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Incidence and characteristics of atrial high-rate episodes in patients with implantable cardiac devices

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Abstract

Background: The most prevalent persistent arrhythmia is atrial fibrillation (AF), which is frequently linked to a high risk of morbidity and mortality. Despite the increasingly recognized integrated management as anticoagulation treatment in AF patients, Still, a sizable proportion of people are suffering from AF. admitted with heart failure, stroke, and other comorbidities. This is explained by the asymptomatic nature of AF. The aim of this work was to assess how frequently atrial high-rate events occur in patients with implantable cardiac devices and to determine their characteristics.

Methods: This prospective observational study was conducted at Tanta University Hospital on patients with implantable cardiac device who attended the cardiovascular outpatient clinic. All patients gave their informed consent. The inclusion criteria included patients with implantable cardiac device that includes an Atrial lead.

Results: Regarding the demographic characteristics, our study revealed no significant connection between atrial high-rate episodes (AHRE) detection with both age ($P = 0.897$) and gender ($P = 0.624$) of the patients. The general medical history of included patients revealed no significant association with AHRE except for ischemic heart disease (IHD) patients.

Conclusions: Patients with cardiac implanted devices experience a significant incidence of AHREs. It is likely that AHRE will be reported more frequently in the future due to improvements in cardiac monitoring. Previous research showing a strong link between AHREs and clinically verified AF has been used to support this viewpoint.

Keywords: Atrial high-rate episodes, implantable cardiac devices, incidence, characteristics

Introduction

The most prevalent persistent arrhythmia is atrial fibrillation (AF), which is typically linked to a high risk of morbidity and mortality ^[1]. Despite the increasingly recognized integrated management as anticoagulation therapy in AF patients ^[2], there are still a large number of patients that have AF. admitted with heart failure (HF), stroke, and other comorbidities ^[3].

Many asymptomatic cases of AF are diagnosed only after the occurrence of complications as congestive HF and ischemic stroke ^[4]. Atrial tachyarrhythmias that are presented as subclinical or asymptomatic often occur preceding the onset of clinical AF and can be diagnosed in patients with permanent pacemaker e.g (Cardiovascular implantable electronic devices (CIEDs), e.g., implantable cardioverter defibrillators (ICD), permanent pacemakers, and cardiac resynchronization therapy (CRT) devices) ^[5].

Many studies illustrated that atrial high-rate episodes (AHREs) detected by cardiac implantable electronic devices have a substantial function connected with clinically confirmed AF ^[6] and they are separately linked to a greater risk of having an ischemic stroke or systemic embolism ^[7].

Different studies defined the thresholds of the duration and rate for AHRE episodes that may aid in the differentiation of the prolonged AHREs from the sinus tachycardia, shorter and slower atrial tachyarrhythmias that are of vague clinical impact. Applying these rate and duration degrees, the studies were able to associate the prolongation of AHRE with thromboembolic insults ^[8]. There is evidence that indicates that large cardiovascular outcomes (MACE) are more likely to occur when AHRE is sustained ^[9].

In order to estimate the danger of these occurrences, cardiac implantable electronic devices that can detect these AHRE are becoming a powerful tool in the arsenal of doctors. Atrial fibrillation, atrial flutter, and extended atrial tachycardias are clinically significant occurrences of prolonged AHREs above the established threshold that cause cardioembolic and cardiovascular problems.^[10]

Great efforts were conducted to determine the potential risk factors for the occurrence of AHRE and to examine the relationship between AHREs and the results in CIED patients. Although some studies have assessed the effect of AHRE on patient with AHREs management, the ideal management of such patients is still unclear in the current clinical recommendations, particularly when it comes to anticoagulant treatments for patients with AHREs^[11].

Modern pacemaker technology has low-power consumption memory, high-density and can automatically record and store episodes of spontaneous atrial tachy-arrhythmias based on program detection standards. These episodes can be recorded as interval information, electrograms, or both. It is thought that these episodes constitute non-sustainable AF but could be precursors to sustained AF.

The aim of this work was to assess the incidence of Atrial high-rate episodes in patients with implantable cardiac devices and to determine their characteristics.

Patients and Methods

This prospective observational study was performed on 100 patients ranging in age from 24 to 82, both sexes, with clinical criteria of implantable cardiac device that includes an Atrial lead.

e.g.: dual chamber pacemaker, dual chamber ICDs, CRT-P, CRTD with atrial lead.

