EVALUATION OF EARLY OUTCOMES OF PERMANENT PACEMAKER IMPLANTATION IN HYPERTENSIVE PATIENTS WITH BRADYARRHYTHMIAS

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ABSTRACT

Objective: This study aims to describe the clinical characteristics and the features of bradyarrhythmias on 24-hour Holter monitoring and to evaluate the early outcomes of permanent pacemaker implantation in hypertensive patients with bradyarrhythmias. ***Subjects and method:*** This cross-sectional study was conducted on 57 subjects with hypertension and bradyarrhythmias who were indicated for permanent pacemaker implantation. ***Results:*** The most common clinical symptoms recorded were fatigue, dizziness, and chest pain, accounting for 47.4%, 45.6%, and 42.1% respectively. The majority of patients had sinus node dysfunction (73.7%) and most underwent dual-chamber permanent pacemaker implantation (87.7%). The 24-hour Holter monitoring results showed that 42.1% had sinus atrial block - sinus pause in the sinus node dysfunction group and 15.8% of patients had third-degree atrioventricular block (AV block) in the AV block group. A good treatment outcome was observed in 72.0% of cases. Age > 70 (OR: 6.1; 95% CI: 1.2-30.1), female gender (OR: 4.2; 95% CI: 1.2-15.4), and single-chamber pacemaker (OR: 8.9; 95% CI: 1.5-52.1) were associated with a higher risk of moderate to poor treatment outcomes. ***Conclusion:*** Permanent pacemaker implantation generally tends to have good short-term outcomes. However, it should be noted that older age, female, and single-chamber pacemaker implantation in association with worse outcomes.

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Abbreviations:

Atrioventricular block: AV block.
BMI: Body mass index.
ECG: Electrocardiogram.
ESC: European Society of Cardiology.

I. INTRODUCTION

Bradyarrhythmias are among the conditions directly linked to an increased sudden death rate in both patients and healthy individuals, with a trend that appears to be on the rise [10]. Thanks to advancements in treating bradyarrhythmias, particularly through the implantation of permanent pacemakers, the quality of life and survival rates for many cases, especially those with severe bradyarrhythmias, have significantly improved [13]. From 1993 to 2009, according to statistics in the United States, there were 2.9 million patients who received permanent pacemaker implantations, equating to a 55.6% increase in the demand for pacemakers, primarily among older patients with multiple comorbidities [6]. Among these comorbidities, recent studies published in the American Journal of Cardiology have demonstrated a link between hypertension and bradyarrhythmias, especially regarding the treatment outcomes of permanent pacemaker implantation [5]. Furthermore, other studies have also indicated that hypertension is the most common comorbidity in patients with

bradyarrhythmias indicated for permanent pacemaker implantation [12], [13]. Globally, as of the time this study was conducted, there is very limited data on the treatment outcomes of bradyarrhythmias requiring pacemaker implantation in patients with hypertension. Particularly in Vietnam, there has been no research conducted on this issue. Therefore, we conducted the study "Evaluation of early outcomes of permanent pacemaker implantation in hypertensive patients with bradyarrhythmias" with the following two objectives:

1. To describe the clinical characteristics and 24-hour Holter monitor features in hypertensive patients with bradyarrhythmias indicated for permanent pacemaker implantation.

2. To evaluate the treatment outcomes of permanent pacemaker implantation in hypertensive patients with bradyarrhythmias and assess several related factors.

II. MATERIALS AND METHODS

All hypertensive patients diagnosed with bradyarrhythmias and indicated for permanent pacemaker implantation admitted to the Cardiology Department of Can Tho Central General Hospital from September 2022 to August 2023.

2.1. Study Population

2.1.1. Inclusion criteria

Subjects aged 18 and over, regardless of gender.

Patients meeting the hypertension diagnosis criteria according to the 2023 ESC guidelines as they have a blood pressure reading ≥ 140/90 mmHg in this admission; or patients with a history of previously diagnosed and treated hypertension [11].

Patient diagnosed with bradyarrhythmias (heart rate < 60 beats/min) on 24-hour Holter monitoring including sinus node dysfunction and AV block [8].

Patients indicated for permanent pacemaker implantation according to the 2021 ESC guidelines with two main indication levels being class I and Iia [5].

2.2.2. Exclusion criteria

Patients with reversible causes of bradyarrhythmias.

