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Increased P wave duration and dispersion is associated with catheter-related atrial fibrillation during electrophysiological study

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ABSTRACT

Objectives: Catheter-related atrial fibrillation (AF) is a common cause during electrophysiological study (EPS) and prolongs the duration of the procedure. In our study, we compared P wave duration and dispersion in patients with and without catheter-related atrial fibrillation during EPS.

Methods: One hundred forty five patients who had normal EPS findings and who were found to have catheter related atrial fibrillation were included in our study. Electrocardiogram was performed in all patients and the pulse rate, the longest P wave duration (Pmax), the shortest P wave duration (Pmin) and the difference between of those (P wave dispersion: Pdisp) were recorded. EPS was performed in all patients. The patients were divided into two groups as the group 1 (without catheter-related AF) and group 2 (with catheter-related AF).

Results: In group 2, EPS time was significantly longer, Pmax and Pdisp were found to be significantly higher, Pmin was found to be significantly lower. Binominal logistic regression analysis revealed that, Pmax (OR: 1.077, 95% CI: 1.043-1.112, $p < 0.001$), Pmin (OR: 0.889, 95% CI: 0.853-926, $p < 0.001$) and Pdisp (OR: 1.125, 95% CI: 1.080-1.173, $p < 0.001$) were all independent predictors for catheter-related AF. In ROC analyses, Pmax cut-off value of 120 ms determined the catheter-related AF with 61% sensitivity and 67% specificity, Pdisp cut-off value of 35 ms determined the catheter-related AF with 80% sensitivity and 71% specificity.

Conclusion: Patients with longer Pdisp and Pmax and shorter Pmin may develop catheter-related AF during EPS.

Keywords: Atrial fibrillation, P wave dispersion, electrophysiological study

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Electrophysiological study (EPS) is a common invasive method that is used for diagnosis and treatment of arrhythmic patients which was recommended by guidelines [1]. If ablation is not performed, the diagnostic EPS can be done in a short time. In some patients, arrhythmias including dual pathway, accessory pathway or atrial tachycardia are not found and only catheter-related atrial fibrillation (AF) episodes may develop. This episodes may lead to prolongation of the EPS time and more radiation exposure.

P wave dispersion (Pdisp) is calculated as the difference between the longest P wave duration and the shortest P wave duration on 12 lead surface elec-

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trocardiogram (ECG) [2]. Pdisp demonstrates electrical heterogeneity in the atriums so have been identified as indicator in patients with AF [2-6]. It is inevitable that the EPS catheter is in contact with the atrium wall during EPS. So, catheter-related irregular atrial arrhythmias may develop including AF and EPS time may delay.

If we can predict which patients will develop AF, we can be more careful while placing catheter and reduce the probability of catheter related AF. In the literature, there is no clear association between catheter-related AF and P wave duration-Pdisp. In this study, we aim to investigate whether there is a relationship between catheterrelated AF and P wave duration-Pdisp.

METHODS

Patient Population

A total of 145 patients who preformed EPS due to palpiation were included retrospectively between 2011 and 2015 in this study. Inclusion criteria were accepted as being in sinus rhythm before and after EPS. The patients with coronary artery disease were excluded due to their possible possibility to develop AF. Also, structural heart disease and another chronic disease as well as another arrhythmia in association with AF (Such as atrioventricular nodal reentran tachycardia, atrioventricular reciprocal tachycardia, Wolf-Parkinson-White syndrome) were excluded from the study. Demographic findings were recorded in all patients. The study protocol was approved by the local ethics committee.

Electrocardiographic and Echocardiographic Assessment

Twelve-lead surface ECGs of all patients were recorded by the Nihon Kohden Cardiofax V model ECG-1550K device before the EPS procedure. ECGs with a speed of 25 mm/s and standard calibration of 1 mv/10 mm were used. These ECGs were assessed by two cardiologists independently. The longest P wave duration on sufrace ECG was accepted Pmax, the shortest P wave duration was accepted as Pmin. The difference between these parameters was accepted to be P wave dispersion (Pdisp). Mean values were recorded. Echocardiographic examinations were performed by using an Epiq 7 (Philips Healthcare, DA Best, Netherlands) echocardiography system. Ejection fraction (EF) by Simpson's method, left atrial volüme (LAV), left atrial diameter, E wave velocity and A wave velocity were measured with transthoracic echocardiography.

