JACC: CLINICAL ELECTROPHYSIOLOGY VOL. 9, NO. 2, 2023

PUBLISHED BY ELSEVIER

ORIGINAL RESEARCH

CATHETER ABLATION - ATRIAL FIBRILLATION

Impact of Low Body Mass Index on Cardiac Tamponade During Catheter Ablation for Atrial Fibrillation

Reina Tonegawa-Kuji, MD, PhD,[a] Michikazu Nakai, PhD,[a] Koshiro Kanaoka, MD, PhD,[a] Yoko Sumita,[a] Yoshihiro Miyamoto, MD, PhD,[b] Kengo Kusano, MD, PhD,[c] Yoshitaka Iwanaga, MD, PhD,[a] Teiichi Yamane, MD, PhD[d]

ABSTRACT

BACKGROUND Cardiac tamponade is a potentially fatal complication of catheter ablation for atrial fibrillation (AF).

OBJECTIVES This study aimed to evaluate the impact of body mass index (BMI) on cardiac tamponade during AF ablation.

METHODS Patients who underwent catheter ablation for AF between April 1, 2016 and March 31, 2018 were analyzed using a Japanese nationwide claims database. Mixed-effects multivariable Poisson regression analysis was performed to investigate the association between BMI and cardiac tamponade.

RESULTS A total of 59,789 hospitalizations (age 65.6 ± 10.4 years, 29% women) with catheter ablation for AF were analyzed. Cardiac tamponade occurred in 647 patients (1.1%). Multivariable analysis revealed that being underweight (BMI <18.5 kg/m^2) was associated with an increased risk of cardiac tamponade (relative risk [RR]: 1.42; 95% CI: 1.03-1.95) when compared with having a normal weight (BMI ≥18.5 and <25 kg/m^2). Other characteristics that were associated with an increased risk of cardiac tamponade were age ≥75 years, female sex, and a history of heart failure, hypertension, diabetes, and dialysis treatment.

CONCLUSIONS In this analysis of a large nationwide database of patients with AF who underwent ablation, being underweight was independently associated with an increased risk of cardiac tamponade during AF ablation. Clinicians should consider the higher risk of cardiac tamponade in the underweight population and take appropriate measures to reduce this risk. (J Am Coll Cardiol EP 2023;9:200–208) © 2023 by the American College of Cardiology Foundation.

Catheter ablation for atrial fibrillation (AF) is widely accepted and has become an effective alternative to drug therapy.[1,2] Cardiac tamponade is among the most common, potentially life-threatening complications of AF ablation and has been employed as a specific electrophysiological performance measure by the Heart Rhythm Society.[3] Recent reports from the United States and Europe have indicated the incidence of cardiac tamponade to be 0.6%-1.9%,[4-7] and risk factors have also been reported.[8] Obesity is a known risk factor for AF development and has recently been reported to be a risk

From the [a]Department of Medical and Health Information Management, National Cerebral and Cardiovascular Center, Suita, Japan; [b]Open Innovation Center, National Cerebral and Cardiovascular Center, Suita, Japan; [c]Department of Cardiovascular Medicine, National Cerebral and Cardiovascular Center, Suita, Japan; and the [d]Division of Cardiology, Jikei University School of Medicine, Tokyo, Japan.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received June 22, 2022; revised manuscript received August 4, 2022, accepted August 25, 2022.

ISSN 2405-500X/$36.00 https://doi.org/10.1016/j.jacep.2022.08.025

factor for cardiac tamponade.[1,8] On the other hand, the risk of cardiac tamponade during AF ablation in patients who are underweight has never been investigated; a reason for this may be that the proportion of patients who are underweight is low in Western countries.[9-11] Recent reports have revealed that being underweight (body mass index [BMI] <18.5 kg/m^2) is associated with a higher risk of bleeding in patients with AF who are taking anticoagulants.[12-14] We hypothesized that being underweight may also be associated with an increased risk of cardiac tamponade during AF ablation because of the higher risk of bleeding.

The present study aimed to evaluate the association between BMI and cardiac tamponade during AF ablation using a large nationwide database.

METHODS

This retrospective cross-sectional study used the JROAD-DPC (Japanese Registry of All Cardiac and Vascular Diseases and the Diagnosis Procedure Combination), which has been previously described in detail.[15,16] JROAD-DPC is an administrative database that covered more than 1,500 Japanese Circulation Society-certified training hospitals during the study period. The JROAD-DPC includes the following information for each patient: age; sex; height; weight; Barthel index score; primary diagnoses, comorbidities, conditions arising after admission based on the International Classification of Diseases-10th Revision (ICD-10) codes; drugs used; diagnostic and therapeutic procedures; length of stay; and discharge status. BMI was calculated using height and weight and was divided into 4 categories: 1) underweight (BMI <18.5 kg/m^2); 2) normal weight (BMI ≥18.5 and <25 kg/m^2); 3) overweight (BMI ≥25 and <30 kg/m^2); and 4) obese (BMI ≥30 kg/m^2). Regarding diagnosis, in addition to the ICD-10 codes, detailed names of diagnoses are listed; therefore, detailed names of diseases that cannot be identified using the ICD-10 codes alone could be determined. The procedure codes, ICD-10 codes, and other definitions used for baseline characteristics are shown in Supplemental Table S1. The association between hospital-level characteristics and cardiac tamponade was also investigated, and detailed methods and results are described in the Supplemental Appendix.