Patients with acute conditions such as sepsis, chest infection at the pacemaker implantation site, acute myocardial infarction, myocarditis, bacterial endocarditis, severe renal failure, allergic to contrast dye.

2.2. Study Method

2.2.1. Research desgin: Cross-sectional descriptive study.

2.2.2. Sample size

Convenience sampling, selecting all hypertensive patients with bradyarrhythmias and indicated for pacemaker implantation who meet the sample selection criteria during the study period based on data collection sample. A total of 57 eligible patients were selected and followed up until the end of the study.

2.2.3. Study contents

General characteristics of the study subjects: age, age group (< 70/> 70), height (cm, average), weight (kg, average), body mass index [BMI] (kg/m^2, mean). Medical history including myocardial ischemia, type 2 diabetes mellitus, heart failure (yes/no per one).

Clinical characteristics: symptoms of fainting, shortness of breath, palpitations, chest pain, dizziness, fatigue (yes/no per one).

24-hour Holter ECG characteristics: sinus node dysfunction, AV block, temporary pacemaker implantation, permanent

pacemaker implantation, single-chamber, dual-chamber, sinus bradyarrhythmias, sinus atrial block-sinus pause, tachy-brady syndrome, second-degree Mobitz II AV block, high-degree AV block, third-degree AV block (yes/no per one).

Treatment outcome evaluation (good/moderate - poor):

- Good treatment outcome: when the patient meets three or more criteria at a good level [7].

- Moderate - poor treatment outcome: when the patient meets any criteria at a poor level or three or more criteria at a moderate level [7].

- Assessing some factors related to the two treatment outcome groups: age group (< 70/> 70), gender (male/female), body mass index group [overweight-obese (≥ 23 kg/m^2), non-overweight-obese (< 23 kg/m^2)], temporary pacemaker (yes/no), permanent pacemaker (single-chamber/dual-chamber), medical history: myocardial ischemia, type 2 diabetes mellitus, heart failure (yes/no per one).

2.2.4. Data collection tools

Data collection forms, clinical examination tools, medical records, 24-hour Holter ECG devices, at Can Tho Central General Hospital.

2.2.5. Data analysis

The collected data was analysis using SPSS software version 26.0.

2.3. Research Ethics

The study was conducted after approval from the Scientific Research Board of Can Tho University of Medicine and Pharmacy. All procedures were performed in accordance with ethical standards in biomedical research.

III. RESULTS

Table 1. ***General characteristics of study participants (n = 57)***

Characteristics		Frequency	Percentage (%)
Age group	≤ 70	21	36.8
	> 70	36	63.2
Average age (years), mean ± SD		73.11 ± 10.97	
Gender	Male	28	49.1
	Female	29	50.9
Height (cm), mean ± SD		157.44 ± 5.05	
Weight (kg), mean ± SD		54.86 ± 5.13	
Body mass index (kg/m²), mean ± SD		22.11 ± 1.47	
Medical history	Myocardial ischemia	39	68.4
	Type 2 diabetes	9	15.8
	Heart failure	2	3.5

Concerning the general characteristics of the research subjects, the ratio of male to female participants is nearly 1:1, with an average age of 73.11 ± 10.97 years; the mean BMI is 22.11 ± 1.47. In terms of medical history, a predominant majority of the patients presented with myocardial ischemia (68.4%). The prevalences of type 2 diabetes mellitus and heart failure were 15.8% and 3.5%, respectively.