The study was executed between March 2021 and September 2021 with the Ethical Committee Tanta University Hospitals' approval. An informed written consent was obtained from all patients.

Exclusion criteria were patients with permanent AF, patients who refused to join the study and single chamber device: One lead in the ventricle.

All patients underwent the following

Demographic data, full history, clinical examination (vital signs, systolic blood pressure, diastolic blood pressure, mean arterial blood pressure, HR, cardiac examination [inspection, palpation, and auscultation].

12-lead ECG was performed for all patients to detect irregular rhythms. Transthoracic two-dimensional echocardiography was carried out for all patients at admission to the coronary care unit (CCU) to measure left ventricular ejection fraction, left ventricular systolic diameter, left ventricular diastolic diameter, and left atrial diameter.

Then the patients were followed up till occurrence of atrial high-rate episodes, which was defined by:

- a) Atrial tachyarrhythmia including atrial flutter, fibrillation, and tachycardia.

- b) A prolonged AHRE episode is one that exceeds a predetermined rate and duration threshold. These are instances of prolonged atrial tachycardias, flutter, or atrial fibrillation. c) The current study considered AHREs with heart rate <150 beats per minute.

Statistical analysis

SPSS v26 was used to conduct the statistical analysis (IBM Inc., Chicago, IL, USA). Histograms and Shapiro-Wilks test were employed to assess the normality of the data distribution. The mean and standard deviation (SD) were employed to depict quantitative parametric data. Interquartile range (IQR) and median were used to depict non-parametric quantitative data. The qualitative characteristics were provided in terms of frequency and percentage (%).

Results

The characteristics of the medical history among the studied group. 27% of the patients were diabetic, 41 had hypertension, 11 suffered from IHD, and 21 patients were smokers. Regarding medications, 48% of the patient were on beta-blockers, 7% were on both beta-blockers and anti-coagulants, 28% had other medications, and the rest (17%) had no medications. Table 1

Table 1: General characteristics of the studied patients (N=100)

		No. (100)
Age (year)		54.81 ± 13.77
Sex	Male	43 (43%)
	Female	57 (57%)
DM		27 (27%)
HTN		41 (41%)
IHD		11 (11%)
Smoking		21 (21%)
Medications	No	17 (17%)
	Beta-blockers	48 (48%)
	Beta-blockers & anti-coagulants	7 (7%)
	Others	28 (28%)

Data presented as mean ± SD or frequency (%). DM: diabetes mellitus; HTN: hypertension; IHD: ischemic heart disease

3% of the patients had prosthetic valves. 8 had moderate to severe mitral stenosis, 73 suffered from other valvular lesions, while 19 didn't. Regarding type of pacemaker, 77% of the patients had DDD type, 17% had CRT-D type and 6% had ICD-dual chamber. The mean value of EF (%) was 58.27 ± 8.33. Left atrial dimension ranged from 2-6 cm. Displays the AHRE characteristics among the studied group. 47% of the patients had AHRE. 68.1% of them had a duration of less than 5 minutes, 19.1% had 5-15 minutes, 10.6% had 15-60 minutes, while only 2.1% had more than 60 minutes. The mean value of the AHRE rate was 170.47 ± 20.52. Table 2

Table 2: Cardiac, AHRE characteristics of the studied group (N=100)

		No. (100)
Prosthetic valve		3 (3%)
EF (%)		58.27 ± 8.33
LA dimensions (cm)		3.7 ± 0.75
Valvular lesions	No	19 (19%)

	Moderate to severe MS	8 (8%)
	Others	73 (73%)
Type of pacemaker	DDD	77 (77%)
	CRT-D	17 (17%)
	ICD-dual chamber	6 (6%)
Detection of AHRE		47 (47%)
Rate (n=47)		170.47 ± 20.52
Longest duration (min) (n=47)		6.65 ± 12.9
Duration (n=47)	Less than 5 min	32 (68.1%)
	5-15 min	9 (19.1%)
	15 – 60 min	5 (10.6%)
	More than 60 min	1 (2.1%)

Data presented as frequency (%) or mean ±SD. EF: ejection fraction. LA: left atrium. MS: mitral stenosis. DDD: dual chamber. CRT-D: cardiac resynchronization therapy. ICD: implantable cardiac defibrillators. AHRE: Atrial High-Rate Episodes; min: minute.