This study was approved by the Institutional Review Board of Jikei University School of Medicine (approval number: 32-323 [10405], approval date: November 9, 2020). The requirement for informed consent was waived because information specific to individuals was not included in the database.

STUDY POPULATION. The flowchart of the study is shown in Figure 1. We initially identified patients aged ≥20 years who underwent catheter ablation and were diagnosed with AF between April 1, 2016 and March 31, 2018. To exclude ablations with the main purpose of treating other arrhythmias, the following cases were excluded: 1) catheter ablation without septal puncture (n = 5,039); and 2) the presence of atrial flutter, atrial tachycardia, premature atrial/ventricular contractions, and ventricular tachycardia/fibrillation (n = 4,396). Cases of catheter ablation other than radiofrequency or cryoballoon ablation were excluded (n = 4). In addition, patients who died after AF ablation were excluded (n = 18).

OUTCOMES. The primary outcome in this study was the occurrence of cardiac tamponade during AF ablation. Cardiac tamponade was defined as the presence of either: 1) a diagnosis of cardiac tamponade in conditions arising after admission identified by ICD-10 codes (I319 or I971); or 2) procedure codes for pericardiocentesis or pericardial drainage (J048 or J002). Additionally, the diagnosis recorded in text format was carefully reviewed to exclude vague diagnoses other than cardiac tamponade.

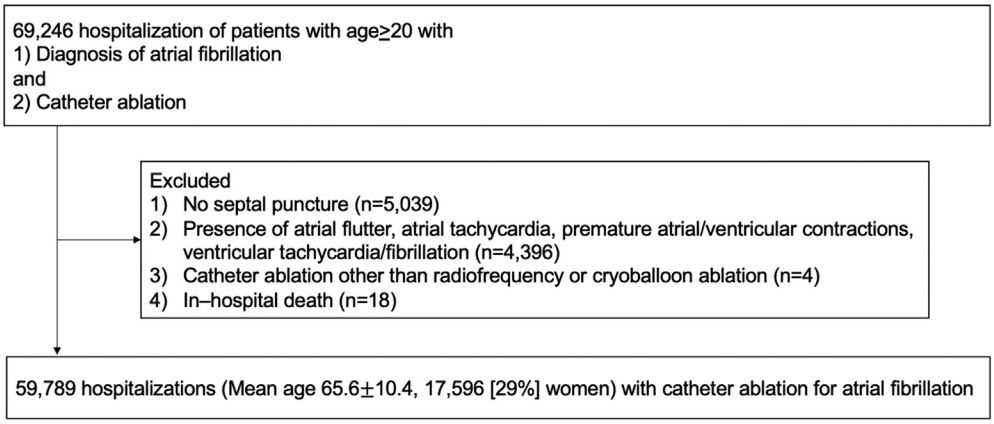
STATISTICAL ANALYSIS. Categorical data are presented as frequencies (percentages), whereas continuous data are expressed as mean ± SD. Emergency hospitalization, BMI, and Barthel index score were missing in 0.002%, 0.7%, and 1.8% of records, respectively; there were no missing data for other patient-level variables. To account for missing data, multiple imputation methods using the chained equation algorithm were applied based on 10 replications, assuming missing random mechanisms.

Mixed-effects multivariable Poisson regression analysis, using institute as the random intercept, was performed to estimate the relative risk (RR) and 95% CI for cardiac tamponade in the overall sample of patients who underwent cryoballoon and radiofrequency ablation. The model assumptions regarding explanatory and response variables were satisfied. Using normal BMI as a reference, the RR and 95% CI for being underweight, overweight, and obese were estimated. All statistical comparisons were 2-sided, with statistical significance set at $P < 0.05$. All analyses were performed using STATA (version 16.0, StataCorp).

ABBREVIATIONS AND ACRONYMS

AF = atrial fibrillation
BMI = body mass index
ICD-10 = International Classification of Diseases-10th Revision
ICE = intracardiac echocardiography
RR = relative risk

FIGURE 1 Flowchart of the Study



Inclusion/exclusion criteria of the study and the number of final cohort are shown.

