ORIGINAL ARTICLE

DOI: 10.4274/nkmj.galenos.2021.29290
Nam Kem Med J 2021;9(3):295-301

Risk Factors for Atrial Fibrillation Recurrence in Patients Undergoing Ablation

Ablasyon Yapılan Hastalarda Atriyal Fibrilasyon Rekürrensi için Risk Faktörleri

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ABSTRACT

Aim: The current study aimed to investigate the predictors of recurrence in patients with paroxysmal atrial fibrillation (AF) undergoing cryoballoon ablation.

Materials and Methods: This study was conducted with the participation of the patients who underwent cryoballoon ablation between October 2013 and March 2016. Patients' medical records were retrospectively evaluated. Patients were divided into two groups as those with AF recurrence and those without AF recurrence.

Results: A total of 68 patients undergoing cryoballoon ablation were included in the study. The mean age of the patients was 57.3±12 years, and 32% were male. Concomitant conditions included coronary artery disease in 25 patients (36.8%), diabetes mellitus in 9 (13.2%), hypertension in 46 (67.6%), and history of cerebrovascular event in 3 (4.4%). During the early period involving the initial three months, AF recurrence was found in 16 patients (23.5%), while 52 (76.5%) remained in the sinus rhythm during the follow-up. There were significant differences between two groups in left atrium size (38±5.3 and 44±6.6, p=0.003), left atrial appendage (LAA) flow rate [38 (24-62) cm/sec and 28 (22-55) cm/sec, p=0.001], presence of pulmonary venous anomaly [5 (9.6%) and 6 (37.5%), p=0.016], the number of antiarrhythmic drugs before the ablation (1.78±0.7 and 2.43±0.5, p=0.002), interventricular septal thickness (11±1.7 mm and 12±1.47 mm, p=0.008), left ventricular posterior wall thickness (11±0.9 mm and 12±1.3 mm, p=0.007), and left ventricular mass (195±51 g and 181±37.9 g, p=0.028).

Conclusion: According to the results, AF recurrence after ablation was found to be associated with the use of multiple antiarrhythmic drugs before the ablation, increased left atrial diameter, the reduced flow rate in the LAA, presence of a pulmonary venous anomaly, increased interventricular septal thickness, left ventricular posterior wall thickness, and left ventricular mass.

Keywords: Atrial fibrillation, cryoballoon ablation, pulmonary vein isolation, left atrium

ÖZ

Amaç: Çalışmamızda kriyobalon ablasyon uygulanan paroksismal atriyal fibrilasyon (AF) tanılı hastalarda nüksün prediktörlerinin saptanması amaçlandı.

Gereç ve Yöntem: Ekim 2013-Mart 2016 tarihleri arasında kriyobalon ablasyon uygulanan hastalar değerlendirildi. Hastaların tıbbi kayıtları retrospektif olarak incelendi. Hastalar işlem sonrası AF nüksü gelişen ve AF nüksü olmayan şeklinde iki gruba ayrıldılar.

Bulgular: Kriyobalon ablasyon uygulanan 68 hasta çalışmaya dahil edildi. Hastaların ortalama yaşı 57,3±12 yıldı ve %32'si erkekti. Eşlik eden durumlar arasında 25 hastada (%36,8) koroner arter hastalığı, 9'unda (%13,2) diabetes mellitus, 46'sında (%67,6) hipertansiyon ve 3 hastada