There was no significant connection between AHRE detection and either age, gender, history of either DM,

hypertension, smoking or medications and the presence of prosthetic valve, EF%, LA demotions or the type of pacemaker of the patients. The p value of incidence of AHRE with IHD appears to be statistically significant, but probably there is no clinical significance of this finding due to the low number of patients in our study. Table 3

Table 3: Relationship between AHRE detection and sociodemographic data, medical history and cardiac-related history among the studied group (N=100)

		AHRE (n=47)	No AHRE (n=53)	P value
Age		55.00 ± 14.51	54.64 ± 13.21	0.897
Sex	Male	19 (40.4%)	24 (45.3%)	0.624
	Female	28 (59.6%)	29 (54.7%)	
DM		12 (25.5%)	15 (28.3%)	0.755
HTN		22 (46.8%)	19 (35.8%)	0.266
IHD		2 (4.3%)	9 (17%)	0.042*
Smoking		8 (17%)	13 (24.5%)	0.358
Medications	No	7 (14.9%)	10 (18.9%)	0.296
	Beta-blockers	19 (40.4%)	29 (54.7%)	
	Beta-blockers & anti-coagulants	4 (8.5%)	3 (5.7%)	
	Others	17 (36.2%)	11 (20.8%)	
Prosthetic valve		2 (4.3%)	1 (1.9%)	0.488
EF (%)		57.74 ± 9.01	55.87 ± 8.72	0.293
LA dimensions (cm)		3.72 ± 0.78	3.85 ± 0.89	0.455
Valvular lesions	No	11 (23.4%)	8 (15.1%)	0.541
	Moderate to severe MS	4 (8.5%)	4 (7.5%)	
	Others	32 (68.1%)	41 (77.4%)	
Type of pacemaker	DDD	40 (85.1%)	37 (69.8%)	0.103
	CRT-D	4 (8.5%)	13 (24.5%)	
	ICD-dual chamber	3 (6.4%)	3 (5.7%)	

Data exhibited as mean ± SD or frequency (%). AHRE: Atrial High-Rate Episodes. DM: diabetes mellitus. HTN: hypertension. IHD: ischemic heart disease. EF: ejection fraction; LA: left atrium; MS: mitral stenosis. DDD: dual chamber. CRT-D: cardiac resynchronization therapy. ICD: implantable cardiac defibrillators.

The AHRE rate was significantly higher in males than females (p value 0.016). There was a significant relationship between AHRE duration and valvular lesions among AHRE patients (p value = 0.048). Table 4

Table 4: Relationship between AHRE rate and other studied variables among the AHRE patients (n=47)

	r	AHRE rate	P value
Age		0.153	0.356
Sex	Male	160.21 ± 22.24	0.016*
	Female	158.18 ± 18.41	
DM	Yes	171.00 ± 24.06	0.727
	No	186.49 ± 20.41	
HTN	Yes	171.81 ± 20.93	0.538
	No	167.32 ± 21.62	
IHD	Yes	177.00 ± 9.90	0.596
	No	168.78 ± 21.51	
Smoking	Yes	160.13 ± 22.83	0.189
	No	170.97 ± 20.62	
Medications	No	166.71 ± 17.04	0.095
	Beta-blockers	171.84 ± 22.78	

	Beta-blockers & anti-coagulants	190.25 ± 17.44	
	Others	162.12 ± 19.03	
Prosthetic valve	Yes	190.00 ± 28.28	0.156
	No	168.20 ± 20.72	
EF (%)	r	0.011	0.942
LA dimensions (cm)	r	0.116	0.438
Valvular lesions	No	168.91 ± 23.41	0.048*
	Moderate to severe MS	193.50 ± 13.08	
	Others	166.16 ± 19.62	
Type of pacemaker	DDD	168.50 ± 21.01	0.679
	CRT-D	167.50 ± 30.96	
	ICD-dual chamber	179.67 ± 8.39	

Data presented as mean±SD. DM: diabetes mellitus; HTN: hypertension; IHD: ischemic heart disease; EF: ejection fraction; LA: left atrium; MS: mitral stenosis; DDD: dual

chamber; CRT-D: cardiac resynchronization therapy; ICD: implantable cardiac defibrillators; AHRE: Atrial High-Rate Episodes.

