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Association of HFA-PEFF score with clinical outcomes after catheter ablation for atrial fibrillation

Taiji Okada ,[1] Takeshi Kitai,[2] Atsushi Kobori,[3] Madoka Sano,[1] Ryosuke Murai,[1] Toshiaki Toyota ,[1] Yasuhiro Sasaki,[1] Tomohiko Taniguchi ,[4,5] Kitae Kim,[1] Natsuhiko Ehara,[3] Makoto Kinoshita,[1] Yutaka Furukawa[1]

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[1]Department of Cardiovascular Medicine, Kobe City Medical Center General Hospital, Kobe, Japan
[2]Department of Cardiovascular Medicine, National Cerebral and Cardiovascular Center, Suita, Japan
[3]Cardiology, Kobe City Medical Center General Hospital, Kobe, Japan
[4]Kobe City Medical Center General Hospital, Kobe, Japan
[5]Cardiology, Kokura Memorial Hospital, Kitakyushu, Japan

Correspondence to
Dr Taiji Okada; taiji_okada@kcho.jp

ABSTRACT

Background The Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testing and final aetiology (HFA-PEFF) score has been developed for diagnosing heart failure with preserved ejection fraction (HFpEF), which is frequently associated with atrial fibrillation (AF). We aimed to investigate whether preprocedural HFA-PEFF score could be used to predict clinical outcomes in patients with AF who underwent catheter ablation (CA).

Methods Overall, 1679 patients with AF who underwent primary CA (71±10 years, 1218 males (72.5%), median follow-up duration 3.3 years) from July 2011 to December 2019 were included in this retrospective study. HFpEF was defined as an HFA-PEFF score ≥5. The primary study outcome was 5-year major adverse cardiovascular and cerebrovascular events (MACCE), which is a composite of all-cause death, hospitalisation for heart failure (HF) and hospitalisation for stroke.

Results The prevalence of HFpEF was 32.3%, but only 7.7% were diagnosed with HF at the time of $CHADS_2$ scoring. Five-year MACCE occurred in 77 patients (4.6%). The cumulative 5-year incidence of MACCE was significantly higher in the HFpEF group than in the non-HFpEF group (11.2% vs 4.8% at 5 years, p<0.001). In the multivariable analysis, HFpEF by the HFA-PEFF score was associated with MACCE (adjusted HR 1.65, 95% CI 1.02 to 2.65, p=0.041).

Conclusions Early detection of HFpEF using the HFA-PEFF score may have clinical applications in guiding therapeutic decision-making and improving prognosis by preventing HF and stroke in patients with AF undergoing CA.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Atrial fibrillation (AF) and heart failure (HF) with preserved ejection fraction (HFpEF) are common conditions with increasing prevalence and are associated with increased morbidity and mortality.
⇒ The diagnosis of HFpEF remains challenging, and differences in clinical events after catheter ablation (CA) between HFpEF and non-HFpEF have been variously reported.

WHAT THIS STUDY ADDS

⇒ In patients with AF undergoing CA, using the Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testing and final aetiology (HFA-PEFF) score could help identify more patients with HFpEF, which were initially identified as having HF.
⇒ In addition, HFpEF diagnosed by the HFA-PEFF score is associated with a higher risk of hospitalisation for HF, hospitalisation for stroke and death (major adverse cardiovascular and cerebrovascular events) after CA.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ In patients undergoing CA for AF, using the HFA-PEFF score may help to identify patients with underdiagnosed HFpEF, which could, in turn, improve their prognosis.
⇒ Future studies using the HFA-PEFF and the H_2FPEF scores could detect 'early HFpEF' and may represent a potential target for CA, which may contribute to improved prognosis through the prevention of HF and stroke.

INTRODUCTION

Atrial fibrillation (AF) and heart failure with preserved ejection fraction (HFpEF) are common conditions with increasing prevalence and are associated with increased morbidity and mortality.[1 2] However, the diagnosis of HFpEF remains challenging.[3] HFpEF is defined as symptomatic heart failure (HF) with a left ventricular ejection fraction (LVEF) ≥50% according to a universal definition,[4] and two other scores have been proposed.[5 6] The Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testingand final aetiology (HFA-PEFF) score is one of the steps in the algorithm developed by the Heart Failure Association of the European Society of Cardiology, based on echocardiographic and laboratory findings,[6] and the H_2FPEF score includes six demographic, clinical and echocardiographic

variables.[5] These scores have shown different diagnostic performance[7 8] and outcome prediction[9 10] in different cohorts.