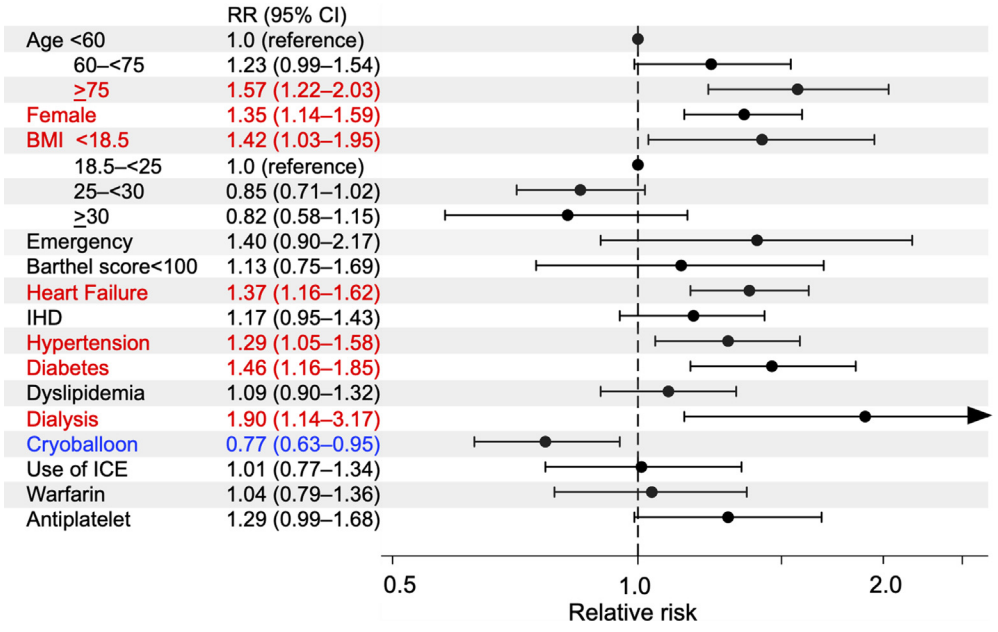
TABLE 1 Baseline Characteristics of Patients and Complications with AF Ablation

		BMI			
	Total (N = 59,789)	**<18.5 kg/m²**	**≥18.5 and <25 kg/m²**	**≥25 and <30 kg/m²**	**≥30 kg/m²**
Patients		2,302 (3.9)	34,695 (58)	18,681 (31)	4,111 (6.9)
Age, y	65.6 ± 10.4	68.7 ± 9.3	66.6 ± 10.1	64.7 ± 10.3	60.4 ± 11.0
<60	14,589 (24)	348 (15)	7,260 (21)	5,166 (28)	1,815 (44)
≥60 and <75	33,527 (56)	1,276 (55)	20,034 (58)	10,301 (55)	1,916 (47)
≥75	11,673 (20)	678 (29)	7,401 (21)	3,214 (17)	380 (9.3)
Women	17,596 (29)	1,278 (55)	10,533 (30)	4,430 (24)	1,355 (33)
Emergency admission	1,090 (1.8)	87 (3.8)	666 (1.9)	276 (1.5)	61 (1.5)
Barthel index score <100	2,124 (3.6)	157 (6.8)	1,242 (3.6)	579 (3.1)	146 (3.6)
Comorbidities					
Heart failure	21,600 (36)	940 (41)	12,539 (36)	6,611 (35)	1,510 (37)
Ischemic heart disease	10,020 (17)	373 (16)	5,834 (17)	3,144 (17)	669 (16)
Hypertension	42,311 (71)	1612 (70)	23,668 (68)	13,773 (74)	3,258 (79)
Diabetes	5,541 (9.3)	135 (5.8)	2,593 (7.5)	2,001 (11)	812 (20)
Dyslipidemia	15,538 (26)	378 (16)	8,238 (24)	5,487 (29)	1,435 (35)
Chronic kidney disease with dialysis	779 (1.3)	102 (4.4)	491 (1.4)	139 (0.7)	47 (1.1)
Procedural factors					
Cryoballoon ablation	14,673 (25)	616 (27)	8,942 (26)	4,280 (23)	835 (20)
Use of ICE	48,381 (81)	1,863 (81)	27,932 (81)	15,151 (81)	3,435 (84)
Medications					
Warfarin	4,951 (8.3)	261 (11)	2,884 (8.3)	1,458 (7.8)	348 (8.5)
Antiplatelet therapy	4,947 (8.3)	177 (7.7)	2,823 (8.1)	1,586 (8.5)	361 (8.8)
Length of stay, d					
≤2	5,138 (8.6)	184 (8.0)	3,011 (8.7)	1,610 (8.6)	333 (8.1)
3-5	42,346 (71)	1,492 (65)	24,484 (71)	13,409 (72)	2,961 (72)
6-7	7,287 (12)	297 (13)	4200 (12)	2,302 (12)	488 (12)
≥8	5,018 (8.4)	329 (14)	3,004 (8.7)	1,356 (7.3)	329 (8.0)
Complications					
Cardiac tamponade	647 (1.1)	44 (1.9)	393 (1.1)	171 (0.9)	39 (0.9)

Values are n (%) or mean ± SD.

AF = atrial fibrillation; BMI = body mass index; ICE = intracardiac echocardiography.

FIGURE 2 Results of Multivariable Analysis for Cardiac Tamponade in the Entire Cohort



Relative risks (95% CI) are shown in a forest plot. BMI = body mass index; ICE = intracardiac echocardiography; IHD = ischemic heart disease; RR = relative risk.

