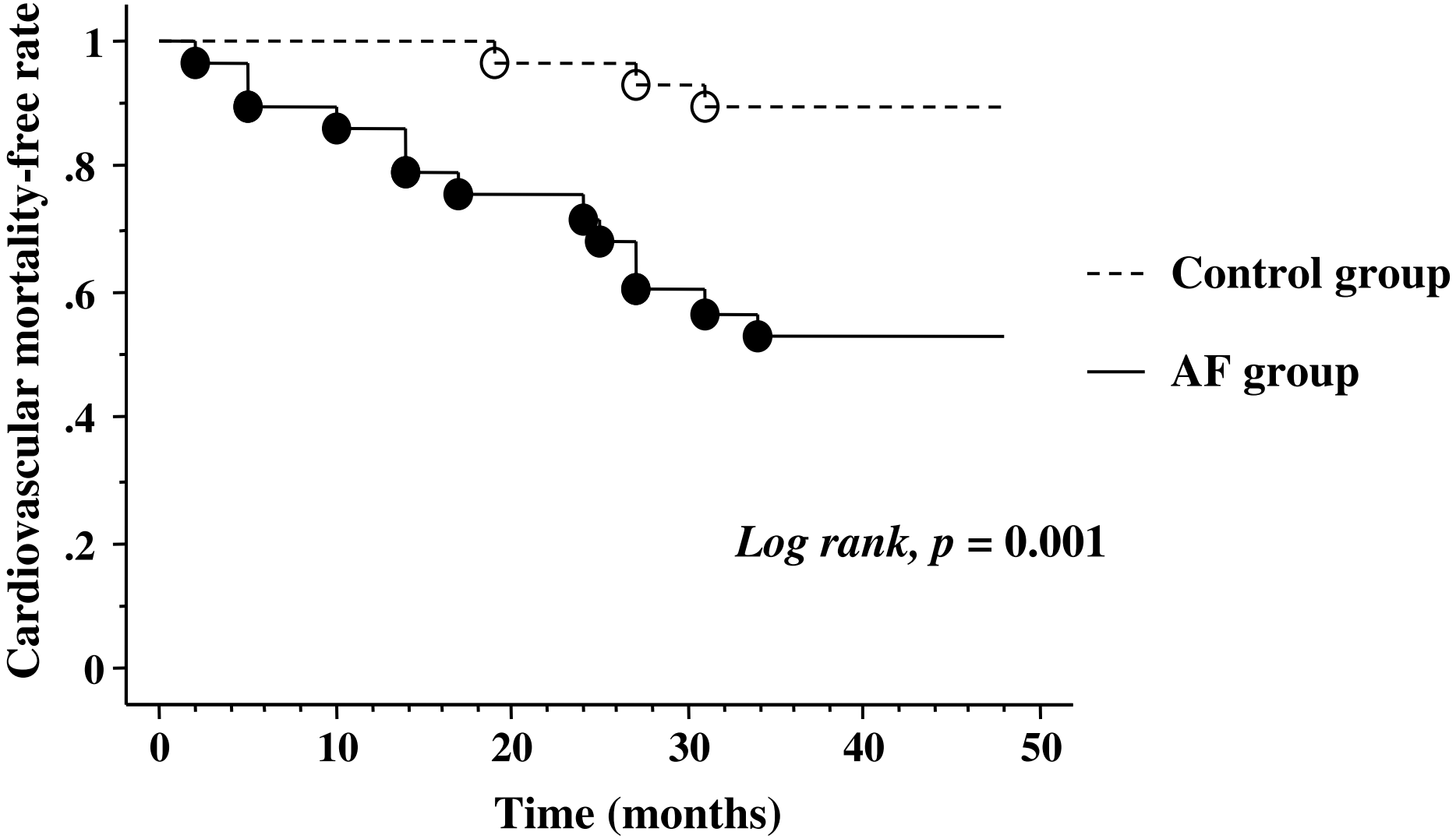
(C) Cardiovascular events

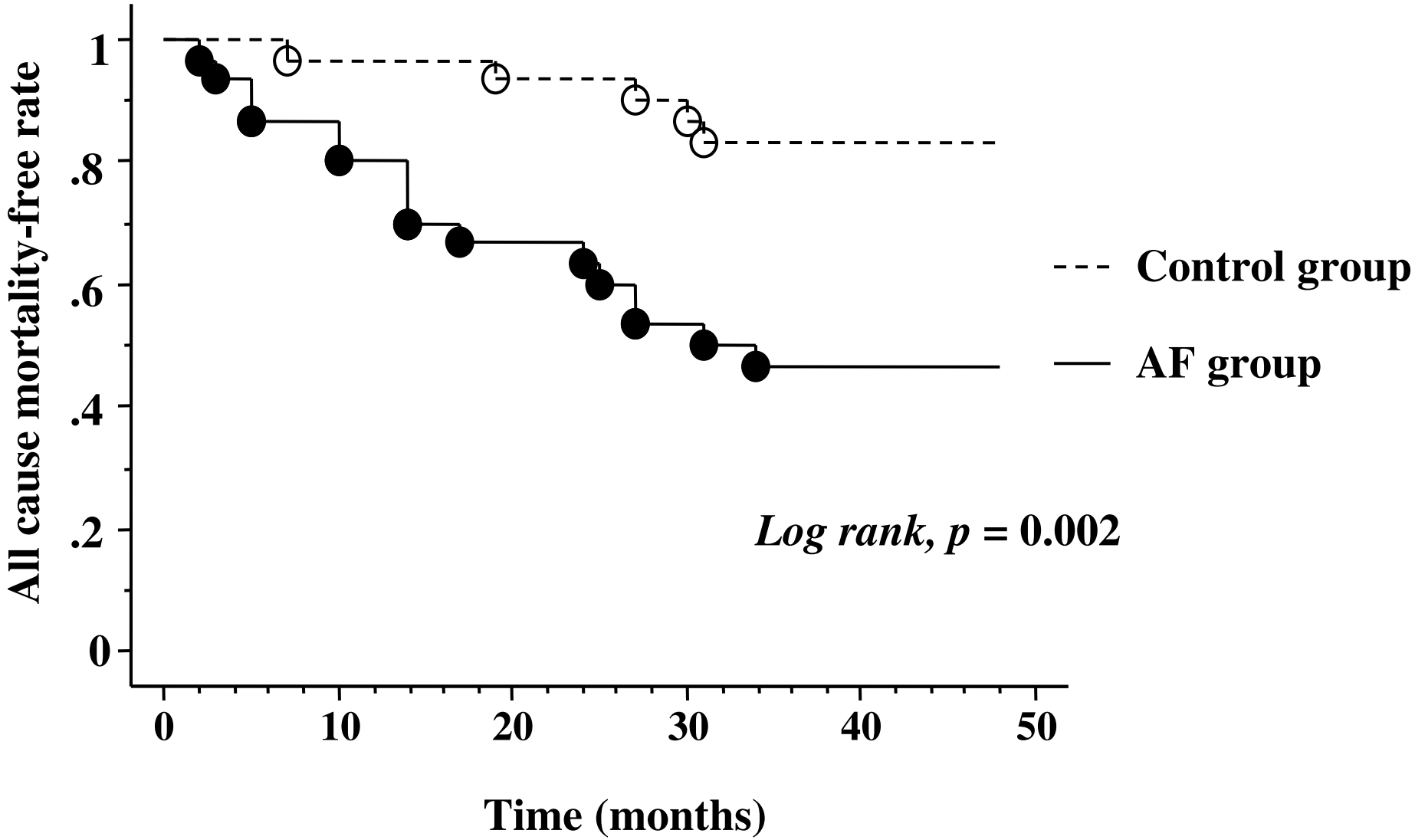
Figure 2. All-cause and cardiovascular mortality and cardiovascular events of hemodialysis patients with transient atrial fibrillation and chronic atrial fibrillation.