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Received: 12.05.2021 **Accepted**: 07.09.2021

serebrovasküler olay öyküsü yer almıştır (%4,4). İlk üç ayı kapsayan erken dönemde 16 hastada (%23,5) AF nüksü saptanırken, 52 hastada (%76,5) AF nüksü saptanmadı. İki grup arasında sol atriyum boyutu (38±5,3 mm ve 44±6,6 mm, p=0,003), sol atriyal apendiks (LAA) akım hızı [38 (24-62) cm/sec ve 28 (22-55) cm/sec, p=0,001], pulmoner venöz anomali varlığı [5 (%9,6) ve 6 (%37,5), p=0,016] ve işlem öncesi kullanılan antiaritmik ilaç sayısı (1,78±0,7 ve 2,43±0,5, p=0,002) açısından anlamlı farklılıklar saptandı. Sol ventrikül septum (11±1,7 mm and 12±1,47 mm, p=0,008) ve arka duvar kalınlığı (11±0,9 mm and 12±1,3 mm, p=0,007) AF rekürrensini öngörmede istatistiksel olarak anlamlı bulundu. AF nüksü olan ve olmayan hastalarda sol ventrikül kitlesi sırasıyla 195±51 g ve 181±37,9 g olarak saptandı ve fark istatistiksel olarak anlamlıydı (p=0,028).

Sonuç: Ablasyon sonrası AF nüksünün öngördürücüleri arasında işlem öncesinde öyküde çoklu antiaritmik ilaç kullanımının olması ile ekokardiyografide artmış sol atriyal çapı, azalmış LAA akış hızı, pulmoner venöz anomali saptanması, artmış interventriküler septal kalınlık, artmış sol ventrikül arka duvar kalınlığı ve artmış sol ventrikül kitlesi sayılabilir.

Anahtar Kelimeler: Atriyal fibrilasyon, kriyobalon ablasyon, pulmoner ven izolasyonu, sol atrium

INTRODUCTION

Atrial fibrillation (AF) is a supraventricular arrhythmia occurring in the atrium that is associated with irregular ventricular responses. AF is the most common type of persistent cardiac arrhythmia observed in 1 to 2% of the general population[1]. Although AF may lead to symptoms such as palpitations, fatigue, polyuria, dizziness, exertion dyspnea, chest pain, hypotension, and syncope, a significant proportion of patients with AF rhythm may be asymptomatic[2]. AF is associated with a 5-fold increased risk of stroke[3]. Cardiac and non-cardiac factors associated with AF include chronic alcohol intake, cardiac valvular disease, CAD, heart failure (HF), left ventricular hypertrophy, diabetes mellitus (DM), HT, hyperthyroidism, pulmonary embolism, chronic obstructive pulmonary disease, surgical intervention, hypertrophic or dilated cardiomyopathy or congenital cardiac diseases[1,4]. The triggering focus originates from the pulmonary veins (PV) in 90% of the cases with paroxysmal AF (PAF). Other identified foci include superior vena cava, coronary sinus, and the Marshall ligament[5,6]. The primary therapeutic method in AF ablation is based on the electrical isolation of PVs from LA. The European Society of Cardiology 2016 AF guidelines recommend catheter ablation to be performed in specialized centers by properly trained electrophysiologists for patients with symptomatic PAF recurrences during antiarrhythmic therapy, for whom the preferred therapeutic modality is rhythm control treatment[2].

In this study, the predictors of AF recurrence were investigated in 68 patients who underwent cryoablation due to symptomatic PAF.

MATERIALS AND METHODS

A retrospective file review was performed and outpatient medical records were evaluated, yielding the information of 68 patients who underwent cryoballoon ablation due to a diagnosis of symptomatic PAF between October 2013 and March 2016. Diagnoses of ischemic stroke or recurrent AF after the procedure were ascertained by telephone calls and through the review of clinical records. The first 3 months following the procedure were defined as the blind period and AF, atrial flutter, or episodes of atrial tachycardia during this period were considered as early AF recurrence. Episodes after the first 3 months were considered as recurrence.

Patients under 18 years of age and those with persistent AF, serious valvular disease, and thrombus in LA, pregnant women, and those with active neoplasm, prosthetic cardiac valve, implantable cardiac rhythm devices were excluded from the study.