RESULTS

A total of 59,789 hospitalizations (age 65.6 ± 10.4 years, 17,596 [29%] women) with catheter ablation for AF were analyzed (**Table 1,** Supplemental Table S2). Cryoballoon ablation was performed in 25% of patients, and radiofrequency ablation was performed in the rest. Intracardiac echocardiography (ICE) was performed in 81% of cases. Cardiac tamponade occurred in 647 patients (1.1%), and pericardiocentesis or pericardial drainage was performed in 619 patients (1.0%).

PATIENT-LEVEL CHARACTERISTICS AND CARDIAC TAMPONADE. According to the multivariable analysis, being underweight was associated with an increased risk of cardiac tamponade (RR: 1.42; 95% CI: 1.03-1.95) when compared with having a normal weight (**Figure 2, Central Illustration**). Other factors that were associated with an increased risk of cardiac tamponade were as follows: age ≥75 years (RR: 1.57; 95% CI: 1.22-2.03); female sex (RR: 1.35; 95% CI: 1.14-1.59); and a history of heart failure (RR: 1.37; 95% CI: 1.16-1.62), hypertension (RR: 1.29; 95% CI: 1.05-1.58), diabetes (RR: 1.46; 95% CI: 1.16-1.85), and dialysis treatment (RR: 1.90; 95% CI: 1.14-3.17). Moreover, the use of cryoballoon ablation (RR: 0.77; 95% CI: 0.63-0.95) was associated with a decreased risk of cardiac tamponade. The use of ICE was not associated with cardiac tamponade.

Multivariable analyses were subsequently performed in subsets of patients who underwent either cryoballoon ablation (n = 14,673) or radiofrequency ablation (n = 45,116) (**Table 2**). In multivariable analysis, being underweight was associated with an increased risk of cardiac tamponade in the radiofrequency ablation group but not in the cryoballoon ablation group.

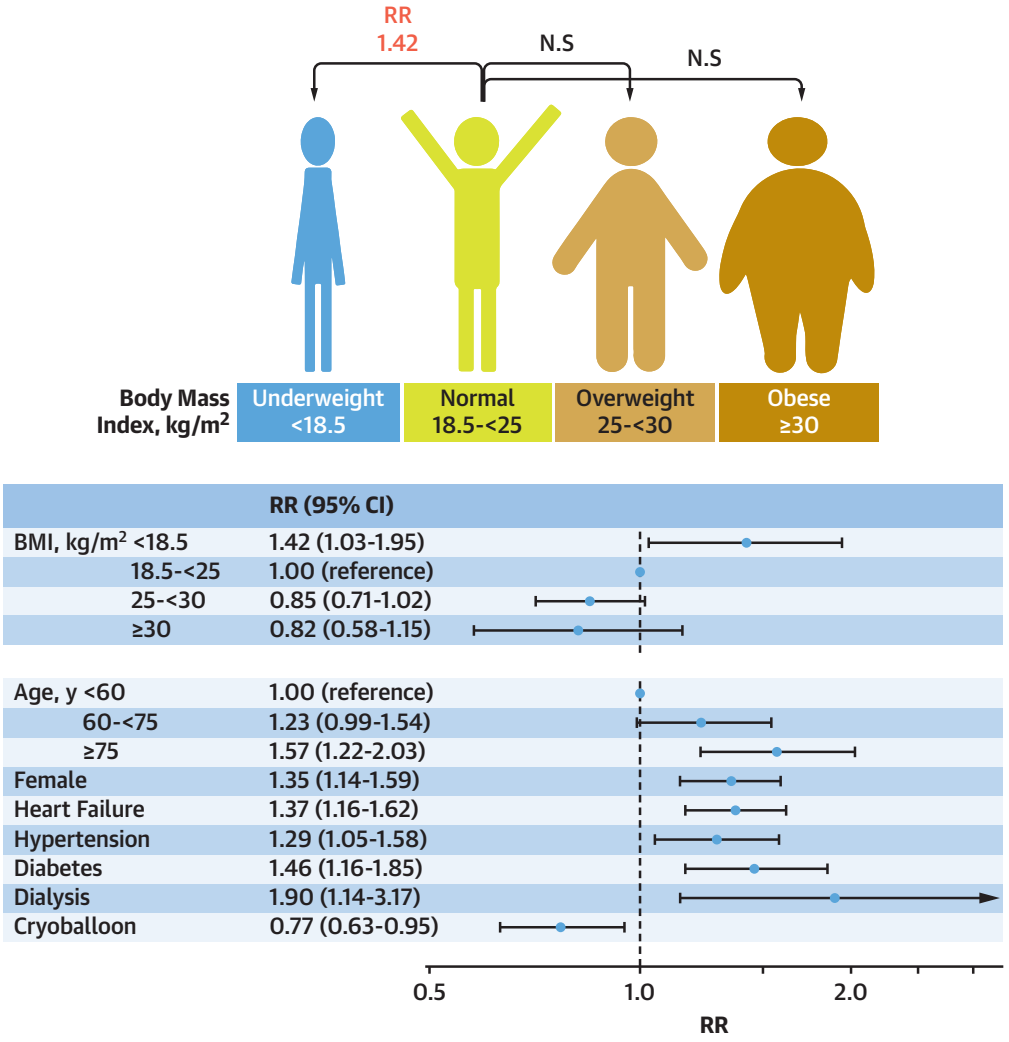
The association between hospital-level characteristics and cardiac tamponade was also investigated, and the results are shown in Supplemental Table S3.

