I.R Iranian Heart Journal; 2016; 17 (1)

Original Article

Incessant Atrial Tachycardia:P-Wave Morphology and Echocardiographic Characteristics

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ABSTRACT

Background: Incessant atrial tachycardia (AT) is a kind of sustained supraventricular tachycardia. P-wave morphology in surface ECG is a useful criterion to recognize anatomical origination of AT. In the present study, the origination of incessant AT on the basis of P-wave morphology before electrophysiology study (EPS) and echocardiographic criteria alteration before and after ablation were assessed.

Methods: In this case series, 185 patients (mean age =43±18 y; age range =16 to 87 y) with AT were enrolled. Of these patients, 37 (10% of all cases of AT) had incessant AT. The P-wave morphology of all 12 leads acquired from surface ECG was recorded before EPS, and the origin of incessant AT was diagnosed. Alterations in echocardiographic characteristics such as ejection fraction (EF), end-diastolic diameter (EDD), and end-systolic diameter (ESD) were all measured before and after ablation.

Results: The study of surface ECG showed that the negative P wave in lead I was a characteristic parameter for AT originating from the left atrial appendage with 100% sensitivity and 96.8% specificity. A negative or positive/negative P wave in lead V_1 was seen in right atrial appendage AT with 100% sensitivity and 79.3% specificity, and a negative or positive/negative P wave in lead V_1 originating from the crista terminals had 80% sensitivity and 68.8% specificity. In AT originating from the coronary sinus, a negative P wave in the inferior leads (sensitivity of 100%, specificity of 97%) and a positive P wave in lead aVR were the characteristic parameters. The mean value of left ventricular ejection fraction before and after ablation was 41.76±12.5 and 48.5±8.15, respectively (P<0.01), and a significant change due to this alteration was seen in terms of the duration of tachycardia (P<0.01). The mean of left ventricular end-diastolic diameter (LVEDD) and systolic diameter (LVESD) was 5.60±0.75 and 4.40±0.79, respectively, which significantly changed to 4.67±0.53 and 3.51±0.59 after ablation (P<0.01).

Conclusions: A significant relationship was seen between P-wave morphology and the origin of incessant AT. The ablation of incessant AT conferred improvement in EF, LVEDD, and LVESD (P<0.00). ***(Iranian Heart Journal 2016; 17(1): 14-19)***

Keywords: ▪Atrial tachycardia ▪Incessant atrial tachycardia ▪P wave ▪Morphology ▪Ventricular ejection fraction

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Received: August 25, 2015 **Accepted:** January 18, 2015

Atrial tachycardia (AT) is a rare supraventricular tachycardia (SVT) and is seen in 5% to15% of the patients referred to the electrophysiology study (EPS) lab.[1] AT is divided into repetitive and sustained forms.[2] Incessant AT is the kind of sustained AT which lasts >12 hours without duration of interruption of arrhythmia. P-wave morphology in surface ECG can help us to recognize the anatomical origination of AT.[3] Incessant AT can result in decreased left ventricular (LV) function by tachycardia-induced cardiomyopathy mechanism.[4,5] In the present study, the relationships between P-wave morphology in the 12 leads of surface ECG and the origin of incessant AT were assessed. Furthermore, the echocardiographic characteristics of incessant AT such as left ventricular ejection fraction (LVEF), left ventricular end-systolic diameter (LVESD), and left ventricular end-diastolic diameter (LVEDD) before and after ablation were studied.

METHODS

In this retrospective case-series study, out of 185 patients who underwent EPS and ablation due to AT in our tertiary research center's EPS laboratory between 2010 and 2013, 37 patients with incessant AT were enrolled. Incessant AT was defined as 12-hour tachycardia without a cutoff in the duration of tachycardia. All the patients signed an informed consent form and underwent echocardiographic study before ablation and then 1 year after the procedure. LVEF, LVEDD, and LVESD were studied by 2-dimensional M- mode echocardiography from the left parasternal and apical views. Twelve-lead standard ECG was obtained before EPS. P-wave morphology was described on the basis of deviation from the isoelectric baseline (T-P segment). It was considered positive, if a positive deviation was observed, or negative, if a negative deviation was seen. It was regarded as positive/negative, if there was a positive deviation in the first part of P wave from the baseline and the other segment of P wave was under the isoelectric line. It was considered negative/positive, if there was a negative deviation and then a positive deviation (the revere of the previous description). Finally, the morphology was considered isoelectric if there was no P-wave deviation.