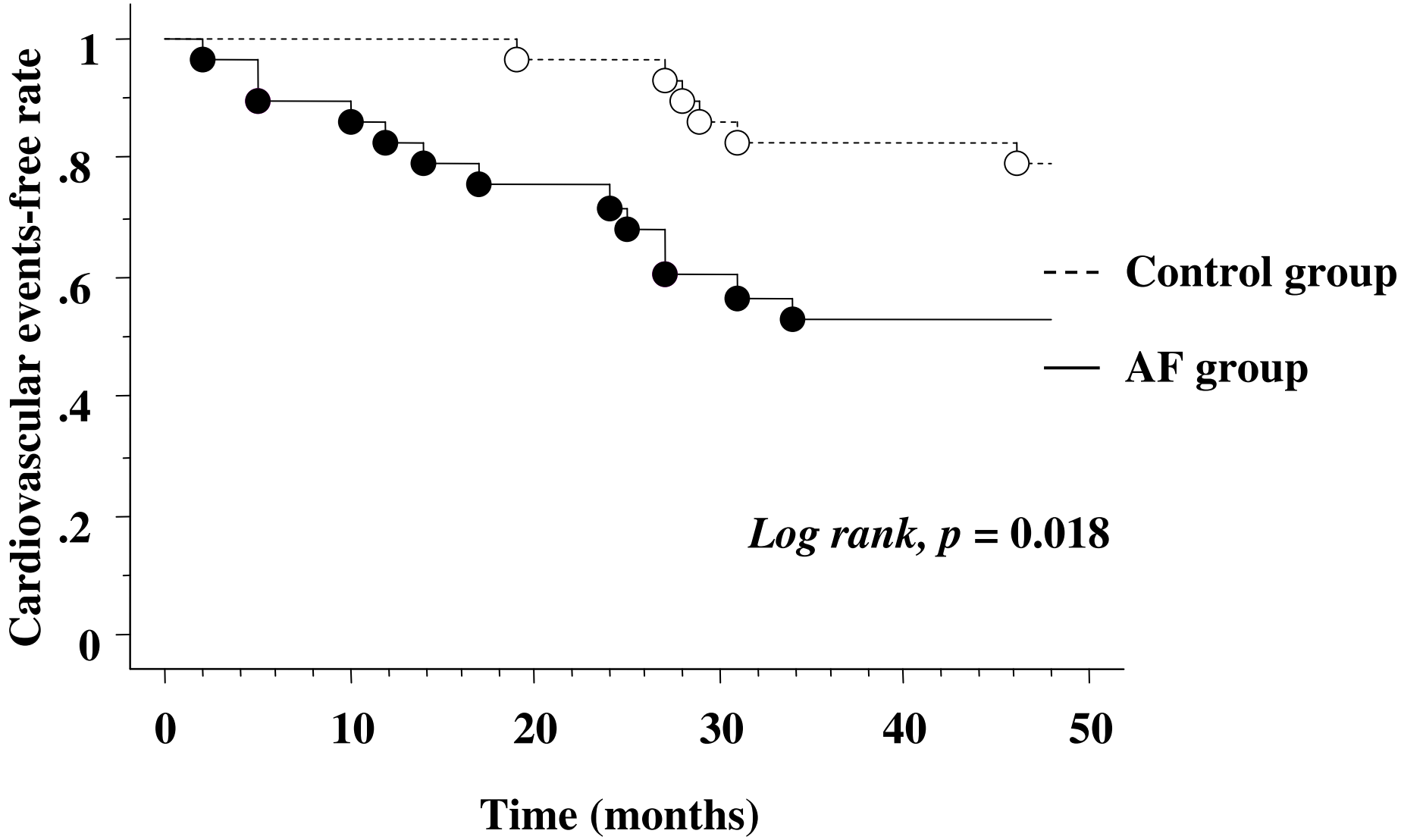
(A) All-cause mortality

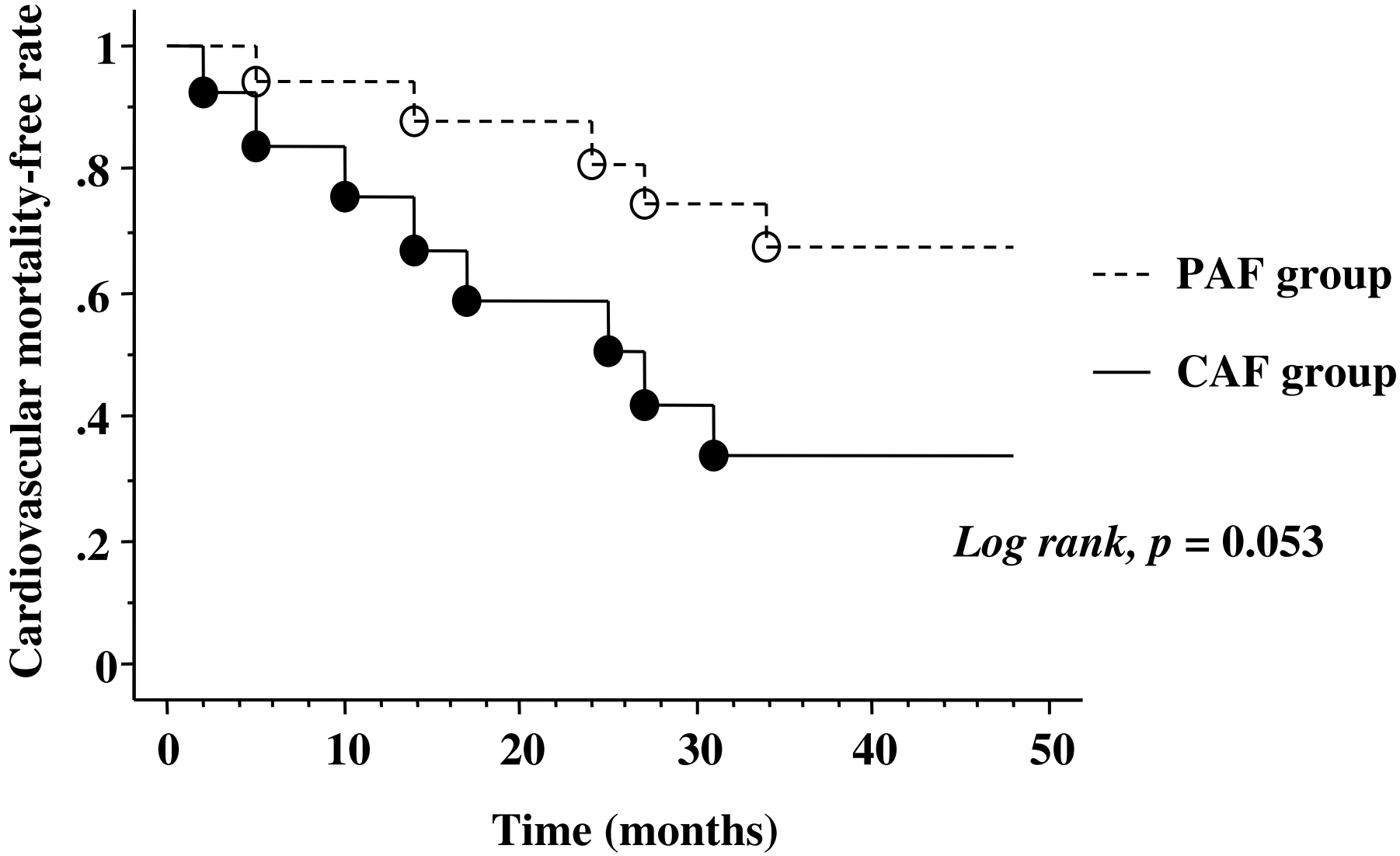
(B) Cardiovascular mortality

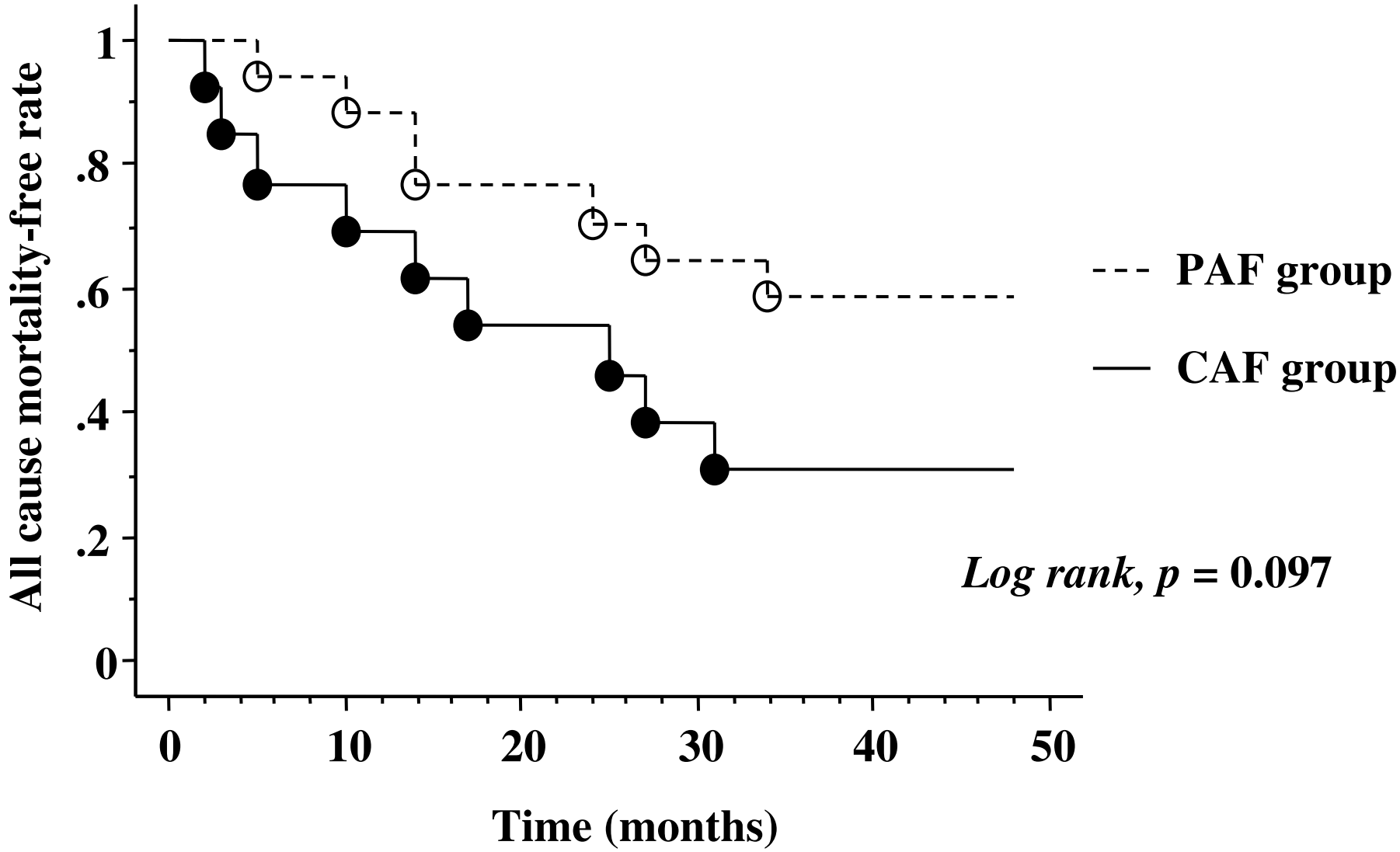
(C) Cardiovascular events

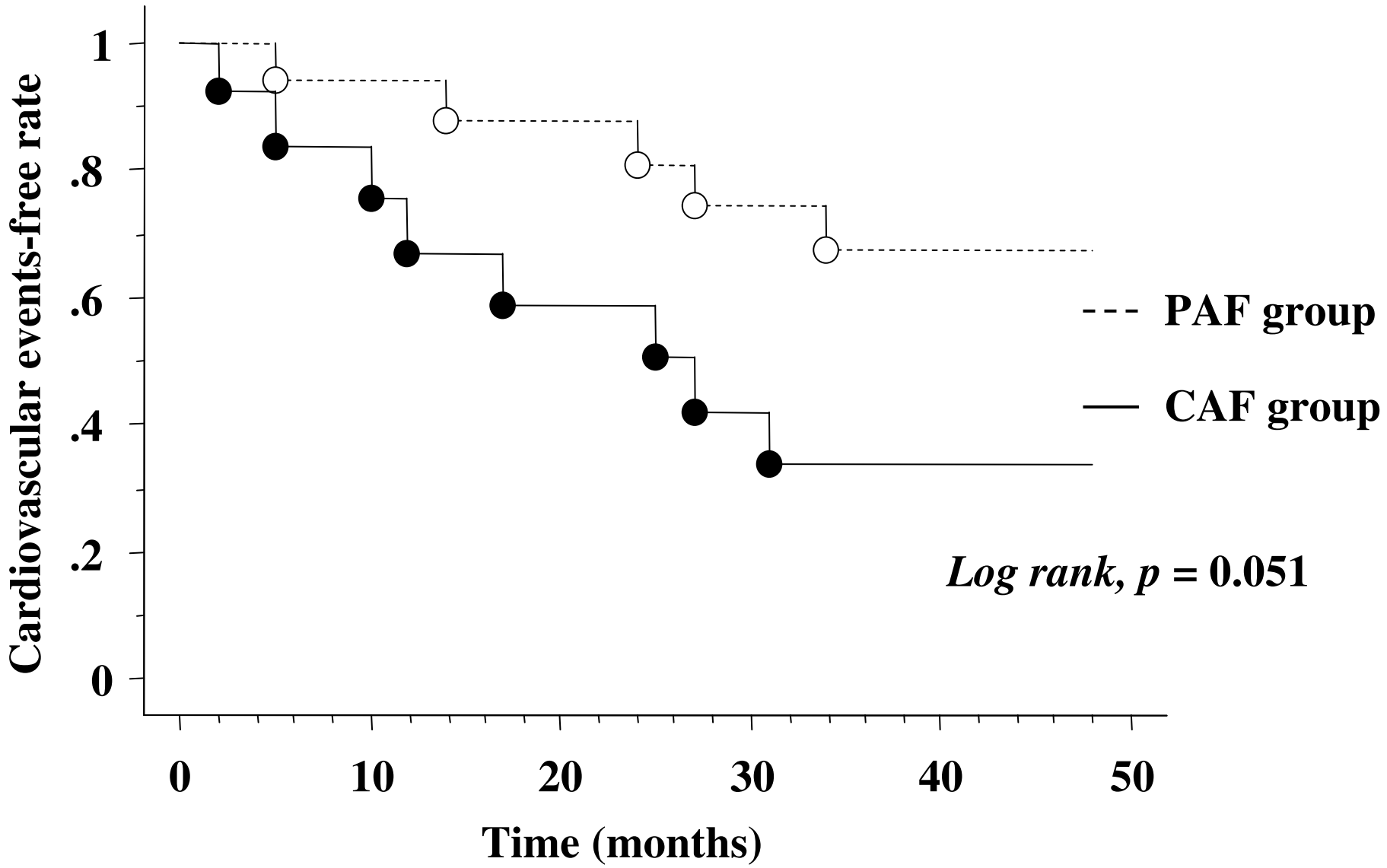

Cardiovascular mortality-free rate
1
.8
.6
.4
.2
0
0
10
20
30
40
50
Time (months)
Control group
AF group
Log rank, p = 0.001


All cause mortality-free rate
1
.8
.6
.4
.2
0
0
10
20
30
40
50
Time (months)
Control group
AF group
Log rank, p = 0.002


Cardiovascular events-free rate
1
.8
.6
.4
.2
0
0
10
20
30
40
50
Time (months)
Control group
AF group
Log rank, p = 0.018


Cardiovascular mortality-free rate
1
.8
.6
.4
.2
0
0
10
20
30
40
50
Time (months)
PAF group
CAF group
Log rank, p = 0.053


All cause mortality-free rate
1
.8
.6
.4
.2
0
0
10
20
30
40
50
Time (months)
PAF group
CAF group
Log rank, p = 0.097


Cardiovascular events-free rate
1
.8
.6
.4
.2
0
0
10
20
30
40
50
Time (months)
PAF group
CAF group
Log rank, p = 0.051