DISCUSSION

The main findings obtained from the analysis of the nationwide claims database are as follows: First, the incidence of cardiac tamponade during AF ablation in Japan was 1.1%, which is similar to that in previous reports.[4,5,7,8] Second, being underweight was associated with an increased risk of cardiac tamponade.

JACC: CLINICAL ELECTROPHYSIOLOGY VOL. 9, NO. 2, 2023
FEBRUARY 2023:200–208

CENTRAL ILLUSTRATION **Relationship Between Body Mass Index and Risk of Cardiac Tamponade During Atrial Fibrillation Ablation**



Tonegawa-Kuji R, et al. J Am Coll Cardiol EP. 2023;9(2):200-208.

Results of multivariable analysis for cardiac tamponade. Only variables that are significantly associated with cardiac tamponade are shown. AF = atrial fibrillation; BMI = body mass index; NS = not significant; RR = relative risk.

IMPACT OF BMI ON CARDIAC TAMPONADE. In our data, when BMI in the normal range was used as a reference, being underweight was associated with an increased risk of cardiac tamponade. To the best of our knowledge, being underweight has never been reported as a risk factor for complications associated with ablation for AF. Asians tend to be smaller and leaner than non-Asians; thus, patients with low body weight are more common in Asian populations than in non-Asian populations.[9-11] As the number of people with low BMI is limited in Western countries, the relationship between low body weight and the risk of complications with AF ablation may not have been fully investigated.

The higher risk in patients with a low BMI might be attributed to their higher bleeding risk in the anticoagulant state. A recent observational study that included a large population of patients with AF (≤60 kg) taking oral anticoagulants showed that direct oral anticoagulants were associated with lower

TABLE 2 Results of Univariate and Multivariable Analyses for Cardiac Tamponade in Cryoballoon and Radiofrequency Ablation Groups

	Cryoballoon Ablation		Radiofrequency Ablation	
	Univariate	Multivariable	Univariate	Multivariable
Age, y				
<60	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
≥60 and <75	1.47 (0.93-2.34)	1.27 (0.79-2.04)	1.42 (1.12-1.82)	1.22 (0.95-1.56)
≥75	1.75 (1.03-2.98)	1.37 (0.78-2.40)	2.18 (1.67-2.86)	1.64 (1.23-2.18)
Female	1.29 (0.91-1.84)	1.15 (0.80-1.66)	1.57 (1.32-1.88)	1.41 (1.17-1.70)
BMI				
Underweight (<18.5 kg/m^2)	1.46 (0.75-2.82)	1.30 (0.67-2.54)	1.68 (1.18-2.40)	1.44 (1.01-2.07)
Normal (≥18.5 and <25 kg/m^2)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Overweight (≥25 and <30 kg/m^2)	0.79 (0.52-1.21)	0.80 (0.53-1.23)	0.83 (0.68-1.02)	0.86 (0.70-1.05)
Obese (≥30 kg/m^2)	1.17 (0.56-2.43)	1.18 (0.56-2.47)	0.75 (0.52-1.10)	0.75 (0.51-1.11)
Emergency hospitalization	2.60 (1.05-6.40)	1.85 (0.70-4.90)	2.00 (1.27-3.16)	1.25 (0.76-2.04)
Barthel index score <100	1.28 (0.50-3.28)	0.92 (0.34-2.51)	1.77 (1.18-2.64)	1.21 (0.79-1.87)
Heart failure	1.84 (1.27-2.67)	1.74 (1.20-2.54)	1.38 (1.14-1.66)	1.31 (1.08-1.57)
Ischemic heart disease	1.20 (0.77-1.86)	0.94 (0.59-1.50)	1.45 (1.17-1.80)	1.24 (0.99-1.57)
Hypertension	1.51 (0.99-2.30)	1.27 (0.82-1.96)	1.51 (1.21-1.89)	1.30 (1.04-1.64)
Diabetes	1.30 (0.72-2.38)	1.04 (0.56-1.95)	1.76 (1.38-2.24)	1.57 (1.22-2.03)
Dyslipidemia	1.45 (0.99-2.13)	1.21 (0.79-1.84)	1.35 (1.11-1.63)	1.05 (0.85-1.29)
Dialysis	2.96 (1.07-8.17)	2.30 (0.72-7.41)	2.42 (1.44-4.07)	1.86 (1.05-3.31)
Use of ICE	1.26 (0.64-2.49)	1.24 (0.63-2.43)	1.03 (0.97-1.11)	0.98 (0.73-1.33)
Warfarin	1.57 (0.84-2.95)	1.08 (0.52-2.23)	1.36 (1.04-1.78)	1.03 (0.77-1.39)
Antiplatelet	2.07 (1.21-3.52)	1.63 (0.89-2.97)	1.70 (1.31-2.21)	1.22 (0.91-1.64)