Catheter ablation (CA) is a therapeutic strategy for patients with AF in the rhythm control strategy. CA is a reasonable treatment for patients with AF, particularly when the symptoms are not adequately controlled or tolerated with pharmacological therapy. Some studies have shown that the restoration of sinus rhythm by CA for treating HFpEF can reduce clinical events.[11 12] However, a large retrospective cohort study[13] and the Catheter Ablation versus Antiarrhythmic Drug Therapy for Atrial Fibrillation trial,[14] in which most participants had preserved LVEF, did not demonstrate a beneficial effect on the primary outcome. One reason for this may be that HFpEF was variously defined as LVEF alone. Therefore, we hypothesised that using the HFA-PEFF score could help identify patients with AF at high risk of death and hospitalisation for HF and stroke.

In this study, we performed a retrospective analysis of patients with AF undergoing CA to assess whether the diagnosis of HFpEF using preprocedural HFA-PEFF score is associated with clinical outcomes.

METHODS

Study population

From July 2011 to December 2019, 2123 consecutive patients with AF who underwent primary CA were screened. We excluded patients with prior cardiac surgery, prior catheter interventions for valve disease, haemodialysis, significant left-side valvular disease (defined as moderate or severe mitral stenosis, moderate or severe mitral regurgitation, moderate or severe aortic regurgitation and moderate or severe aortic stenosis),[15] atrial septal defects, LVEF <50% and hypertrophic cardiomyopathy. Finally, 1679 patients were analysed retrospectively in this study (figure 1).

Echocardiographic measurements

Two-dimensional echocardiography was performed before CA using the Aplio Artida (Canon Medical Systems, Otawara, Japan) or Epic 7, iE 33 (Philips Healthcare, Eindhoven, The Netherlands) ultrasound systems, and data were obtained following the recommendations of the American Society of Echocardiography and the European Association of Cardiovascular Imaging.[16 17] All measurements were quantified as an average of three consecutive heartbeats for patients with sinus rhythm and as an index beat for patients with AF.[18]

HFA-PEFF and H_2FPEF scores

The HFA-PEFF score was calculated as the sum of (i) the functional domain (e′, E/e′ and tricuspid regurgitation peak velocity (TRV) excluding global longitudinal strain), (ii) the morphological domain (left atrial volume index, left ventricular mass index, relative wall thickness or LV end-diastolic wall thickness) and (iii) the laboratory domain (N-terminal

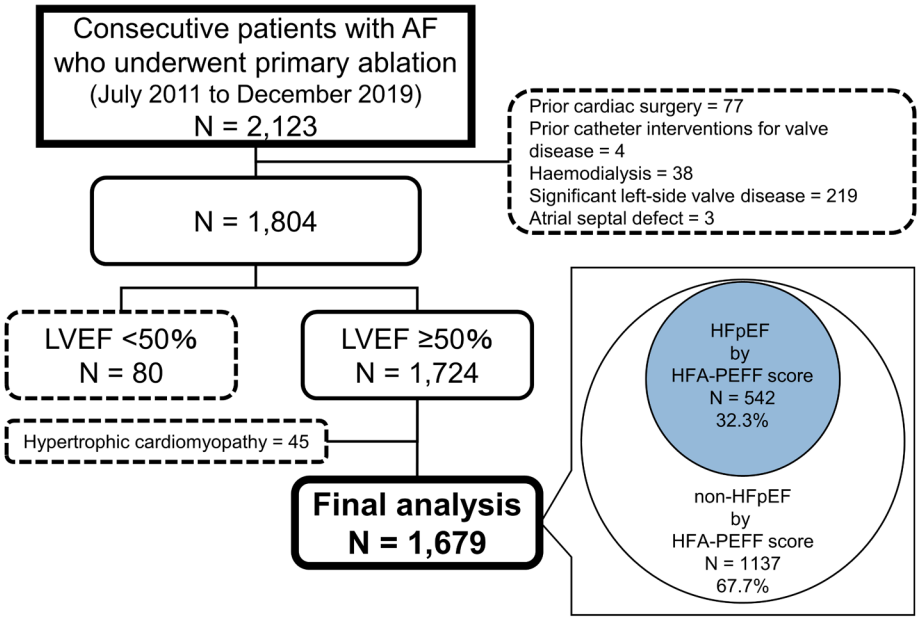

Figure 1 Flow chart illustrating the study population. Overall, 2123 patients with AF who underwent primary ablation were screened, and finally, 1679 patients were analysed retrospectively in this study. The circles in the diagram represent the percentage of heart failure with preserved left ventricular ejection fraction at each score. AF, atrial fibrillation; HFA-PEFF, Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testing and final aetiology; HFpEF, heart failure preserved left ventricular ejection fraction; LVEF, left ventricular ejection fraction.

