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Study of Pacing Dependency in Patients with a Cardiac Implanted Electronic Device at the National Teaching Hospital of Cotonou in 2023

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Abstract

Introduction: Pacing dependency is defined as the inadequacy or absence of intrinsic rhythm that can lead to bradycardia-related symptoms or cardiac arrest upon cessation of ventricular stimulation. The aim of the present work was to study it in a sample of patients followed at the CNHU-HKM in Cotonou. **Method and patients:** This was a descriptive, analytical cross-sectional study carried out at the University Cardiology Clinic of Cotonou from February 1 to August 1, 2023. It included an exhaustive sampling of all patients admitted as outpatients for follow-up of a cardiac implanted electronic device (CIED). The variables studied were the presence or absence of pacing dependency and the factors associated with it. **Results:** One hundred and eleven patients were included, aged 69.6 ± 13.7 years. The sex ratio was 0.91. The type of CIED was a pacemaker in 96.4% of patients. Complete atrioventricular block was the indication for pacemaker implantation in 76.6% of cases. On the electrocardiogram, 82% of patients had a paced rhythm. During the control by programmer, pacing dependency was found in 45.1% of cases. In multivariate analysis, female gender, preoperative complete atrioventricular block and less than 12 months of CIED wearing time were significantly associated with pacing dependency. **Conclusion:** This result is highly dependent on the criteria used to define pacing dependency. The associated factors identified have also been found by other authors. Other factors remain to be discovered in studies involving larger samples.

Keywords

Cardiac Pacing, Pacing Dependency, Cotonou

1. Introduction

Antibradycardia cardiac pacing has grown significantly worldwide in recent decades. Its growth has been encouraged by the simplification of the technique, the improvement of equipment, and the undeniable improvement in the prognosis of implanted patients [1]. In Spain, 11648 pacemakers were implanted in 2010, representing an estimated 738 implantations per million inhabitants [2]. In Africa, the technique has grown in recent decades, with an average of 2.78 implantations per million inhabitants in 23 countries in 2018 [3]. But cardiac pacing is not just about implanting a pacemaker in a symptomatic patient with a conduction disorder. It also involves lifelong monitoring of the patient's condition, through regular monitoring and optimization of pacemaker function. One of the steps in the monitoring of cardiac implanted electronic devices (CIEDs) is the search for possible pacing dependency during the ventricular sensing study. Pacing dependency is defined as the inadequacy or absence of intrinsic rhythm that can lead to bradycardia-related symptoms or cardiac arrest upon cessation of ventricular pacing. This definition has been adapted from those proposed by Mar, Grimm and Ali Abdullah [4]-[7]. In order to guarantee the safety of patients with CIED in any situation, it is essential to investigate this pacing dependency. In Benin, studies focusing on this condition and its associated factors are scarce. The present study aims to fill this information gap.

2. Method and Patients

This was a descriptive and analytical cross-sectional study conducted over an eight-month period (February 1 to August 1, 2023) at the University Cardiology Clinic (CUC) of the National Teaching Hospital Hubert Koutoukou Maga in Cotonou. Patients of all ages and of both sexes carrying a CIED who were seen for follow-up were included. The authors carried out an exhaustive recruitment of all patients admitted during the study period and fulfilling the inclusion criteria.

The variables studied were pacing dependency and associated factors. Pacing dependency was investigated during CIED control by the dedicated programmer. To determine this, the CIED's stimulation mode was changed for a few seconds to VVI mode (ventricular cavity stimulated and detected, stimulation inhibited as soon as an intrinsic ventricular rhythm was detected) at a frequency of 30 beats per minute (bpm). The absence of an intrinsic ventricular rhythm confirmed pacing dependency. Other variables included type of CIED, CIED wearing time, indication for implantation, number of leads implanted, blood pressure level and electrocardiogram. During control by the dedicated programmer, the variables studied were right ventricular lead impedance and sensing parameters in this cavity.

To minimize variability, VVI 30 bpm tests were performed in a standardized manner, with the patient strictly in the supine position. All patients continued their usual medical therapy.

Data were collected by structured interview between the interviewer and respondent, electrocardiogram interpretation and direct observation during control of the stimulation system using the dedicated programmer.

Data were cleaned and coded, then entered into EPI data 3.1 software. Analysis was performed using SPSS/PC (Statistical Package for Social Science) version 21. Quantitative variables were expressed as means with their standard deviation and 95% confidence interval. Qualitative variables were presented as proportions. Frequencies and means were compared either by Pearson's Chi^2 test if one of the theoretical numbers is ≥ 5 or by Fischer's test for numbers < 5. A significance level of 5% was used.