EPS study was performed for all the patients with sustained or nonsustained AT using 4 diagnostic catheters positioned in the following situations: 1) high right atrium (RA) catheter (4-pole, with 2-mm interelectrode spacing), positioned along the crista terminalis, 2) coronary sinus (CS) catheter (10-pole, with 2-mm interelectrode spacing), positioned at the CS, 3) His bundle electrogram catheter; and if left-sided AT origination was suspected 4) left atrial (LA) catheter via septostomy.

Mapping of Atrial Tachycardia

Mapping and ablation was performed with fluoroscopy and conventional mapping system. Following the diagnosis of AT origination, ablation was performed by the radiofrequency method.

The origination of arrhythmia was localized during tachycardia or atrial ectopy via the analysis of P-wave morphology in surface ECG, RA endocardial activation sequence, entrainment mapping, and point mapping with the site of the earliest endocardial activation relative to the onset of P wave through the mapping/ablation catheter. LA mapping was performed via septostomy and comprised LA free wall, all PVs, left side of the interatrial septum, LA appendage, and the mitral annulus. AT focus ablation was performed by radiofrequency.[6]

Statistical Analysis

The chi-square test was used to analyze the nominal data. The Fisher exact test was employed if fewer than 5 samples were in a subgroup. The differences between LVEF, LVEDD, and LVESD before and after ablation were examined using the Wilcoxon

2-related sample tests in SPSS, version 21. A P value <0.05 was considered the level of significance.

RESULTS

Out of 185 patients who underwent EPS due to AT, 37 patients (60.5% female, 39.5% male, mean age =43±18 y; age range =16 to 87 y) had incessant AT. Patients with simultaneous tachyarrhythmia (atrial flutter, atrial fibrillation, atrioventricular reentrant tachycardia, etc.) were excluded. All patients with incessant atrial tachycardia (n=37) had an atrial origin as follows: All the cases with AT originating from the RA appendage (8 [21.6%]) and LA appendage (6 [16.2%]) were incessant. Also, 25% of the cases with AT originating from the lateral part of the left atrium (1 [2.7%]), 31% of the cases with AT with origins from PVs (9 [24.3%]), 17.5% of the cases with AT with an interatrial septum origin (3 [8.1%]), 4 (10.8%) of the cases of AT with a coronary sinus origin (13.8%), 33.3% of the cases of AT with para-Hisian origination (1 [2.7%]), and 10.2% of the cases of AT with crista terminalis origination (5 [13.5%]) were incessant.

There was a significant relationship between the origination of AT and incessant arrhythmia (P<0.01).

P-wave morphology according to the origination of incessant AT is depicted in Table 1. Negative P wave was a characteristic parameter for AT originating in the LA appendage with 100% sensitivity and 96.8% specificity. Negative or positive/negative P wave in lead V_1 was observed in AT originating in the RA appendage with 100% sensitivity and 79.3% specificity. Negative or positive-negative P wave in lead V_1 was seen in AT originating at the crista terminalis with 80% sensitivity and 68.8% specificity. In AT originating from the CS, a negative P wave in the inferior leads (sensitivity 100%, specificity 97%) and a positive P wave in aVR were considered useful diagnostic indices (Table 1).

Table 1. P-wave polarities in surface ECG in incessant atrial tachycardia according to the origination