Table 1 Characteristics and outcome of the study population divided by HFpEF or non-HFpEF in the HFA-PEFF score

	All (n=1679)	HFpEF (n=542)	Non-HFpEF (n=1137)	P value*
Demographic data				
Age, years	71±10	76±7	68±11	<0.001
Sex, male	1218 (72.5)	325 (60.0)	893 (78.5)	<0.001
Height, m	1.66±0.09	1.62±0.09	1.67±0.09	<0.001
Weight, kg	65.6±12.4	62.5±12.4	67.1±12.1	<0.001
Body mass index, kg/m^2	23.8±3.5	23.7±3.6	23.9±3.5	0.128
Body surface area, m^2	1.72±0.19	1.66±0.19	1.75±0.18	<0.001
$CHADS_2$ score	1 (1 – 2)	2 (1 – 2)	1 (0–2)	<0.001
Congestive heart failure	130 (7.7)	72 (13.3)	58 (5.1)	<0.001
Hypertension	925 (55.1)	345 (63.7)	580 (51.0)	<0.001
Age ≥75 years	664 (39.5)	310 (57.2)	354 (31.1)	<0.001
Diabetes mellitus	245 (14.6)	85 (15.7)	160 (14.1)	0.382
Prior stroke	147 (8.8)	66 (12.2)	81 (7.1)	0.001
Coronary artery disease	142 (8.5)	53 (9.9)	89 (7.9)	0.178
Chronic kidney disease ≥grade 3	587 (45.7)	247 (45.7)	340 (30.1)	<0.001
Paroxysmal AF	1085 (64.6)	343 (63.3)	742 (65.3)	0.429
2D echocardiographic data				
LV end-diastolic dimension, mm	45.6±4.5	45.6±4.8	45.7±4.4	0.703
LVEF, %	62.4±4.0	62.5±4.2	62.3±3.9	0.301
LV mass index, g/m^2	82.4±17.0	87.8±18.3	79.8±15.7	<0.001
LA diameter, mm	38.2±6.4	40.4±6.0	37.2±6.3	<0.001
LA volume index, mL/m^2	43.2±14.4	50.2±13.2	40.0±14.6	<0.001
LA emptying fraction, %	32.6±14.7	29.6±14.6	34.0±14.6	<0.001
E velocity, cm/s	75.4±20.8	80.9±21.4	72.8±18.4	<0.001
Septal e′, cm/s	7.9±2.3	6.8±1.7	8.4±2.4	<0.001
Lateral e′, cm/s	10.1±3.0	8.7±2.2	10.7±3.0	<0.001
Mean E/e′	9.0±3.0	10.9±3.2	8.0±2.4	<0.001
TRV, m/s (n=1547)	2.3±0.3	2.5±0.3	2.3±0.3	<0.001
Moderate or severe TR	161 (9.6)	83 (15.3)	78 (6.9)	<0.001
Laboratory data				
BNP, pg/mL (n=826)	50.0 (23.4–101.5)	88.8 (53.0–154.7)	32.6 (16.7–73.0)	<0.001
NT pro-BNP, pg/mL (n=942)	192.7 (71.3–622.8)	602.5 (240.8–1035.8)	100.5 (44.7–347.8)	<0.001
Estimated GFR, mL/min/1.73 m^2	2.4±0.3	61.9±14.7	67.4±14.3	<0.001
HFA-PEFF score	4 (3–5)	5 (5–6)	3 (2–4)	<0.001
Outcome				
5-year MACCE	77 (4.6)	42 (7.7)	35 (3.1)	<0.001
5-year death	38 (2.3)	20 (3.7)	18 (1.6)	0.007
5-year hospitalisation for heart failure	11 (0.7)	9 (1.7)	2 (0.2)	<0.001
5-year hospitalisation for stroke	34 (2.0)	18 (3.3)	16 (1.4)	0.009
5-year AF recurrence	495 (29.5)	189 (34.9)	306 (26.9)	0.001

Data are expressed as mean±SD or median (IQR) or number (%).
*P values refer to the difference between HFpEF and non-HFpEF.
AF, atrial fibrillation; BNP, B-type natriuretic peptide; 2D, two-dimensional; GFR, glomerular filtration rate; HFA-PEFF, Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testing and final aetiology; HFpEF, heart failure preserved left ventricular ejection fraction; LA, left atrial; LV, left ventricular; LVEF, left ventricular ejection fraction; MACCE, major adverse cardiovascular and cerebrovascular events; NT pro-BNP, N-terminal prohormone brain natriuretic peptide; TR, tricuspid regurgitation; TRV, tricuspid regurgitation peak velocity.