In our center, procedures were performed under sedation with midazolam. The Seldinger technique was used for access via the left femoral vein and artery, and the right femoral vein. Access to the left atrium was performed under fluoroscopy with transseptal puncture with a modified Brockenborough needle accompanied by transesophageal echocardiography. The Flaxcath (metronik) brand steerable transseptal catheter was directed to the left atrium over the guide wire. Arctic front® and arctic front advance® (metronik) brand cryoablation balloon was directed through this sheath. PV circular mapping catheter through balloon the Achieve catheter was directed. Following left atrial puncture, anticoagulation was achieved using heparin with a target ACT of 300-350 seconds. After complete occlusion of PVs was ensured, a 5-minute standard cooling procedure was carried out by pumping a freezing agent (N2O) into the balloon. While ablation was performed in right PVs, continuous phrenic nerve stimulation at a low rate was performed in the superior vena cava, in conjunction with manual palpation of the contractions in the diaphragmatic area. After two freezing procedures with a minimum duration of five minutes in each PV, the procedure was terminated. One day after the cryoballoon ablation, transthoracic echocardiography was performed to rule out pericardial effusion, and patients were discharged. Treatment with oral anticoagulants and antiarrhythmic agents was planned to be continued for a minimum duration of 3 months following the cryoballoon ablation procedure, after which anticoagulant treatment was scheduled based on the CHA2DS2-VASc risk assessment.

The study was approved by the Uludağ University Local Ethics Committee for Clinical Research with decree no: 2016-5/21 and approval date: 29.11.2019.

Statistical Analysis

Statistical Package for Social Sciences for Windows 23.0 software pack was used for the statistical assessment. Descriptive statistics were expressed as mean, standard deviation, median, minimum, and maximum. Categorical variables were expressed as numbers and percentages. The Shapiro-Wilk test was used to test whether the data had a normal distribution. The t-test was employed for variables with normal distribution and the Mann-Whitney U test was used for comparisons between the two groups. Logistic regression analysis was performed to evaluate the association between variables tested and the recurrence. A p value <0.05 was considered statistically significant.

RESULTS

A total of 68 patients undergoing cryoablation due to PAF between October 2013 and March 2016 were included in the study. Patients were followed up for a mean duration of 22 months (8-37). The 68 patients included in the study were stratified into two groups as those who had AF recurrence and those who remained in sinus rhythm after the blind period of the initial three months. Of the 68 patients in the study, 32 (47.1%) were male and 36 (52.9%) were female. The mean age of the overall patient group was 57.3±12 years. With regards to cardiovascular risk factors, 25 patients (36.8%) had CAD, 9 (13.2%) had DM, 46 (67.6%) had HT, and 3 (4.4%) had a history of cerebrovascular event. Among all patients, the mean CHA2DS2-VASc score was 2.2±1.39, and the mean number of antiarrhythmic drugs the patients received was 1.94±0.7 (0-3) (Table 1).

Transthoracic echocardiography and transesophageal echocardiography performed before the procedure showed a median LA size, left ventricular ejection fraction, and LAA flow rate of 39.5±6.0 mm, 62±5.7%, and 36.5 (22-62) cm/sec, respectively. The median duration of fluoroscopy was 14±2.5 minutes. The success rate defined as successful ablation in three or PVs was 100%. PV anomaly (left or right-sided common PV) was identified in eleven patients (16.2%).

During the early period involving the initial three months, AF recurrence was found in 16 patients (23.5%), while 52 (76.5%) remained in the sinus rhythm during the follow-up. According to the evaluation of demographic characteristics of the

Table 1. Demographics and clinical characteristics of study subjects

	The study group (n=68)
Age (years)	57.3±12
Gender (male)	32 (47.1%)
BMI (kg/m^2)	29 (21-39)
BSA (m^2)	1.90±0.18
Diabetes mellitus	9 (13.2%)
Hypertension	46 (67.6%)
Hyperlipidemia	6 (8.8%)
Coronary artery disease	25 (36.8%)
Cerebrovascular event	3 (4.4%)
CHA2DS2-VASc score	2.2±1.39
Mean duration of follow up (months)	22 (8-37)
Pulmonary vein anomaly	11 (16.2%)
Number of antiarrhythmic drugs	1.94±0.7
Left ventricular ejection fraction	62±5.7
Left atrial diameter	39.5±6.0
Medical treatment	
- Beta-blocker	47 (69.1%)
- Calcium channel blocker	18 (26.5%)
- Digoxin	4 (5.8%)
- Amiodarone	26 (38.2%)
- ACEI/ARB	36 (52.9%)
- Sotalol	14 (20.6%)
- Propafenone	28 (41.2%)
- Warfarin	6 (8.8%)
- ASA	37 (54.4%)