Values are relative risk (95% CI).
Abbreviations as in Table 1.

risks of ischemic stroke and major bleeding than warfarin, and these results were largely consistent in patients weighing <50 kg.[12] However, even among patients on direct oral anticoagulants, having a low BMI has been reported to be associated with an increased risk of major bleeding, as compared with having a normal weight or with being overweight or obese.[13] Because high-dose heparin is additionally used during ablation for AF, patients with a low BMI, who are originally at a higher risk for bleeding, may be more prone to puncture site bleeding and cardiac tamponade than other patients may be.

A lower BMI has been reported to be associated with lower left atrial volume.[17,18] Although further examination is needed to examine why a low BMI is a risk factor for cardiac tamponade, our hypothesis is that a smaller left atrium in patients with a low BMI may have made it more difficult to manipulate the radiofrequency ablation catheter in the left atrium, causing mechanical trauma to the left atrial wall. In fact, being underweight was not a significant risk factor for cardiac tamponade in patients who underwent cryoballoon ablation. Therefore, cryoballoon ablation should be considered in patients who are underweight. In addition, the use of contact force-sensing catheters was reported to be associated with a lower incidence of tamponade than noncontact force-sensing catheters were.[19] Although the information regarding the use of contact force-sensing catheters was not available in this database and we could not analyze the association of its use and cardiac tamponade, its use may be encouraged in patients considered high-risk, such as those with a low BMI.

Although a recent study from the US Medicare database reported obesity as a risk factor for cardiac tamponade,[8] our results did not concur. The reason for this difference might be related to the degree of obesity of patients included in the obesity group, as the proportion of people with severe obesity is reported to be lower in Asia than in Western countries.[11] In fact, in the present database, the proportion of patients with a BMI >35 kg/m^2 was only 1.9%. Stratified analysis among patients who are obese may be necessary to further understand the association between obesity and cardiac tamponade.

ABLATION STRATEGIES AND CARDIAC TAMPONADE. Although the notion that cryoballoon ablation might reduce the risk of cardiac tamponade remains controversial, some studies support this idea.[7,20,21] In the present study, being underweight was associated with an increased risk of cardiac tamponade in the radiofrequency ablation group, but not in the cryoballoon ablation group. However, it might be

inappropriate to conclude based only on these results that cryoballoon ablation is a safer option than radiofrequency ablation in patients who are underweight because safety endpoints other than cardiac tamponade and precise ablation strategies could not be considered in the present study. Therefore, further analysis using registry data including other complications and detailed ablation strategies is warranted to determine a better ablation strategy for patients who are underweight.

ICE was used in 80% of cases in our study, which is high compared to that reported in the United States and described in the guidelines.[1,8,22,23] Additionally, the use of ICE for AF ablation to reduce cardiac tamponade is controversial.[8,23,24] Although the use of ICE was not associated with complications in this study, this result does not immediately negate the usefulness of ICE to improve safety; cases performed without ICE might have been performed by highly experienced operators, and the usefulness of ICE depends largely on the proficiency of the operators in understanding anatomical structures from ICE images. Further studies are warranted to determine the contexts in which ICE might be useful for improving both the safety and efficacy of AF ablation.

OTHER PATIENT-LEVEL CHARACTERISTICS AND CARDIAC TAMPONADE. Consistent with several previous studies, our study identified higher age, female sex, hypertension, and diabetes as risk factors for cardiac tamponade.[1,7,8,22] Although little is known about the safety of AF ablation in patients receiving dialysis treatment because of the limited number of such patients in previous reports,[25,26] the present study identified dialysis treatment as a risk factor for cardiac tamponade during AF ablation. This might be attributed to the patients' higher risk of bleeding caused by anticoagulant use during dialysis. Another possibility is that dialysis-related cardiac amyloidosis among patients with long-term dialysis treatment might cause some histological change in the left atrial wall, making them more susceptible to cardiac tamponade.

Moreover, a history of heart failure was identified as a risk factor for cardiac tamponade. Further studies are warranted to examine why these comorbidities were important for the occurrence of cardiac tamponade during AF ablation.