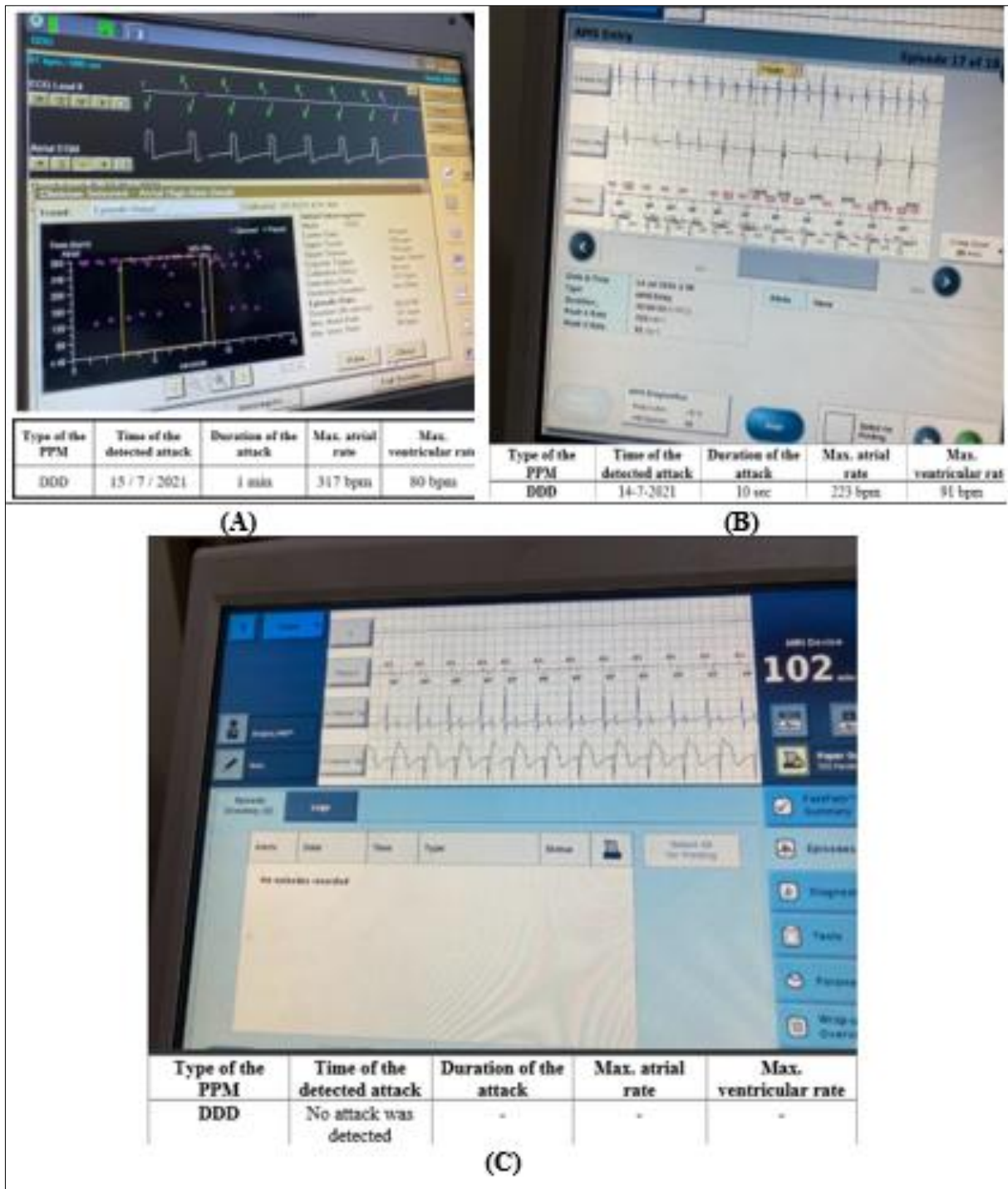


Fig 1: (A), (B) and (C) show demonstration

Discussion

In the last 10 to 15 years, the expanded usage of CIED and their technical capacity to track atrial rhythm and detect even very brief bouts of atrial arrhythmias have revolutionized our understanding of these events [12].

Atrial fibrillation is much more common in older adults Kim *et al.* [13]. The age range of people with AF is between 65 and 85 for about 70% of cases. CIEDs can be configured to track and recognize AHREs. CIEDs can track, record, and interpret complex arrhythmias Nishinarita *et al.* [14].