Table 2 Difference in factors of the HFA-PEFF score

	All (n=1679)	HFpEF (n=542)	Non-HFpEF (n=1137)	P value*
HFA-PEFF score	4 (3–5)	5 (5–6)	3 (2–4)	<0.001
Functional				
Mean E/e′ 9–14, 1 pt.	650 (39.2)	330 (60.9)	320 (28.7)	<0.001
Mean E/e′ ≥15, 2 pts.	89 (5.4)	70 (12.9)	19 (1.7)	<0.001
Septal e′ <7 or Lateral e′ <10, 2 pts.	960 (57.8)	475 (87.6)	485 (43.4)	<0.001
TRV ≥2.8 m/s (n=1547), 2 pts.	89 (5.8)	64 (12.4)	25 (2.4)	<0.001
Morphological				
LAVI 29–34 mL/m^2, 1 pt.	233 (13.3)	12 (2.2)	211 (18.6)	<0.001
LAVI >34 mL/m^2, 2 pts.	1203 (71.7)	519 (95.8)	684 (60.2)	<0.001
LVMI >115/95 g/m^2 (M/F), 1 pt.	127 (7.6)	80 (14.8)	47 (4.1)	<0.001
RWT >0.42, 1 pt.	624 (37.2)	237 (43.7)	387 (34.0)	<0.001
LVMI ≥149/122 g/m^2 (M/F) and RWT >0.42, 2 pts.	3 (0.2)	3 (0.2)	0 (0.0)	0.012
LV wall thickness ≥12 mm, 1 pt.	68 (4.1)	42 (7.7)	26 (2.3)	<0.001
Biomarker				
BNP 35–80 or NT-pro BNP 125–220 at sinus rhythm, BNP 105–240 or NT-pro BNP 365–660 at AF, 1 pt.	466 (27.8)	217 (40.0)	249 (21.9)	<0.001
BNP >80 or NT-pro BNP >220 at sinus rhythm, BNP >240 or NT-pro BNP >660 at AF, 2 pts.	446 (26.6)	325 (60.0)	121 (10.6)	<0.001

Data are expressed as mean±SD or median (IQR) or number (%).
*P values refer to the difference between HFpEF and non-HFpEF.
AF, atrial fibrillation; BMI, body mass index; BNP, B-type natriuretic peptide; F, female; HFA-PEFF, Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testing and final aetiology; HFpEF, heart failure preserved left ventricular ejection fraction; LA, left atrial; LAVI, left atrial volume index; LV, left ventricular; LVEF, left ventricular ejection fraction; LVMI, left ventricular mass index; M, male; NT pro-BNP, N-terminal prohormone brain natriuretic peptide; pt., patient; RWT, relative wall thickness; TRV, tricuspid regurgitation peak velocity.

prohormone brain natriuretic peptide (BNP) or BNP). A major criterion scores 2 points and a minor criterion scores 1 point within each domain (online supplemental figure S1A).

The H_2FPEF score is used with some modifications and calculated as the sum of (i) AF, 3 points; (ii) obesity defined as body mass index >30 kg/m^2, 2 points; (iii) age >60 years, 1 point; (iv) hypertension diagnosis or treatment with two or more antihypertensive drugs, 1 point; (v) E/e′ ratio >9, 1 point and (vi) TRV >2.8 m/s, 1 point (online supplemental figure S2A).

In this study, HFpEF was defined as an HFA-PEFF score ≥5.

Study outcomes

The primary study outcome was 5-year major adverse cardiovascular and cerebrovascular events (MACCE), which was a composite of all-cause death, hospitalisation for HF and hospitalisation for stroke. The secondary study outcomes were 5-year all-cause death, 5-year hospitalisation for HF and 5-year hospitalisation for stroke. All adverse events were collected during follow-up using electronic records, laboratory findings and echocardiographic reports.

Statistical analysis

Categorical data are expressed as numbers and percentages, while quantitative data are described as the mean±SD or median and IQR. The comparison between patients with HFpEF and those without HFpEF was performed using the unpaired t-test or Mann-Whitney U test, according to the normality of the data. The χ^2 test, or Fisher's exact test, was performed to compare categorical data. For four-group comparisons of baseline characteristics, we used analysis of variance with Dunnett's test as a post hoc analysis. Survival curves were obtained using the Kaplan-Meier method and compared using the log-rank test. The unadjusted and adjusted HRs and 95% CIs for the associations of the clinical and echocardiographic variables and HFpEF with the primary end point were obtained from univariate and multivariate Cox regression analysis. In the multivariate Cox regression, model 1 included HFpEF, age and sex, and model 2 included model 1, hypertension, diabetes mellitus, prior stroke, chronic kidney disease ≥grade 3 and moderate or severe tricuspid regurgitation (TR).