3. Results

The sample comprised 111 patients with a mean age of 69.6 ± 13.7 years, ranging from 6 to 100 years. Females were the most represented, accounting for 52.3% of cases (58 cases), *i.e.* a sex ratio of 0.91. The average length of time the CIED had been worn was 72.3 ± 63.7 months, with extremes of 3 and 384 months. The type of CIED was a pacemaker in 96.4% of patients (107 cases). The majority of implanted leads were 02 in 76.6% of patients (85 cases). Mean arterial pressure was 139.9 ± 18.9/77.8 ± 11.4 mmHg. Fifty-six patients (50.4% of cases) had systolic blood pressure greater than or equal to 140 mmHg and/or diastolic blood pressure greater than or equal to 90 mmHg. Complete atrioventricular block (AVB) was the main indication for pacemaker implantation, accounting for 73.9% of cases (82 patients). Table 1 shows the general characteristics of the sample.

Table 1. Distribution of 111 patients with cardiac implanted electronic devices followed at the University Cardiology Clinic of the National Teaching Hospital Hubert Koutoukou Maga, according to their general characteristics (Cotonou, 2023).

		Workforce	Percentage (%)
CIED wearing time	<12 months	20	18.0
	≥12 months	91	82.0
Number of leads implanted	01	23	20.7
	02	85	76.6
	03	03	2.7
Age (years, n = 111)	≥60	91	82.0
	<60	20	20.0
Sex (n = 111)	Female	58	52.3
	Male	53	47.7
Type of CIED (n = 111)	Pacemaker	107	96.4
	ICD	04	3.6
Blood pressure (n = 111)	≥140 mmHg and/or ≥90 mmHg	56	50.4
	<140 mmHg and <90 mmHg	55	49.6
Indications for pacemaker implantation (n = 107)	Complete AVB	82	76.6
	2/1 AVB	13	11.7
	Bradycardia-tachycardia syndrome	06	5.4

Continued

	Sinus node disease	04	3.6
	Alternating bundle branch block	02	1.8
Indications for ICD implantation (all for primary prevention of sudden death, n = 4)	Dilated cardiomyopathy	02	1.8
	Ischemic cardiomyopathy	01	0.9
	Hypertrophic cardiomyopathy	01	0.9

CIED: cardiac implanted electronic device; AVB: atrioventricular block; ICD: Implanted Cardioverter Defibrillator.

Table 2. Distribution of 111 patients with cardiac implanted electronic devices followed at the University Cardiology Clinic of the National Teaching Hospital Hubert Koutoukou Maga, according to the description of the electrocardiogram (Cotonou, 2023).

		Workforce	Percentage (%)
Intrinsic rythm (n = 20)	Normal AV conduction	13	11.7
	First degree AV bloc AV	07	6.3
Paced rythm (n = 91)	AsVp	54	48.6
	ApVp	13	11.7
	VVI	24	21.6

AV: atrioventricular; VVI: Paced QRS complex, only ventricular rhythm detected, inhibition of pacing after detection; ApVs: paced P wave, spontaneous QRS complex; ApVp: paced P wave, paced QRS complex; AsVp: intrinsic P wave, paced QRS complex.

Table 3. Distribution of 111 patients with cardiac electronic implanted devices followed up at the University Cardiology Clinic of the National Teaching Hospital Hubert Koutoukou Maga, according to pacemaker dependency and age, sex, indication for implantation, duration of implant wear, diabetes and use of beta-blocker (Cotonou, 2023).

		Dependent		OR	IC 95%	p-value
		Yes	No			
Age	<60 years	08	11	-	-	-
	≥60 years	43	49	0.92	[0.27 - 3.07]	0.9
Sex	Masculin	30	23	-	-	-
	Féminin	21	37	3.28	[1.32 - 8.64]	**0.012**
Indication	Complete AVB	46	35	-	-	-
	Others	5	25	**0.11**	[0.03 - 0.32]	**0.001**
CIED wearing time	<12 months	4	16	-	-	-
	≥12 months	47	44	0.22	[0.05 - 0.73]	**0.02**
Diabetes	Yes	9	11	-	-	-
	No	42	49	1.72	[0.53 - 5.95]	0.4
Beta-blocker	Yes	12	11	-	-	-
	No	39	49	0.91	[0.31 - 2.67]	0.9
Total		**51**	**60**			

CIED: cardiac implantable electronic device; AVB: atrioventricular block.