	SENS	SPEC	PPV	NPV
CS				
I(+)	75	27.3	11.1	90
II,III,aVf(-)	100	97	80	100
aVr(+)	100	84.8	44.4	100
aVl(+)	100	60.6	23.5	100
V1(+)	100	42.4	17.4	100
V2(+)	100	27.3	14.3	100
V3(+, +/iso)	100	24.2	13.8	100
VF(+, +/iso)	100	15.2	12.5	100
V5,V6(+, +/iso)	100	9.1	11.8	100
CT				
I(+)	100	31.2	18.5	100
II(+)	100	18.8	16.1	100
III(+)	80	25	14.3	88.9
aVr(-)	100	34.4	19.2	100
aVl(+)	60	56.2	17.6	90
aVf(+)	80	18.8	13.3	85.7
V1(-, +/-)	80	68.8	28.6	95.7
V2(+)	80	25	14.3	88.9
V3(+)	80	21.9	13.8	87.5
V4(+)	80	12.5	12.5	80
V5,V6(+)	80	9.4	12.1	75
RAA				
I(+)	100	58.6	40	100
II(+)	100	20.7	25.8	100
III(+)	100	31	28.6	100
aVr(-)	100	41.4	32	100
aVl(+)	62.5	58.6	29.4	85
aVf(+)	100	24.1	26.7	100
V1(-,+/-)	100	79.3	57.1	100
V2(-)	50	89.7	57.1	86.7
V3(+)	50	10.3	13.3	42.9
V4(+)	87.5	13.8	21.9	80
V5,V6(+)	100	13.8	24.2	100
PV				
I(+)	100	32.1	32.1	100
II(+)	100	21.4	29	100
III(+,-/+)	100	28.6	31	100
AVr(-)	100	39.3	34.6	100
aVl(+)	66.7	60.7	35.3	85
aVf(+)	100	25	30	100
V1(+)	100	50	39.1	100
V2(+)	100	25	30	100
V3(+)	100	25	30	100
V4(+)	100	14.3	27.3	100
V5,V6(+)	100	14.3	27.3	100
LAA				
I(-)	100	96.8	85.7	100
II(+)	100	16.7	19.4	100
III(+)	100	29	21.4	100
aVr(+,+/-)	66.7	77.4	36.4	92.3
aVl(-)	100	64.5	35.3	100
aVf(+)	100	22.6	20	100
V1(+)	100	45.2	26.1	100
V2(+,ISO/+)	83.4	32.14	17.85	90
V3(+,ISO/+)	83.4	32.25	19.23	90.9
V4-V6(+,ISO/+)	83.3	18.1	15.6	85.7

AT, Atrial tachycardia; CS, Coronary sinus; CT, Crista terminalis; LAA, Left atrial appendage, NPV, Negative predictive value; PVs, Pulmonary veins; PPV, Positive predictive value, RAA, Right atrial appendage; SENS, Sensitivity; SPEC, Specificity

The origination of incessant AT characterized by P-wave morphology in surface ECG is shown in an algorithm (Fig. 1). Mean LVEF (41.76±12.5) before ablation changed (48.5±8.15) after ablation, which was statistically significant (P<0.01), and the relationship between LVEF alteration and the duration of tachycardia was significant (P<0.01). The mean LVEDD and mean LVESD were 5.60±0.75 and 4.40±0.79, respectively, which improved significantly to 4.67±0.53 and 3.51± 0.59 after ablation (P<0.01) (Fig. 2).

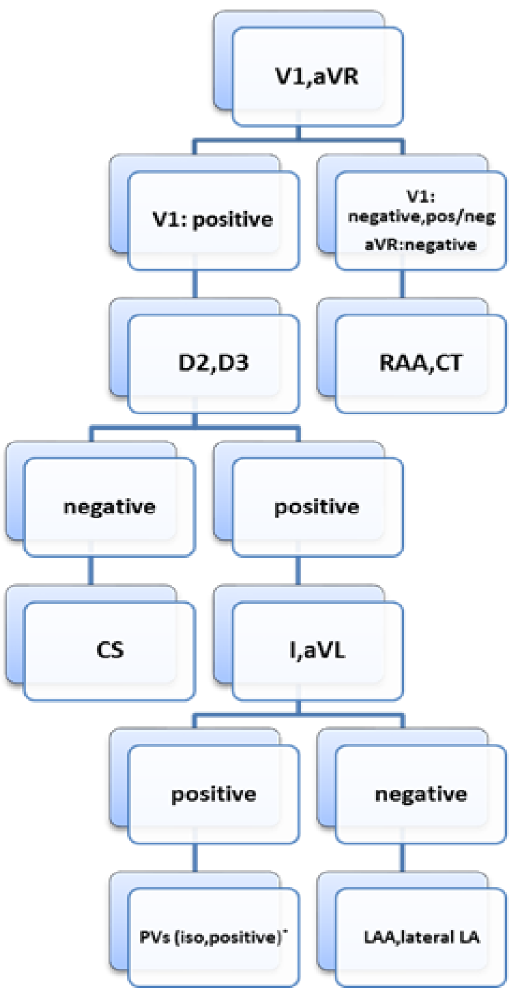

Figure 1. Algorithm of incessant atrial tachycardia origination on the basis of the morphology of P wave in ECG.
* Positive P wave in lead I had 100% sensitivity, but aVL can be positive or negative on the base of the position of the pulmonary vein.