Electrophysiological Study Data Assessment

All antiarrhythmic drugs were discontinued for at least five half-lives before initiation of the EPS. The patients were subsequently transferred into EPS laboratory. EP Tracer device was used for the procedure (Medtronic Inc., USA). A four pole diagnostic catheter (6F, 110 cm, Mariner® SC Series, Medtronic, Minneapolis, MN, USA) was placed in the right atrial appendix. A four pole radiofrequency ablation catheter (7F, 110 cm, RF Mariner® MC, Medtronic, USA) was placed in the region where sensory recording was made in the right ventricle. Tachycardia was attempted to be induced with programmed atrial and ventricular beats in all patients. Irregular and chaotic atrial rhythm in intra cardiac record was accepted catheter-related AF (Figure 1A and 1B). Patients without catheter-related AF were accepted group 1 and with catheter-related AF were accepted group 2. The EPS time was recorded in both groups.

Statistical analysis

The variables were divided into two groups as continuous and categorical variables. Kolmogorov-Smirnov test was used to determine whether continuous variables had normal distribution or not. Continuous variables were expressed as a mean ± standard deviation and were analyzed with independent samples t-test. Not normal distributed variableswere expressed as a median value (maximum and minimum value) and were analyzed with the Mann-Whitney U-test. A value of $p < 0.05$ was considered to be significant. Correlation analyses was performed with continuous variables. Binominal logistic regression analysis was performed with the significant values in univariate analyses. Independent predictors were determined for AF. ROC analyses were done.

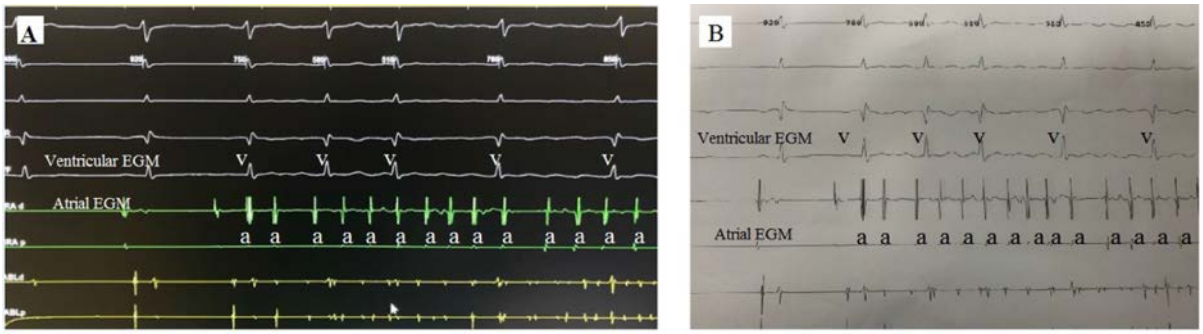

Figure 1A and 1B. Showing of catheter-related atrial fibrillation with intracardiac EGM. a = irregular and caotic electrical signal of the atrium, v = irregular ventricular signal.

RESULTS

Sixty-eight patients were in the group 1 (median age: 48 years, range: 18-70 years) and 77 patients were in the group 2 (median age: 43 years, range:18-70 years). Mean catheter-related AF duration was 145 ± 35 ms (13 of these patients duration < 30 ms). Demographic findings and medications were similar in both groups (Table 1 and 2). The procedure time was significantly longer in the group 2 [median value: 20 min (11-35) vs. 14 min (9-17)]. Pmax [median time: 120 ms (70-160) vs. 110 ms (80-160), $p < 0.001$] and Pdisp [median time: 45 ms (10-80) vs. 25 ms (10-80), $p < 0.001$] were found to be significantly higher in group 2, Pmin [median time: 75 ms (40-95) vs. 80 ms (45-120), $p < 0.001$] was found to be significantly higher in group 1. Echocardiographic parameters were similar in both groups (Table 3). In correlation analyses, there was positive correlation between Pmax and Pmin, Pmax and Pdisp. There was negative correlation Pmin and Pdisp (Table 4). In the multiple logistic regression analysis, it was found that Pmax (OR:1.077, 95% CI: 1.043-1.112, $p < 0.001$), Pmin (OR: 0.889, 95% CI: 0.853-926, $p < 0.001$) and Pdisp (OR:1.125, 95% CI: 1.080-1.173, $p < 0.001$) were all independent predictors for AF (Table 5). In ROC

Table 1. Comparison of demographic findings

	Goup 1 (n = 68)	Group 2 (n = 77)	*p* value
Age, years	48 (18-80)	43 (17-80)	0.283
Male gender, n (%)	28 (41.2)	30 (39.0)	0.786
Pulse, n (beat/minute)	75 (115-55)	75 (45-150)	0.820
BMI, n (kg/m^2)	23 (34-21)	24 (33-22)	0.202
DM, n (%)	8 (11.8)	6 (7.8)	0.419
HT, n (%)	16 (23.5)	10 (13.0)	0.099
HPL, n (%)	2 (2.9)	4 (5.2)	0.401
Smoking, n (%)	9 (13.2)	5 (6.5)	0.17