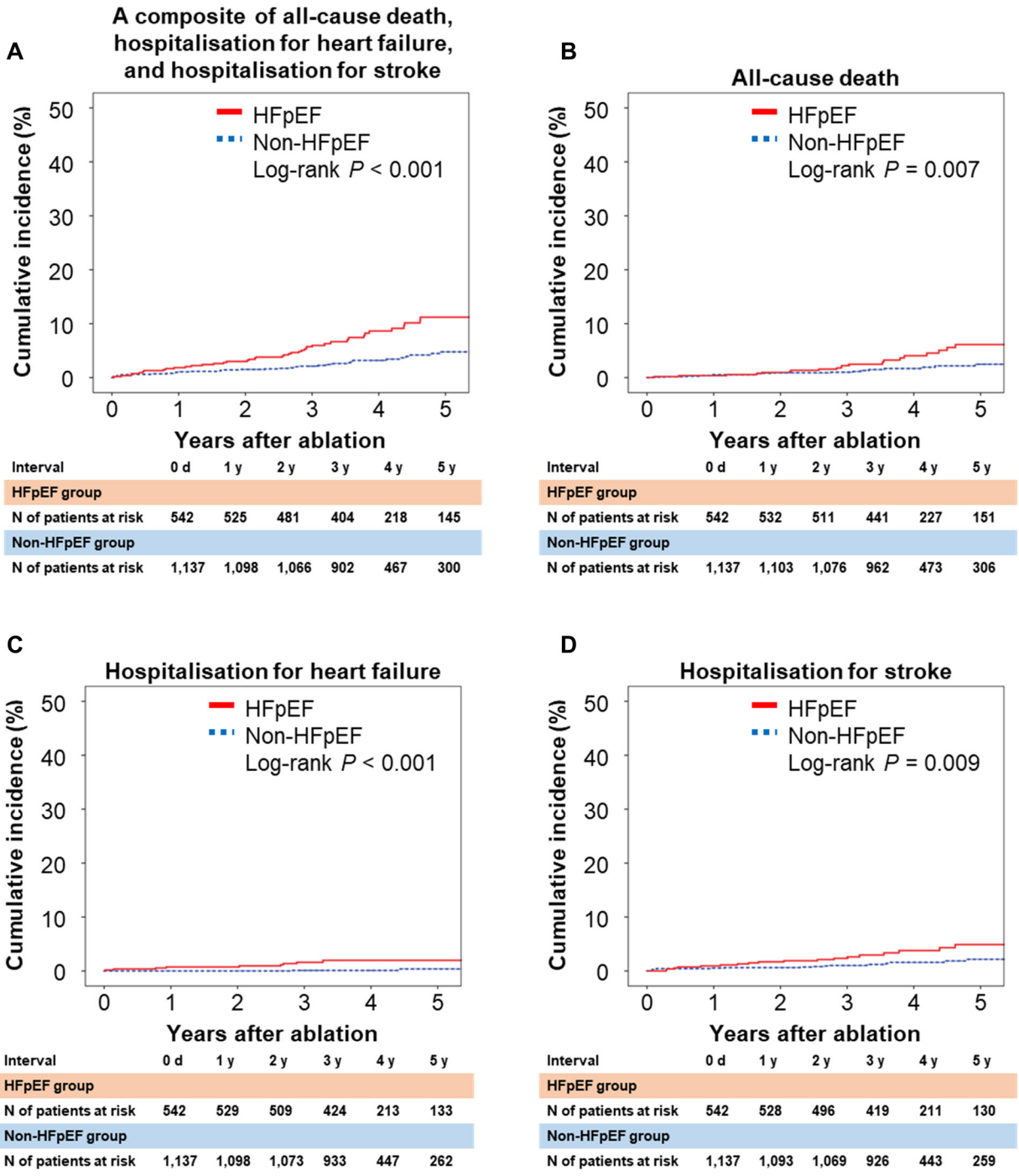

Figure 2 Kaplan-Meier analyses show the cumulative rate of the primary composite end point (A), all-cause death (B), hospitalisation for HF (C) and hospitalisation for stroke (D) stratified by the Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testing and final aetiology score. HFpEF, heart failure preserved left ventricular ejection fraction.

Subgroup analysis for MACCE was repeated in patients with paroxysmal AF, persistent AF and AF recurrence, defined as any documented atrial arrhythmia of >30 s after CA, and without AF recurrence using the Kaplan-Meier method and compared using the log-rank test. The sensitivity analysis for MACCE was performed using a multivariate Cox regression analysis including all predictors of MACCE with p values <0.10 in the univariate analysis, with stepwise backward regression using a probability to leave of 0.10. In addition, multivariate Cox regression analysis performed by replacing HFpEF by HFA-PEFF score with HFpEF by H_2FPEF score, which was defined as an H_2FPEF score ≥6.

P values <0.05 were considered statistically significant. The statistical analysis was performed using SPSS Statistics V.23.0 (IBM, Armonk, New York, USA).