BMI: Body mass index, BSA: Body surface area, CHA2DS2-VASc: Heart failure, hypertension, age, diabetes, history of stroke, vascular disease, female gender, ACEI: Angiotensin converting enzyme inhibitor, ARB: Angiotensin receptor blocker, ASA: Acetylsalicylic acid

patients, of the 16 patients with AF recurrence, 5 (31.3%) were female and 11 (68.7%) were male, while the corresponding figures among the 52 subjects with no recurrence included 31 (59.6%) female and 21 (40.4%) male. There were no statistically significant differences between the groups with regards to gender distribution (p>0.05) (Table 2).

Again, no statistical differences between patients who had or did not have AF recurrence were observed in terms of cardiovascular risk factors such as diabetes, hypertension, hyperlipidemia, coronary artery disease, and cerebrovascular event history (p>0.05) (Table 2).

Before the procedure, the number of antiarrhythmic drugs the patients received was 2.43±0.5 (2-3) and 1.78±0.7 (0-3) in those with and without AF recurrence, respectively. The number of antiarrhythmic drugs used before the procedure was significantly higher among patients who developed AF recurrence compared to those who did not (p=0.002) (Table 2).

Of the 16 patients with AF recurrence, 37.5% (6) had an AF episode during the early period of the first three months while this percentage was 11.5% (6) among the 52 patients who had no AF episodes during the same period. An AF episode during the early period of the first three months was a significant predictor for AF recurrence (p=0.027). The number of prior cardioversions was significantly higher among those with AF recurrence than those without AF recurrence (p<0.001) (Table 2).

LA diameter in patients with and without AF recurrence was 44±6.6 mm and 38±5.3 mm, respectively. LA diameter was higher in the group with AF recurrence compared to the group without AF recurrence with a statistically significant difference (p=0.003). Septum and posterior wall thickness of the left ventricle measured in the parasternal long-axis were found to be statistically significant in predicting AF recurrence (p=0.008 and 0.007, respectively). LV mass in patients with and without AF recurrence was 195±51 g and 181±37.9 g, respectively. The difference in LV mass between the two groups was statistically significant (p=0.028). LAA flow rate determined by transesophageal echocardiography in patients with and without AF recurrence was 28 (22-55) cm/sec and 38 (24-62) cm/sec, respectively. The difference in LAA flow rate between the two groups was statistically significant (p<0.001) (Table 3).

Table 2. Demographics and clinical characteristics of groups with or without atrial fibrillation recurrence