BMI = body mass index, DM = diabetes mellitus, HT = hypertension, HPL = hyperlipidemia

Table 2. Comparison of patients medications

	Goup 1 (n = 68)	Group 2 (n = 77)	*p* value
ACE, n (%)	8 (11.8)	12 (15.6)	0.506
ARB, n (%)	5 (7.4)	3 (3.9)	0.293
B blocker, n (%)	17 (25)	19 (24.7)	0.558
Statin, n (%)	2 (2.9)	5 (6.5)	0.275

ACE = angiotensin converting enzym, ARB = angiotensin receptor blocker

Table 3. Comparison of echocardiographic and electrocardiographic findings

	Goup 1 (n = 68)	Group 2 (n = 77)	*p* value
Pmax (ms)	110 (80-160)	120 (70-160)	0.002
Pmin(ms)	80 (45-120)	75 (40-95)	<0.001
Pdisp(ms)	25 (10-80)	45 (10-80)	<0.001
EPS time (minute)	14 (9-17)	20 (11-35)	<0.001
EF (%)	60 (53-65)	60 (55-65)	0.606
LAD (mm)	35 (30-41)	35 (30-39)	0.325
LAV (ml)	48 (45-54)	48 (38-54)	0.481
E velocity (m/s)	0.83 ± 0.11	0.84 ± 0.12	0.576
A velocity (m/s)	0.28 ± 0.06	0.28 ± 0.05	0.592

EPS = electrophysiology, LAD = left atrial diameter, LAV = left atrial volume, EF = ejection fraction, Pmax = the longest P wave duration, Pmin = the shortest P wave duration, Pdisp = P wave dispersion

Table 4. Correlation analyses between continious parameters

		EF	LAD	LAV	Pmax	Pmin	Pdisp	E velocity	A velocity
EF	r	1	0.012	-0.154	0.083	-0.072	0.113	0.111	-0.144
	p	.	0.889	0.065	0.320	0.392	0.174	0.201	0.095
LAD	r	0.012	1	0.117	0.013	-0.067	0.045	0.007	0.001
	p	0.889	.	0.163	0.874	0.423	0.593	0.939	0.994
LAV	r	0.154	0.117	1	0.021	-0.018	0.030	-0.003	-0.048
	p	0.065	0.163	.	0.802	0.828	0.724	0.969	0.580
P max	r	0.083	0.013	0.021	1	0.276**	0.712**	-0.074	-0.167
	p	0.320	0.874	0.802	.	0.001	0.000	0.391	0.052
P min	r	0.072	-0.067	-0.018	0.276**	1	-0.426**	0.026	-0.025
	p	0.392	0.423	0.828	0.001	.	0.000	0.766	0.777
Pdisp	r	0.113	0.045	0.030	0.712**	-0.426**	1	-0.068	-0.115
	p	0.174	0.593	0.724	0.000	0.000	.	0.430	0.183
E velocity	r	0.111	0.007	-0.003	-0.074	0.026	-0.068	1	0.002
	p	0.201	0.939	0.969	0.391	0.766	0.430	.	0.979
A velocity	r	0.144	0.001	-0.048	-0.167	-0.025	-0.115	0.002	1
	p	0.095	0.994	0.580	0.052	0.777	0.183	0.979	.

LAD = left atrial diameter, LAV = left atrial volume, EF = ejection fraction, Pmax = the longest P wave duration, Pmin = the shortest P wave duration, Pdisp = P wave dispersion

analyses, Pmax cut-off value of 120 ms determined the catheter-related AF with 61% sensitivity and 67% specificity [AUC: 0.652 (0.562-0.741), $p = 0.002$], Pdisp cut-off value of 35 msec determined the catheter-related AF with 80% sensitivity and 71% specificity [AUC: 0.818 (0.748-0.888), $p < 0.001$] (Figure 2).

Table 5. Independent predictors for AF

	Odds ratio	95% CI	*p* value
Pmax	1.077	1.043-1.112	**< 0.001**
Pmin	0.889	0.853-926	**< 0.001**
Pdisp	1.125	1.080-1.173	**< 0.001**

AF = atrial fibrillation, CI = confidence interval, Pmax = the longest P wave duration, Pmin: the shortest P wave duration, Pdisp = P wave dispersion