Table 3 Univariable and multivariable analyses for MACCE for the HFA-PEFF score

	Univariate analysis		Multivariate analysis 1		Multivariate analysis 2	
	HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value
HFpEF by the HFA-PEFF score	2.56 (1.63 to 4.01)	<0.001	1.75 (1.09 to 2.80)	0.021	1.65 (1.02 to 2.65)	0.041
Age	1.09 (1.05 to 1.12)	<0.001	1.08 (1.04 to 1.11)	0.843	1.07 (1.03 to 1.10)	<0.001
Male	0.73 (0.46 to 1.18)	0.199	1.08 (0.66 to 1.76)	0.762	1.13 (0.69 to 1.85)	0.630
Hypertension	1.39 (0.87 to 2.21)	0.165			1.01 (0.63 to 1.62)	0.970
Diabetes mellitus	0.97 (0.51 to 1.83)	0.922			0.95 (0.50 to 1.79)	0.862
Prior stroke	1.57 (0.81 to 3.04)	0.186			1.30 (0.66 to 2.55)	0.444
Chronic kidney disease ≥grade 3	1.95 (1.25 to 3.04)	0.003			1.35 (0.85 to 2.14)	0.202
Moderate or severe TR	2.80 (1.65 to 4.75)	<0.001			1.87 (1.09 to 3.22)	0.024

Multivariate analysis model 1 includes HFpEF, age and sex. Multivariate analysis model 2 includes model 1, hypertension, diabetes mellitus, prior stroke, chronic kidney disease defined as estimated GFR <60 mL/min/1.73 m^2 and moderate or severe TR.
GFR, glomerular filtration rate; HFA-PEFF, Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testing and final aetiology; HFpEF, heart failure with preserved left ventricular ejection fraction; MACCE, major adverse cardiovascular and cerebrovascular events; TR, tricuspid regurgitation.

RESULTS

Patient characteristics

The study population included 1679 patients, with a mean age of 71±10 years, including 1218 males (72.5%); the median HFA-PEFF score was 4 (IQR 3–5, online supplemental figure S1B) and HFpEF was diagnosed in 542 patients (32.3%). The baseline characteristics are presented in table 1. HFpEF had older patients, more female, lower body surface area, more hypertension, prior stroke, chronic kidney disease, diastolic dysfunction, a higher estimated LV filling pressure by echocardiographic findings and no differences in AF type compared with the non-HFpEF group. The difference in the factors of the HFA-PEFF score is shown in table 2.

Prognostic value of the HFA-PEFF score

Five-year MACCE occurred in 77 patients (4.6%) (median follow-up duration: 3.3 years (IQR 3.0–5.0)). All-cause death occurred in 38 patients (2.3%), hospitalisation for HF occurred in 11 patients (0.7%) and hospitalisation for stroke occurred in 34 patients (2.0%) within 5 years after CA (table 1). The cumulative 5-year incidence of MACCE was significantly higher in the HFpEF group than in the non-HFpEF group (11.2% vs 4.8% at 5 years, p<0.001, figure 2A) and the cumulative 5-year incidence of all-cause death, hospitalisation for HF and hospitalisation for stroke were also significantly higher in the HFpEF group than in the non-HFpEF group (figure 2B–D).

The results of the univariable and multivariable Cox regression analyses are presented in table 3. HFpEF was associated with MACCE in the univariate analysis (HR 2.56, 95% CI 1.63 to 4.01, p<0.001). Even after adjusting for model 1, which included age and sex, and model 2, which included age, sex, hypertension, diabetes mellitus, prior stroke, chronic kidney disease and moderate or severe TR, HFpEF was associated with MACCE (HR 1.75, 95% CI 1.09 to 2.80, p=0.021, and HR 1.65, 95% CI 1.02 to 2.65, p=0.041, respectively).

Subgroup and sensitivity analysis for MACCE

The results of the subgroup analysis were similar to those of the primary analysis, regardless of prior AF type or 5-year AF recurrences (figure 3). In the univariate analysis, HFpEF, age, body mass index, body surface area, chronic kidney disease ≥grade 3, LV end-diastolic dimension and moderate or severe TR were p<0.10. In the multivariable Cox regression analysis that included these factors, HFpEF, age and moderate or severe TR were independent predictors for MACCE (HR 1.65, 95% CI 1.03 to 2.64; HR 1.07, 95% CI 1.04 to 1.10 and HR 1.83, 95% CI 1.07 to 3.16, respectively) (online supplemental table S1).

Prognostic value of the H_2FPEF score

HFpEF by the H_2FPEF score was observed in 560 patients (33.3%, online supplemental figure S2B). These patients exhibited similar characteristics to those diagnosed with HFpEF by HFA-PEFF score: older patients, more female, lower body surface area, more hypertension, prior stroke, chronic kidney disease, diastolic dysfunction, a higher estimated LV filling pressure by echocardiographic findings and no significant differences in AF type compared with the non-HFpEF group. The features only in HFpEF by the H_2FPEF score were additional features: higher prevalence of diabetes mellitus, coronary artery disease, larger LV dimension and lower LVEF compared with the non-HFpEF group (online supplemental table S2). However, by the H_2FPEF score, the cumulative 5-year incidence of MACCE did not differ significantly between the HFpEF and non-HFpEF groups (8.9% vs 5.9% at 5 years, p=0.065, online supplemental figure S3A), and the cumulative 5-year incidence of hospitalisation for HF and hospitalisation for stroke were also not different between the HFpEF and non-HFpEF groups, although only the cumulative 5-year incidence of all-cause death was significantly higher in the HFpEF group than the non-HFpEF group (5.8% vs