The electrocardiogram recorded during the consultation was studied. The rhythm was a paced rhythm in 82% of cases (91 patients) and intrinsic in 18% (20 patients). Table 2 shows the electrocardiogram characteristics of the patients included.

Atrial rhythm was a normal intrinsic P wave in 89 cases (80.2%), a paced P wave in 13 cases (11.7%), atrial fibrillation in 7 cases (6.3%) and atrial flutter in 2 cases (1.8%).

During control by the dedicated programmer, the percentage of right ventricular pacing was greater than 50% in 85% of cases (94 patients) and less than or equal to 50% in 15% of cases (17 patients).

Right ventricular lead impedance averaged 521.98 ± 111.68 ohms, with extremes ranging from 330 to 1063 ohms. No patient had an abnormal lead impedance.

Of the 111 patients in the sample, 45.1% (50 cases) were dependent on ventricular pacing. Mean right ventricular lead detection in the remaining 61 patients was 9.14 ± 3.78 millivolts, with extremes of 2.5 and 20 millivolts. Abnormal detection below 6 millivolts accounted for 15.3% of patients (17 cases).

The distribution of pacing dependency patients according to dependent variables was studied. In multivariate analysis, female gender, complete AVB and CIED wearing time under 12 months were significantly associated with pacing dependency (Table 3).

4. Discussion

The factors associated with pacing dependency reported in the literature vary according to the type of patient included. Mar et al included patients in whom a pacemaker had been implanted following tricuspid valve replacement. Coronary-artery disease was the only factor identified [4]. The meta-analysis by Steyers *et al.* summarized the associated factors identified by several authors who had investigated this condition in patients implanted for a conductive disorder following cardiac surgery [8]. These factors included postoperative complete AVB, preoperative 1st degree AVB, preoperative left bundle branch block, syncope, body mass index ≥ 28.5 kilograms per square meter and extracorporeal circulation time > 105 minutes [8]. Other associated factors, such as female gender and a CIED wearing time confirm our findings [7]. Cosma *et al.* (2024) evaluated permanent pacemaker dependency after TAVI over 12 months. Prolonged PR interval and right bundle branch block on baseline ECG were key predictors of persistent dependency [9].

Using a sampling method similar to that used in the present study, Grimm et al identified preoperative 2nd- or 3rd-degree BAV, preoperative atrial fibrillation, a left ventricular ejection fraction ≤ 30%, a Brain Natriuretic Peptid level ≥ 150 picograms per milliliter, chronic kidney disease and a CIED wearing time exceeding 5 years as associated factors [5]. In the present study, a CIED wearing time was by contrast, significantly associated with pacing dependency. This difference

may be explained by the significant difference in sample size (802 patients vs. 111 patients).

There is no clear consensus in the scientific literature on the definition of pacing dependency. In the literature review published by Ravaux *et al.* in patients implanted following TAVR (Transcatheter Aortic Valve Replacement), various criteria were used [10]. Takayashi *et al.* selected, among other criteria, a percentage of ventricular pacing > 95% [11]. Ghannam et al selected a spontaneous ventricular rate below 50 bpm in the absence of normal atrioventricular conduction [12]. Merin et al considered the existence of an intrinsic spontaneous rhythm of less than 40 bpm [13].

These criteria seem incomplete. Indeed, taking into account the percentage of stimulation exposes us to biases related to the programming mode of the stimulation system.

The multiplicity of these criteria largely explains the variety of data in the literature concerning the hospital frequency of pacing dependency. Grimm *et al.* found that 16% of patients were pacing dependent [5], three times less than our findings. One explanation for this finding lies in the difference between the types of indication. High-grade AVB accounted for only 31% of indications for CIED implantation in the Grimm et al series, compared with 87% in the present study. In a series of pacemaker patients in Burkina-Faso, Millogo et al had 83% complete AVB among the indications [14]. These high rates of high-grade AVB may be explained by the low socio-economic level in sub-Saharan Africa, where lifesaving cardiac pacing is more practised.

5. Conclusion

The present study involved a sample of 111 patients with a CIED and found 45.1% of pacing dependency. The factors identified were female gender, an indication of complete AVB and less than 12 months of CIED wearing time. Some previous studies have also found female gender and complete AVB. Other factors remain to be discovered in studies involving larger samples. This work has also demonstrated the absence of a consensual definition of pacing dependency.

Ethics Statement

Administrative approvals were obtained for the conduct of the work. The study was conducted in accordance with the Declaration of Helsinki [15].

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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