	No AF recurrence (n=52)	AF recurrence (n=16)	p value
Age (year)	57.5±12.3	61.5±11.5	0.158
Gender (male) n (%)	21 (40.4%)	11 (68.8%)	0.084
BSA (m^2)	1.90±0.18	1.98±0.17	0.183
BMI (kg/m^2)	28.9 (21.5-39.1)	29.2 (25.5-39.8)	0.241
Duration of atrial fibrillation (month)	27.5 (6-100)	34.5 (12-96)	0.397
Diabetes mellitus n (%)	6 (11.5%)	3 (18.8%)	0.430
Hypertension n (%)	35 (67.3%)	11 (68.8%)	0.914
Hyperlipidemia n (%)	5 (9.6%)	1 (6.3%)	1.000
Coronary artery disease n (%)	16 (30.8%)	9 (56.3%)	0.65
Cerebrovascular event n (%)	2 (3.8%)	1 (6.3%)	0.559
COPD n (%)	5 (9.6%)	1 (6.3%)	1.000
Smoking n (%)	11 (21%)	7 (43%)	0.105
CHA2DS2-VASc score	2.01±1.32	2.81±1.51	0.077
Pre-procedure AF rhythm n (%)	4 (7.7%)	0	0.556
Total number of antiarrhythmic drugs before procedure	1.78±0.7	2.43±0.5	0.002
Use of drug before the procedure n (%)			
- Amiodarone	18 (34.8)	8 (50)	0.268
- Metoprolol	20 (28.4)	15 (93.7)	0.021
- Propafenone	14 (26.9)	5 (31.2)	0.453
- Sotalol	0	2 (12.5)	0.010
- Flecainide	0	1 (6)	0.022
History of cardioversion	0 (0-3)	1 (0-4)	0.001
AF episode within the first three months	6 (11.5%)	6 (37.5%)	0.027
Use of drug after the procedure n (%)			
- Amiodarone	4 (7.6)	1 (6.2)	0.321
- Metoprolol	41 (78.8)	13 (81.2)	0.411
- Propafenone	7 (13.4)	2 (12.5)	0.355

AF: Atrial fibrillation, BMI: Body mass index, BSA: Body surface area, COPD: Chronic obstructive pulmonary disease, CHA2DS2-VASc: Congestive heart failure, hypertension, age ≥75 years, diabetes mellitus, history of stroke, vascular disease, 65-74 years of age, female gender

While six patients (37.5%) had a pulmonary anomaly in the AF recurrence group, the number of corresponding figures was five (9.6%) among those without AF recurrence. Pulmonary anomalies were more common in the group with AF recurrence compared to the group without AF, with a statistically significant difference (p=0.016) (Table 4).

No statistically significant difference was found between the patients who did or did not develop AF recurrence in terms of laboratory parameters such as complete blood count, renal function tests, thyroid function tests, C-reactive protein, erythrocyte sedimentation rate, and uric acid (p>0.05) (Table 5).

DISCUSSION

PV isolation for the management of PAF is performed either by radiofrequency (RF) or cryoballoon ablation. The reported success rate for ablation in patients with persistent AF is lower compared to that in PAF patients. In a meta-analysis involving

Table 3. Distribution of echocardiographic findings across the groups

	No AF recurrence	AF recurrence	p value
LV mass (g)	181±37.9	195±51	**0.028**
LV mass index (g/m^2)	97±17.7	104±22.3	0.075
LA/BSA (cm/m^2)	21.4±3	22.1±2.6	0.515
LVEDD (mm)	46±3.5	46±4.3	0.660
Left atrium (mm)	38±5.3	44±6.6	**0.003**
Septum thickness (mm)	11±1.7	12±1.47	**0.008**
Posterior wall thickness (mm)	11±0.9	12±1.3	**0.007**
Ejection fraction (%)	62±3.96	64±9.2	0.306
Mitral annular calcification	6 (11.5%)	1 (6.3%)	1.000
sPAB (mmHg)	25 (19-45)	31 (20-39)	0.111
Left atrial appendage flow rate (cm/sec)	38 (24-62)	28 (22-55)	**<0.001**

AF: Atrial fibrillation, LV: Left ventricle, LVEDD: Left ventricular end diastolic diameter, LA: Left atrium, BSA: Body surface area, sPAB: Systemic pulmonary artery pressure

Table 4. Pulmonary vein anatomy and procedural characteristics in patients undergoing cryoablation

	No AF recurrence	AF recurrence	p value
Duration of fluoroscopy (min)	26.5±6.2	25±5.8	0.304
Total cooling time (sec)	1920 (960-3200)	1910 (960-3200)	0.836
Pulmonary vein anomaly	5 (9.6%)	6 (37.5%)	**0.016**
Upper PV freezing temperature, left -°C	48±6.9	50±7.0	0.454
Lower PV freezing temperature, left -°C	45±7.1	48±7.3	0.319
Upper PV freezing temperature, right -°C	48.±6.6	49±6.6	0.922
Lower PV freezing temperature, right -°C	41±5.6	47±6.3	0.001