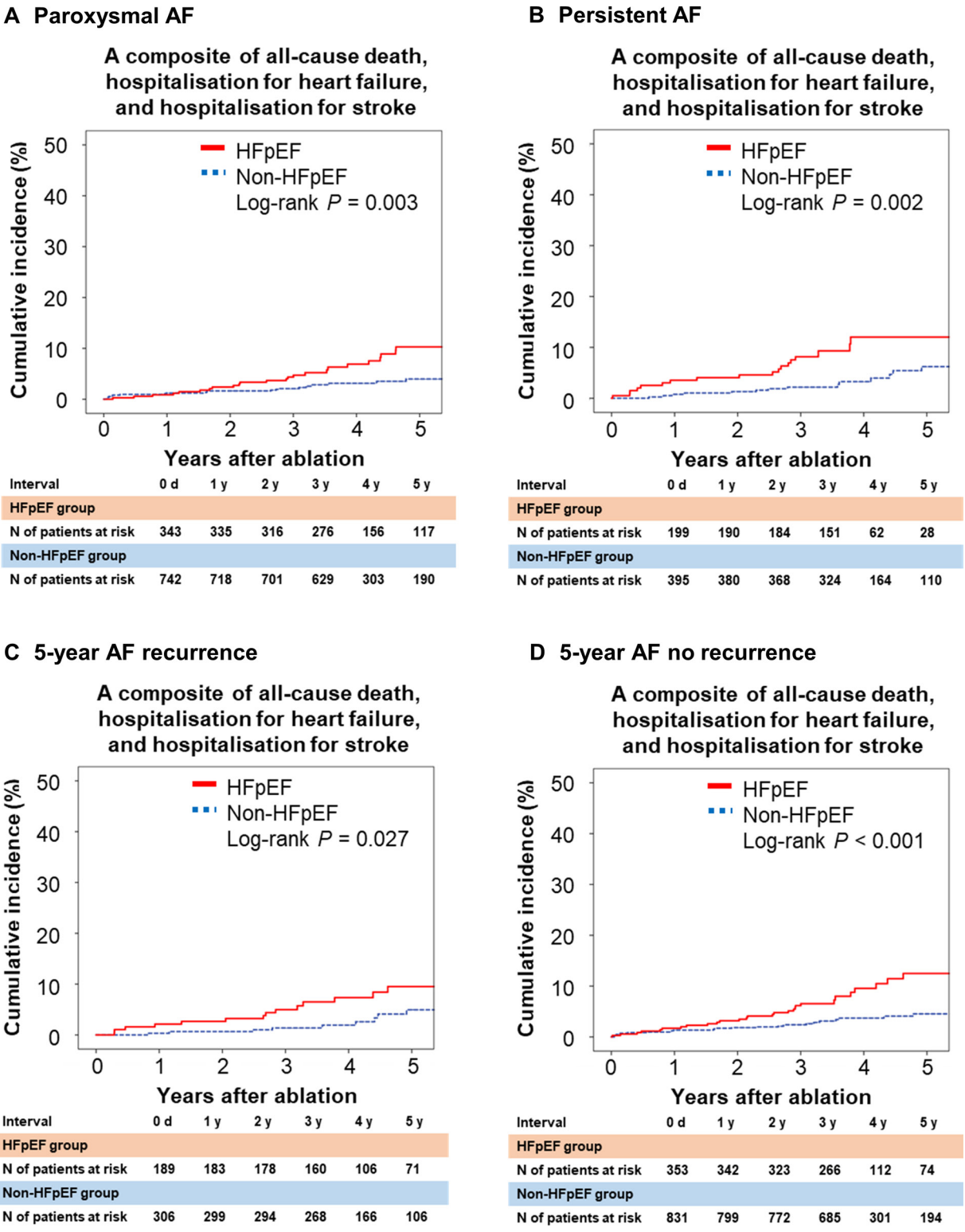

Figure 3 Kaplan-Meier analyses show the cumulative rate of the primary composite end point stratified by the HFA-PEFF score in the subgroup of patients with paroxysmal AF (A), persistent AF (B), AF recurrence (C) and AF no recurrence (D). AF, atrial fibrillation; HFA-PEFF, Heart Failure Association Pretest assessment, echocardiography and natriuretic peptide, functional testing and final aetiology; HFpEF, heart failure preserved left ventricular ejection fraction.

2.7% at 5 years, p=0.026) (online supplemental figure S3B-D). Furthermore, HFpEF by the H_2FPEF score was not associated with MACCE in the multivariate analyses (online supplemental table S3).