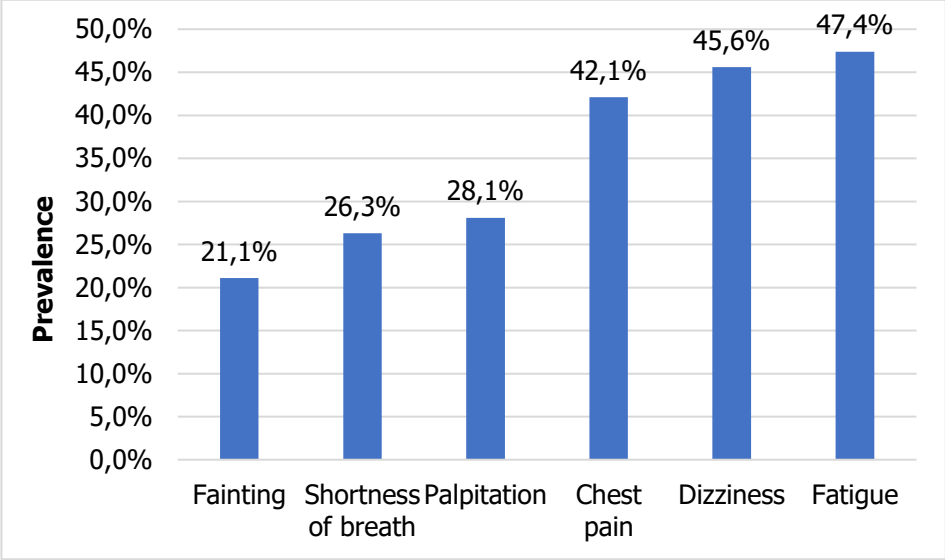

Figure 1. ***Clinical and subclinical characteristics (n = 57)***

The results indicated that nearly half of the patients with bradyarrhythmias accompanied by hypertension who were indicated for pacemaker implantation presented with symptoms of fatigue, dizziness, and chest pain, with respective prevalence rates of 47.4%, 45.6%, and 42.1%. Other symptoms including fainting, shortness of breath, and palpitations were also common, occurring in approximately 20-30% of patients.

Table 2. ***24-hour Holter ECG characteristics***

Characteristics		*Frequency*	*Percentage (%)*
Distribution of bradyarrhythmias	*AV block*	*15*	*26.3*
	Sinus node dysfunction	*42*	*73.7*
Temporary pacemaker	*Yes*	*14*	*24.6*
	No	*43*	*75.4*
Type of permanent pacemaker	*Single-chamber*	*7*	*12.3*
	Dual-chamber	*50*	*87.7*
Characteristics on 24-Hour Holter Monitoring in Patients with sinoatrial dysfunction	*Sinus bradyarrhythmias*	*14*	*24.6*
	Sinus atrial block-sinus pause	*24*	*42.1*
	Tachy-brady syndrome	*6*	*10.5*
Characteristics on 24-Hour Holter monitoring in patients with AV block	*Second-degree Mobitz II AV block*	*4*	*7.0*
	High-degree AV block	*2*	*3.5*
	Third-degree AV block	*9*	*15.8*

The results of the study indicate a predominance of sinoatrial nodal dysfunction among patients with bradyarrhythmias and concomitant hypertension requiring pacemaker intervention. Sinoatrial nodal dysfunction was significantly higher at 73.7% compared to AV block, which stood at 26.3%. The majority of patients did not receive a temporary pacemaker (75.4%), while a substantial majority were implanted

with a dual-chamber permanent pacemaker (87.7%). Additionally, 24-hour Holter monitor findings in patients with sinoatrial dysfunction revealed sinoatrial block or arrest in 42.1% of patients, a slow-fast rhythm pattern in 24.6%, and tachy-brady syndrome accounted for 10.5%. Moreover, in patients with AV block, 15.8% presented with third-degree block, 7.0% with type II second-degree Mobitz 2 block, and 3.5% with high-grade AV block.

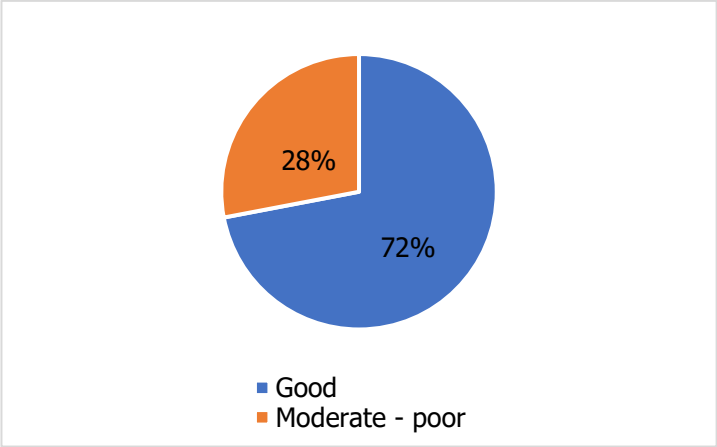

Figure 2. ***Outcomes of permanent pacemaker implantation treatment (n = 57)***

The study evaluated the efficacy of permanent pacemaker implantation in 57 patients with bradyarrhythmias and concurrent hypertension. The results demonstrated that 41 patients, accounting for 72%, experienced favorable outcomes following treatment. In contrast, 16 patients, comprising 28% of the study population, had moderate to poor treatment outcomes.