AF: Atrial fibrillation, PV: Pulmonary vein

Table 5. Distribution of laboratory findings across the groups

	No AF recurrence	AF recurrence	p value
Creatinine (mg/dL)	0.73±0.24	0.70±0.1	0.919
GFR (mL/min)	109.5±33	113.5±25	0.603
Uric acid (mg/dL)	4.8±1.36	4.2±1.56	0.76
CRP (mg/dL)	0.45±1.71	0.52±0.5	0.939
ESR (mm/h)	10 (2-68)	8 (3-62)	0.467
Leukocyte count (10^3/µL)	8±3.16	6.8±3.7	0.452
Hemoglobin (g/dL)	13.2±1.61	13.6±1.52	0.670
LDL cholesterol (mg/dL)	115±43	116±27	0.836
HDL cholesterol (mg/dL)	43±13	36±6.9	0.44
Triglycerides (mg/dL)	115 (52-454)	141 (66-400)	0.517
TSH (µLU/mg)	0.7±1.09	1.56±1.06	0.228

AF: Atrial fibrillation, GFR: Glomerular filtration rate, CRP: C-reactive protein, ESR: Erythrocyte sedimentation rate, LDL: Low-density lipoprotein, HDL: High-density lipoprotein TSH: Thyroid stimulating hormone

63 studies of RF ablation, success rates in paroxysmal and persistent AF were 70% and 14.9%, respectively[7].

Excluding the first 3 months, 76.5% of the patients with PAF in the present study were AF-free during a median follow-up of 22 months. In the STOP-AF study comparing cryoballoon ablation and antiarrhythmic medication, 69.9% of the patients in the ablation group were AF-free during the twelve months of follow-up[8]. In a prospective multi-center study by Stabile et al.[9], the success rate at one year of follow-up was 56% in the ablation group. The slightly higher success rate in the present study might have potentially resulted from the lower number of patients with structural heart disease, the relatively normal left atrium dimensions, and the small sample size.

In the above-mentioned meta-analysis of 63 studies investigating RF ablation, the reported rate of major complications was 4.9%, with PV stenosis (1.6%), pericardial effusion (0.6%), and thromboembolism (0.3%), which are the most frequent complications[7]. In another study on cryoablation, the rates of ischemic stroke, cardiac tamponade, and PV stenosis were reported as 0.3%, 0.3%, and 0.17%, respectively[10]. In the present study, none of the patients had major complications such as PV stenosis, cardiac tamponade, stroke, or death. Again, the lower complication rate in this study compared to the published data may be associated with the expertise level of our center in cryoballoon ablation for AF treatment, the limited number of patients, the inclusion of younger patients, and the lower number of comorbidities.

Pericardial effusion and phrenic nerve injury represent relatively more common complications of cryoablation. In the FIRE and ICE[11] study, phrenic nerve injury was reported in 2.3% of the cases. In the present study, 2 patients had pericardial effusion. Since none of the patients had the signs of cardiac tamponade, pericardiocentesis was not required.

Previously, an anterior-posterior LA diameter in the parasternal long-axis exceeding 45 mm was reported to be predictive for AF recurrence[12]. Aytemir et al.[13] identified LA diameter as an independent predictor for AF recurrence in their study evaluating efficacy and safety endpoints after PV isolation with cryoablation. In the present study, the mean LA diameter in patients with and without AF recurrence was 44±6.6 and 38±5.3 mm, respectively. LA dimensions were predictive for long-term AF recurrence after cryoablation. This observation supports the notion that LA dimensions should be a part of the patient selection process before cryoablation procedures.