STUDY LIMITATIONS. First, the study design was observational and retrospective. Because the DPC data are based on medical claims, data that are not directly related to the cost, such as ICD-10 diagnosis codes of comorbidities other than the main diagnoses, are not completely validated. However, previous studies have proven the validity of JROAD-DPC diagnoses in comparison with other nationwide databases or in-hospital registries.[27,28] Second, characteristics of operators, the number of operators in the hospital, procedural details (eg, only pulmonary vein isolation or any additional procedures performed, whether it was the first or repeat ablation, usage of a contact force-sensing catheter, and precise dose of heparin used during ablation), and precise clinical information, such as type of AF (eg, paroxysmal or persistent AF) and laboratory or echocardiology data, were not available. Third, a history of cardiac surgery has been reported as an important risk factor for cardiac tamponade during AF ablation, but this was not available in our database.[8,29] Fourth, we were only able to identify complications during hospitalization. However, the postoperative hospitalization period is longer than that in Western countries, and almost all ablation procedures are performed in hospitalized settings in Japan. Therefore, we believe that we were able to evaluate complications that may have been overlooked in inpatient reports from countries with shorter hospitalization periods or ablations performed in outpatient settings. Fifth, the precise date of cardiac tamponade occurring during hospitalization was not available in the database. Sixth, although the JROAD-DPC covers >60% of admissions in cardiology or cardiovascular sections of >1,500 Japanese Circulation Society-certified cardiology training hospitals in Japan, admissions to nonteaching hospitals with relatively fewer beds were not included. Lastly, most of the patients included in this study were presumed to be Asian, because most of the Japanese population is of Asian descent. Therefore, further investigation is warranted to determine whether a low BMI is also a risk factor in other races.

CONCLUSIONS

In this analysis of a large nationwide database of patients with AF who underwent ablation and were underweight (BMI <18.5 kg/m^2) was independently associated with an increased risk of cardiac tamponade during AF ablation. Clinicians should consider the higher risk of cardiac tamponade in the underweight population and take appropriate measures to reduce this risk.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

This work was supported by the Ministry of Health, Labor and Welfare Scientific Research Grant for the Comprehensive Research on Life-Style Related Diseases including Cardiovascular Diseases and Diabetes Mellitus (grant 19FA1601) and Intramural Research Fund (21-6-9) for Cardiovascular Diseases of National Cerebral and Cardiovascular Center. Dr Kusano has received speaker honoraria and research grants from Medtronic Japan. Dr Yamane has received speaker honoraria and research grants from Medtronic Japan and Abbott Medical Japan. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr Reina Tonegawa-Kuji, Department of Medical and Health Information Management, National Cerebral and Cardiovascular Center, No. 6-1 Kishibe-Shimmachi, Suita, Osaka, Japan. E-mail: reina.tonegawa@gmail.com.

PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: Being underweight (BMI <18.5 kg/m^2) was associated with an increased risk of cardiac tamponade. Moreover, being underweight was associated with an increased risk of cardiac tamponade in the radiofrequency ablation group but not in the cryoballoon ablation group.

TRANSLATIONAL OUTLOOK: Clinicians should consider tamponade risk in the underweight population and take appropriate measures to reduce this risk, such as choosing cryoballoon ablation instead of radiofrequency ablation, if applicable.

REFERENCES

1. Calkins H, Hindricks G, Cappato R, et al. 2017 HRS/EHRA/ECAS/APHRS/SOLAECE expert consensus statement on catheter and surgical ablation of atrial fibrillation. *Europace*. 2018;20(1):e1–160.

2. Nogami A, Kurita T, Abe H, et al. JCS/JHRS 2019 guideline on non-pharmacotherapy of cardiac arrhythmias. *J Arrhythm*. 2021;37(4):709–870.

3. Friedman DJ, Al-Khatib SM. Measuring quality in electrophysiology. *J Interv Card Electrophysiol*. 2016;47(1):5–10.

4. Piccini JP, Sinner MF, Greiner MA, et al. Outcomes of Medicare beneficiaries undergoing catheter ablation for atrial fibrillation. *Circulation*. 2012;126(18):2200–2207.

5. Cheng EP, Liu CF, Yeo I, et al. Risk of mortality following catheter ablation of atrial fibrillation. *J Am Coll Cardiol*. 2019;74(18):2254–2264.

6. Friedman DJ, Pokorney SD, Khanna R, et al. Catheter ablation of atrial fibrillation with and without on-site cardiothoracic surgery. *J Am Coll Cardiol*. 2019;73(19):2487–2489.

7. Bollmann A, Ueberham L, Schuler E, et al. Cardiac tamponade in catheter ablation of atrial fibrillation: German-wide analysis of 21,141 procedures in the Helios atrial fibrillation ablation registry (SAFER). *Europace*. 2018;20(12):1944–1951.

8. Friedman DJ, Pokorney SD, Ghanem A, et al. Predictors of cardiac perforation with catheter ablation of atrial fibrillation. *J Am Coll Cardiol EP*. 2020;6(6):636–645.

9. Chao TF, Chen SA, Ruff CT, et al. Clinical outcomes, edoxaban concentration, and anti-factor Xa activity of Asian patients with atrial fibrillation compared with non-Asians in the ENGAGE AF-TIMI 48 trial. *Eur Heart J*. 2019;40(19):1518–1527.