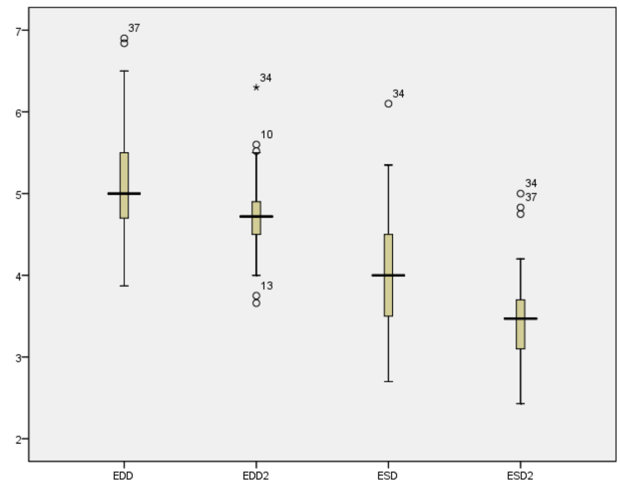

Figure 2. LVEDD and LVESD before and after ablation in incessant atrial tachycardia.
LVEDD, Left ventricular end-diastolic diameter before ablation; EDD2, End-diastolic diameter after ablation; LVESD, Left ventricular end-systolic diameter before ablation; ESD2, End-systolic diameter after ablation

DISCUSSION

AT has been described as a rare supraventricular tachycardia,[7] resulting in tachycardia-induced cardiomyopathy if the tachycardia lasts a long time.[4,5] Incessant AT is deemed to belong to this group of arrhythmias; it continues more than 12 hours without interruption. P-wave morphology in surface ECG at the time of arrhythmia can suggest the origin of AT.[3]
Our study showed a significant relationship between P-wave morphology in surface ECG and the origin of incessant AT in EPS. We also evaluated the echocardiographic characteristics of arrhythmias before and after ablation to explain tachycardia-induced cardiomyopathy. In addition, we demonstrated an improvement in those parameters after ablation.[8-10]
In an investigation, 61 patients with AT were studied for predicting the origin of AT by surface ECG, after successful radiofrequency ablation. The cases of AT were divided into 2 groups regarding their origination: high atrial origin (high CT, superior pulmonary veins, and RA appendage) and right low septal (CS ostium and inferior tricuspid annulus). The

sensitivity and specificity of positive P waves in the inferior leads and a negative P wave in lead aVR in AT with high atrial originations were 95% and 90%, correspondingly. Moreover, 88% sensitivity and 89% specificity were obtained by negative P waves in the inferior leads and a positive P wave in the aVR lead regarding right low septal origination.[10] The results of the mentioned study were in accordance with our study and confirm our results. Nonetheless, 25% of cases of AT with RA appendage origination had a positive P wave in our study. We also obtained comparable results, which are depicted in an in algorithm (Fig. 1) for the localization of incessant AT on the basis of P-wave morphology.

The results of other studies chime in with our results. They assessed adults and children with AT who had shown obvious improvement in echocardiographic parameters after ablation.[8,9] Accordingly, whereas most of the previous studies have been performed on AT, we specifically assessed incessant AT.

CONCLUSIONS

Our study showed a significant relationship between P-wave morphology in the 12 leads of surface ECG and the origin of incessant AT, which results in a diagnostic algorithm. Furthermore, improvement in echocardiographic parameters before and after ablation described LV dysfunction due to tachycardia.

ACKNOWLEDGEMENTS

We thank Dr. Mona Heiadarali and Dr. Shabnam Madadi for assisting with the scientific writing. Also, we thank all the staff of the Electrophysiology Research Center for their great efforts.

Conflict of Interest: The authors hereby declare no conflict of interest.

Funding Support: This project was financially supported by the fund of Iran University of Medical Sciences.

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