Patients with high LAA emptying and filling rates determined by transesophageal echocardiography were found to remain in sinus rhythm for longer periods during their follow-up[14]. In a multi-center prospective study, the LAA emptying rate of less than 40 cm/sec was the single most important predictor of AF recurrence within 1 year[15]. In the current study, patients who developed recurrent AF had a 28 cm/sec (22-55) LAA flow rate determined by transesophageal echocardiography before cryoablation. A low LAA flow rate correlated with a higher likelihood of late AF recurrence. In line with the previous reports, this observation points out the role of a high LAA flow rate in maintaining the sinus rhythm.

AMIO-CAT[16] and EAST-AF[17] studies found that short-term antiarrhythmic treatment after AF ablation did not affect long-term AF recurrence although it might reduce the frequency of atrial tachyarrhythmia during the first 3 months. Lee et al.[18] found late AF recurrence among 35 of the 81 patients (43%) who developed early recurrence. Aytemir et al.[13] observed early AF recurrence in 29.1% of the patients who had AF recurrence after PV isolation with cryoablation. In the present study, 37.5% of the patients with late AF recurrence had an early AF episode, supporting the notion that early AF episodes may predict late AF recurrences.

Kubala et al.[19] performed cryoablation in 118 patients with drug-resistant PAF and found that atypical PV anatomy involving a common left PV was associated with an increased risk of AF recurrence compared to normal PV anatomy. There were 11 patients with PV anomalies in the present study. The rate was 37.5%[6] and 9.5%[5] in the group with AF recurrence and in the group with maintained sinus rhythm, respectively. The presence of a common PV was associated with AF recurrence. This observation suggests that cryoablation may be associated with lower success rates among patients with PV anomalies.

In the study by Evranos et al.[20], several biomarkers including C-reactive protein and erythrocyte sedimentation rate were found to not affect the risk of AF recurrence. Similarly, C-reactive protein and erythrocyte sedimentation rate measurements performed before cryoablation showed no association with AF recurrence in the present study.

Due to financial reasons, we could not use the three dimensional mapping system for ablation in our center. The three dimensional catheter navigation techniques can be applied to facilitate accurate catheter positioning with limited fluoroscopic exposure. The three dimensional mapping systems allow a better understanding of the anatomy and the pathophysiology of the arrhythmia[21]. In the complex patients, the combination of the three dimensional mapping system with image integration and remote magnetic navigation have been shown to be useful to facilitate ablation with very low fluoroscopy exposure. Integration of the fluoroscopy into the mapping system allows better understanding of the anatomy and might be associated with a better safety profile due to continuous catheter visualization during ablation[22].

Study Limitations

This study had several limitations. This was a retrospective analysis. Because of the sample size, future studies of larger cohorts with more statistical power were needed to validate

the findings. Some patients had a relatively short follow-up duration (8 months), and the predictive significance of the specified factors in patients with recurrent AF warrants further evaluation. Some asymptomatic AF cases may not have been included in the study.

CONCLUSION

Cryoablation is widely used for the treatment of AF worldwide. The safety and efficacy of this method have been established in several studies. However, the efficacy may vary depending on the expertise level of the operator, ablation technique, and catheter technology. Based on the results of the present study, several factors, including the occurrence of early AF episodes, history of cardioversion, use of multiple antiarrhythmic drugs before the procedure, high LA diameter, low LAA flow rate, presence of PV anomaly, increased interventricular septal thickness, left ventricular posterior wall thickness, and left ventricular mass, were predictive for AF recurrence during follow up after cryoablation We believe that consideration of these factors during patient selection may improve the success rate of this procedure.

Ethics

Ethics Committee Approval: The study was approved by the Uludağ University Local Ethics Committee for Clinical Research with decree no: 2016-5/21 and approval date: 29.11.2019.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: E.Ç., A.A., Concept: A.D., S.Ç., F.B., A.A., Design: E.Ç., A.A., Data Collection or Processing: E.Ç., Analysis or Interpretation: A.D., S.Ç., F.B., A.A., Literature Search: E.Ç., A.D., S.Ç., F.B., A.A., Writing: E.Ç., A.D., S.Ç., F.B., A.A.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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