10. Chao TF, Joung B, Takahashi Y, et al. 2021 Focused update of the 2017 consensus guidelines of the Asia Pacific Heart Rhythm Society (APHRS) on stroke prevention in atrial fibrillation. *J Arrhythm*. 2021;37(6):1389–1426.

11. Global BMI Mortality Collaboration, Di Angelantonio E, Bhupathiraju ShN, et al. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in 4 continents. *Lancet*. 2016;388(10046):776–786.

12. Lee SR, Choi EK, Park CS, et al. Direct oral anticoagulants in patients with nonvalvular atrial fibrillation and low body weight. *J Am Coll Cardiol*. 2019;73(8):919–931.

13. Park CS, Choi EK, Kim HM, Lee SR, Cha MJ, Oh S. Increased risk of major bleeding in underweight patients with atrial fibrillation who were prescribed non-vitamin K antagonist oral anticoagulants. *Heart Rhythm*. 2017;14(4):501–507.

14. Shinohara M, Fujino T, Yao S, et al. Assessment of the bleeding risk of anticoagulant treatment in non-severe frail octogenarians with atrial fibrillation. *J Cardiol*. 2019;73(1):7–13.

15. Yasuda S, Nakao K, Nishimura K, et al. JROAD Investigators. The current status of cardiovascular medicine in Japan—analysis of a large number of health records from a nationwide claim-based database. *JROAD-DPC. Circ J*. 2016;80(11):2327–2335.

16. Yasuda S, Miyamoto Y, Ogawa H. Current status of cardiovascular medicine in the aging society of Japan. *Circulation*. 2018;138(10):965–967.

17. McManus DD, Xanthakis V, Sullivan LM, et al. Longitudinal tracking of left atrial diameter over the adult life course: clinical correlates in the community. *Circulation*. 2010;121(5):667–674.

18. Armstrong AC, Gidding SS, Colangelo LA, et al. Association of early adult modifiable cardiovascular risk factors with left atrial size over a 20-year follow-up period: the CARDIA study. *BMJ Open*. 2014;4(1):e004001.

19. Akca F, Janse P, Theuns DA, Szili-Torok T. A prospective study on safety of catheter ablation procedures: contact force guided ablation could reduce the risk of cardiac perforation. *Int J Cardiol*. 2015;179:441–448.

20. Cardoso R, Mendirichaga R, Fernandes G, et al. Cryoballoon versus radiofrequency catheter ablation in atrial fibrillation: a meta-analysis. *J Cardiovasc Electrophysiol*. 2016;27(10):1151–1159.

21. Chun KRJ, Perrotta L, Bordignon S, et al. Complications in catheter ablation of atrial fibrillation in 3,000 consecutive procedures: balloon versus radiofrequency current ablation. *J Am Coll Cardiol EP*. 2017;3(2):154–161.

22. Cheung JW, Cheng EP, Wu X, et al. Sex-based differences in outcomes, 30-day readmissions, and costs following catheter ablation of atrial fibrillation: the United States Nationwide Readmissions Database 2010-14. *Eur Heart J*. 2019;40(36):3035–3043.

23. Michowitz Y, Rahkovich M, Oral H, et al. Effects of sex on the incidence of cardiac tamponade after catheter ablation of atrial fibrillation: results from a worldwide survey in 34,943 atrial fibrillation ablation procedures. *Circ Arrhythm Electrophysiol*. 2014;7(2):274–280.

24. Steinberg BA, Hammill BG, Daubert JP, et al. Periprocedural imaging and outcomes after catheter ablation of atrial fibrillation. *Heart*. 2014;100(23):1871–1877.

25. Naruse Y, Tada H, Sekiguchi Y, et al. Concomitant chronic kidney disease increases the recurrence of atrial fibrillation after catheter ablation of atrial fibrillation: a mid-term follow-up. *Heart Rhythm*. 2011;8(3):335–341.

26. Takigawa M, Kuwahara T, Takahashi A, et al. The impact of haemodialysis on the outcomes of catheter ablation in patients with paroxysmal atrial fibrillation. *Europace*. 2014;16(3):327–334.

27. Nakai M, Iwanaga Y, Sumita Y, et al. JROAD Investigators. Validation of acute myocardial infarction and heart failure diagnoses in

hospitalized patients with the nationwide claim-based JROAD-DPC database. *Circ Rep*. 2021;3(3):131–136.

28. Yokoyama Y, Miyamoto K, Nakai M, et al. Complications associated with catheter ablation in patients with atrial fibrillation: a report from the JROAD-DPC Study. *J Am Heart Assoc*. 2021;10(11):e019701.

29. Elayi CS, Darrat Y, Suffredini JM, et al. Sex differences in complications of catheter ablation for atrial fibrillation: results on 85,977 patients. *J Interv Card Electrophysiol*. 2018;53(3):333–339.

KEY WORDS atrial fibrillation, body mass index, cardiac tamponade, catheter ablation, Japanese Registry of All Cardiac and Vascular Diseases, nationwide database

APPENDIX For expanded Methods, Results, and Discussion sections, and supplemental tables, please see the online version of this paper.