The main findings of this study showed nearly half of the collected patients (47%) were detected with AHRE and it revealed no significant relationship between AHRE detection with both age ($P = 0.897$) and gender ($P = 0.624$) of the studied participants.

Regarding the relationship between AHRE detection and socio-demographic data, we found no significant relationship between AHRE detection and either age or gender. AHRE rate was higher in males than females. Also detected the relationship between AHRE and medical history, we found that AHRE detection has a statistically significant association with IHDs. The analysis revealed a significant increase in AHRE detection in IHD patients with a p-value of 0.042.

In terms of LA dimensions in our study, it showed a mean baseline of 3.7 cm ranging from 2 – 6 cm. Between the two groups, there was no substantial difference either with (3.72 cm) or without (3.85 cm) AHRE detection. Regarding the medical history that includes Hypertension, Diabetes and Smoking, there is no direct significant association between AHRE and either diabetes, HTN and Smoking. Similarly, in terms of cardiac-related history, the result of general history and AHRE detection showed no significant relationship exists between AHRE and either prosthetic valve, ejection fraction (EF), valvular lesions, or type of pacemaker. In the current study, AHRE showed significantly higher rates of incidence in patients with moderate to severe mitral stenosis (MS) ($P = 0.048$).

In the current study, no significant relationship was found between AHRE detection, and the medications used to include Beta blockers and Anti-coagulants. This study showed also that using anticoagulants did not reveal a significant connection with AHRE detection. In concordance with our study, Kim *et al.* [13] showed no significant relationship between age and sex ($p > 0.05$). However, Patients who were 19 years of age or older had a significant incidence of AHREs, according to their findings. Another study from Chen *et al.* [15] demonstrated that two independent predictors of AHRE were patient age and the percentage of atrial pacing following pacemaker implantation.

Like our results, Chen *et al.* [15] demonstrated that IHD and other serious adverse cardiac events are at increased risk due to AHRE. In contrary with our study. Doundoulakis *et al.* [16] conducted a systematic review and meta-analysis showing an overall incidence ratio of AHREs in the included studies was estimated to be 17.56 cases per 100 persons years.

Previous studies Healey *et al.* [3], Gladstone *et al.* [17] discovered a number of indicators for AHRE, with the larger LA diameter serving as the common predictor in these investigations. (Healey *et al.* [3], Lin *et al.* [4] A Korean study Kim *et al.* [13] demonstrated that $LA > 41$ mm was significantly associated with the occurrence of $AHRE \geq 6$

min, and Mathen and D.Chase study reported that a larger LA diameter was a factor in the extension of AHRE Mathen and Chase, [18]. In Chen *et al.* [15], Increased LA diameter was consistently and substantially linked with $AHRE \geq 6$ min to 24 h, similar to the findings of the two previously cited investigations. Lin *et al.* [4], Healey *et al.* [3].

The findings imply that measuring LA size as part of patients' echocardiographic parameters evaluation prior to CIED implantation is necessary and may enable early prediction of $AHRE \geq 6$ min. Kim *et al.* [13] demonstrated that individuals with pacemakers who had a history of past stroke or transient ischemic attack (TIA), LA diameter more than 41 millimetres, and sick sinus syndrome prior to the installation of CIEDs but no prior diagnosis of clinical AF experienced AHREs often. The idea that AHREs and AF are likely to reflect a clinical continuity in the spectrum of atrial tachy-arrhythmias is supported by the possibility that the elevated risk connected with developing AHREs may be comparable to that for AF.

Another observation study conducted by Chen *et al.* [15] showed that age, male gender, the presence of hypertension, diabetes mellitus, hyperlipidemia, prior MI, antiplatelet and digoxin use were significantly connected to major cardiovascular events especially AHRE detection. The patients' median age was 76 years, and 58.7% of patients were males in their study.

Limitations: Single -center study, the design was non-randomized and observational, and the length of the study was rather brief (6months).

Conclusions

AHREs have significant incidence in patients with cardiac implanted devices. It is likely that AHRE will be reported more frequently in the future due to improvements in cardiac monitoring. This theory has been backed by earlier research showing a strong link between AHREs and clinically verified AF.

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Conflict of Interest

Nil

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