DISCUSSION

We evaluated the prognostic impact of the HFA-PEFF score in a large retrospective cohort of 1679 patients who underwent CA to treat AF. The main findings were: (i)

while only 7.7% of patients were initially identified as having heart failure, 32.3% were diagnosed with HFpEF based on the HFA-PEFF score and (ii) at the 5-year assessment, HFpEF by HFA-PEFF score was an independent predictor of MACCE.

In the present study, HFpEF by HFA-PEFF score was present in 32.3% of patients. HFpEF is estimated to affect approximately 50% of patients with HF and is associated with age, sex and many comorbidities, including hypertension, diabetes mellitus, chronic kidney disease, AF and multimorbidity.[19] The HFA-PEFF score was proposed as a second step based on echocardiographic parameters and biomarkers. High scores are useful in diagnosing HFpEF[6]; however, the HFA-PEFF score alone provides insufficient information on the risk factors for HFpEF and exercise intolerance. On the other hand, the H_2FPEF score was established based on simple clinical characteristics and echocardiographic parameters, and high scores are useful for discriminating HFpEF from non-cardiac dyspnoea regardless of biomarker.[5] HFpEF met only the H_2FPEF score was considered early HFpEF with obesity, hypertension, a low biomarker and a few findings indicating elevated left atrial pressure. HFpEF, according to both scores, may be distinguished between HFpEF phenotypes with different backgrounds. The results of the present study might suggest that HFA-PEFF score has a potentially superior sensitivity to identify progressive stages of HFpEF compared with the H_2FPEF score.

AF was associated with an increased risk of all-cause mortality and hospitalisation for HF and stroke, regardless of EF.[20] In patients with HFpEF according to LVEF and history of HF, a retrospective, multicentre study has shown that the 3-year cumulative risk for the clinical event was 11.6%, which was lower than that of patients with reduced LVEF.[21] In the present study, the MACCE in patients with HFpEF according to HFA-PEFF score was 11.2% at 5 years, which was lower than that of previous studies,[11 12 21] as there were fewer hospitalisations for HF. Nevertheless, HFpEF by the HFA-PEFF score was useful in predicting all-cause death, hospitalisation for HF and hospitalisation for stroke. Several studies have reported that the HFA-PEFF score is significantly inferior to the H_2FPEF score for diagnostic accuracy[7 22]; however, both scores have been associated with clinical events in patients with HFpEF.[23–25] There have been few studies on CA and clinical events in HFpEF using the HFA-PEFF score. CA reduces hospitalisations for HF and HF symptoms and improves diastolic function compared with medical therapy in patients with HFpEF as measured by the HFA-PEFF score.[11 12] In the present study, the HFA-PEFF score independently predicted MACCE in patients with HFpEF undergoing CA. Importantly, HFpEF by the HFA-PEFF score showed an independent prognostic value of MACCE, while HFpEF by the H_2FPEF score was not independently associated with HF and ischaemic stroke, in contrast with the previous study.[26] The significant difference between the two scores is the use of biomarkers, which can be the most objective indicators of the factors and influence prognostic evaluation.[27] Thus, the HFA-PEFF score may exhibit a propensity towards identifying HFpEF in more advanced stages, whereas the H_2FPEF score could potentially identify HFpEF at an earlier stage, particularly in patients without elevated BNP levels.[28] These findings suggest that CA for 'early HFpEF', which is characterised as non-HFpEF by the HFA-PEFF score and HFpEF by the H_2FPEF score, might contribute to a better prognosis through the prevention of HF and stroke.

Study limitations

This study has several limitations. First, it is a single-centre retrospective study. The results of this study may not be generalised because these patients represent a population of patients who have undergone CA. Second, the lack of information on the severity of HF symptoms and medications might have influenced the clinical events. However, the study population was not taking the sodium-glucose co-transporter-2 inhibitors, which have been reported to improve prognosis in patients with HFpEF,[29 30] at the start of study observation. Third, the HFA-PEFF score might have been inaccurate because it did not use global longitudinal strain, which might have led to underestimation. Conversely, other factors in the HFA-PEFF score were considered accurate as echocardiographic examinations were performed by expert echocardiographers and physicians.

CONCLUSION

The results of our study suggest that the early detection of HFpEF using the HFA-PEFF score may contribute to cardiovascular and cerebrovascular risk prediction in patients with AF undergoing CA. This finding may have clinical applications for therapeutic decision-making for CA by detecting 'early HFpEF' regardless of HF symptoms. There is a need for further studies to test our findings in a larger population or multicentre, prospective study in the future.

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ORCID iDs
Taiji Okada http://orcid.org/0000-0002-8878-3446
Toshiaki Toyota http://orcid.org/0000-0002-7214-2265
Tomohiko Taniguchi http://orcid.org/0000-0002-4999-3432

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