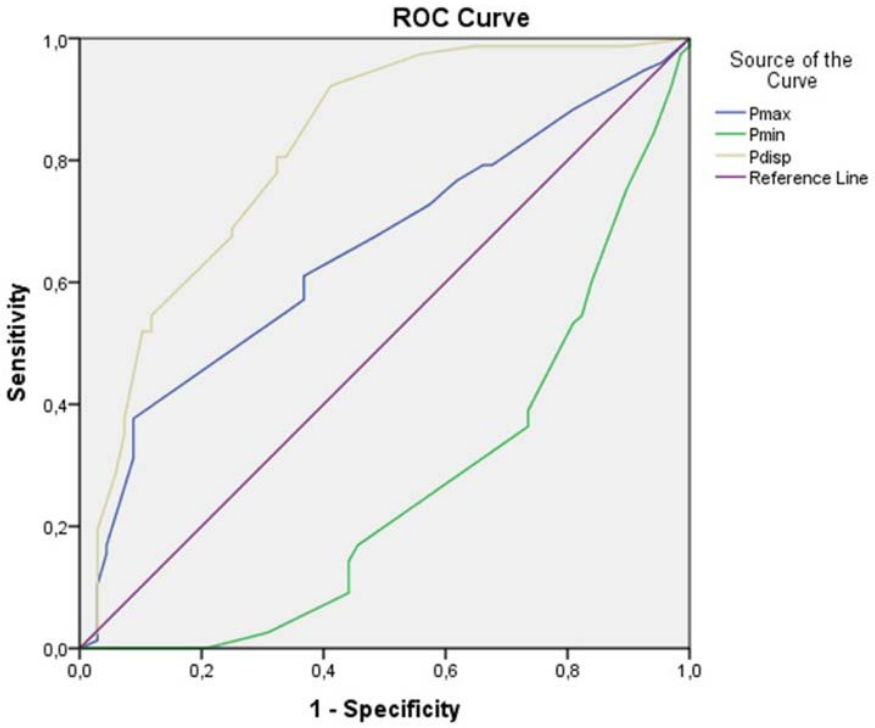

Figure 2. ROC analyses to determine predictive value of Pmax, Pmin and Pdisp for catheter-related atrial fibrillation.

DISCUSSION

We found some important findings in our study. Increased Pmax and Pdisp are closely associated with catheter-related AF. Also, EPS time is significantly prolonged in patients with catheter related AF.

P wave duration on 12 surface ECG shows interatrial conduction time [7]. Atrial dyssynchrony is defined as the difference in P wave durations between leads on superficial ECG [2]. Atrial dyssynchrony is the substrate for many atrial arrhythmias, especially atrial fibrillation [8]. In an update related with Pdisp, it was reported that the probability of atrial tachycardia increased above a value of 40 ms [9]. In a study, it was determined that when taken Pdisp > 40 ms, AF determined to high sensitivity and specificity [2]. In another study, when cut-off value taken 36 ms, AF predicted with a sensitivity of 77% [6]. In a recent meta-analysis, increased Pdisp, especially in obese patients, has said to be predictor of AF [8]. In our study, Pdisp was significantly increased in the patient with catheter-related AF. We thoughtthat these patients had increased interatrial heterogeneous electrical condution. When we contact the catheter directly with the right atrium wall, we think that AF may be started. In addition, a cut-off value of 35 ms of Pdisp detected patients with AF in an overlapping manner with previous studies.

In the literature, it was reported that Pdisp especially in the D2 and V1 derivations was an independent marker in development of Afib in an observational study conducted with a high number of patients [9]. In another study, the persistent AF group was compared with the control group and Pdisp was found to be shorter in the control group [7]. In a study conducted with patients with lone AF, Pdisp was found to be longer and Pmin was found to be shorter compared to the control group [11]. In another study, Pdisp and Pmax were found to be longer in patients with paroxysmal AF [12]. In a study conducted with relapsing AF, it was reported that Pdisp was not an independent predictor of relapse and only prolonged P wave was an independent predictor of relapse [13]. In another relapse study, it was reported that prolonged Pdisp was a predictor for relapse in patients with atrioventricular nodal reentrant tachycardia who were treated with radiofrequency [14]. Besides, Pdisp was shown to be significantly correlated with epicardial adipose tissue, prolonged in cryptogenic stroke and an independent predictor of AF in hypertensive patients

in some studies [15-17]. Our study showed no significant correlation between P wave and other parameters.

Limitations

The duration of AF in our 13 patients is less than 30 sec. In these patients, there is no definition in the guidelines [1]. The radiation dose received by the patients whose EPS lasted longer was not recorded. The patients who developed AF during the procedure were not followed up later. The CHA_2DS_2-VASc score was not calculated after the procedure in the patients with AF. No anticoagulant treatment was initiated. Because our study was retrospective, we did not know if they became symptomatic after the procedure? and if they had a complication due to AF?

CONCLUSION

Patients with longer Pdisp and Pmax and shorter Pmin may develop AF more frequently during EPS and their procedure times may delay. Physician should be careful when placing catheter in these patients.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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