Table 3. ***Association between various factors and treatment outcomes***

Factor		Outcome		OR (95%CI)	P-value
		Good	Moderate - poor		
Age > 70 (yes), n (%)		22 (53,7)	14 (87,5)	**6,1 (1,2-30,1)**	**0,017**
Gender (female), n (%)		17 (41,5)	12 (75,0)	**4,2 (1,2-15,4)**	**0,023**
Body mass index (overweight/obese), n (%)		17 (41,5)	5 (31,2)	0,6 (0,2-2,2)	0,477
Temporary pacemaker (yes), n (%)		8 (19,5)	6 (37,5)	2,5 (0,7-8,9)	0,183
Permanent pacemaker (single-chamber), n (%)		39 (95,1)	11 (68,7)	**8,9 (1,5-52,1)**	**0,015***
Medical history	Myocardial ischemia (yes), n (%)	28 (68,3)	11 (68,8)	1,0 (0,3-3,6)	0,973
	Type 2 diabetes (yes), n (%)	6 (14,6)	3 (18,8)	1,4 (0,3-6,2)	0,7
	Heart failure (yes), n (%)	1 (2,4)	1 (6,3)	2,7 (0,2-45,4)	0,486*

*Fisher exact test

In evaluating factors associated with treatment outcomes, our analysis indicated that patients over the age of 70 (OR: 6.1; 95%CI: 1.2-30.1), female gender (OR: 4.2; 95%CI: 1.2-15.4), and the use of single-chamber pacemakers (OR: 8.9; 95%CI: 1.5-52.1) were more likely to be correlated with moderate to poor treatment outcomes when compared to their respective counterparts.

IV. DISCUSSION

Our study examined 57 patients diagnosed with bradyarrhythmias and hypertension who were indicated for permanent pacemaker implantation. The sample had a nearly equal male-to-female ratio, with most patients having a history of myocardial ischemia. The mean age of the cohort was 73.11 ± 10.97 years. A positive treatment outcome was observed in 72% of the patients. Higher age, female gender, and the implantation of a single-chamber pacemaker were associated with a higher incidence of moderate to poor treatment outcomes.

Clinically, nearly half of the patients exhibited symptoms such as fatigue, dizziness, and chest pain. Symptoms like syncope, shortness of breath, and palpitations were also relatively common. These findings are consistent with Dinh Van Trinh's 2021 study on 31 patients with bradyarrhythmias indicated for permanent pacemaker implantation, which also reported a high incidence of fatigue, dizziness, and chest pain [1]. This suggests that patients with bradyarrhythmias, with or without accompanying hypertension, tend to exhibit similar clinical symptoms. Thus, clinical practice should include screening with electrocardiograms, potentially supplemented by 24-hour Holter monitoring, to prevent diagnostic oversight.

Additionally, the majority of the patients with bradyarrhythmias were found to have sinus node dysfunction, with most treated with dual-chamber permanent pacemakers. These results are in agreement with findings from Dinh Van Trinh's study [1]. The 24-hour Holter ECG revealed a high prevalence of sinus atrial block - sinus pause in the sinus node dysfunction group, and a higher proportion of third-degree AV block compared to type II second-degree Mobitz 2 block in patients with AV block, indicating a tendency towards more severe bradyarrhythmias disorders in our study population. This aligns with expectations, as sinus pause and third-degree AV block are among the indications for permanent pacemaker implantation according to the European Society of Cardiology [5].

In the early treatment outcome assessment of permanent pacemaker implantation, the majority of patients fared well. Age above 70 was associated with an increased likelihood of moderate to poor outcomes, aligning with known correlations between advanced age and cardiac conduction system fibrosis. Comorbidities typical of advanced age, such as myocardial ischemia, were also significant contributors to the severity of bradyarrhythmias [4]. Furthermore, older age poses a higher risk of procedural complications, including pacemaker implantation. Female gender was another factor associated with an increased odds of moderate to poor outcomes post-treatment, echoing recent findings by Markos S. et al, which indicated a higher complication rate in females following pacemaker implantation [12]. In addition, single-chamber permanent pacemaker were linked to worse treatment outcomes than dual-chamber devices, consistent with multiple studies

demonstrating that dual-chamber pacing can improve treatment efficacy and quality of life compared to single-chamber pacemaker [3], [15]. Locally, research by Doan Chi Thang and colleagues at Hue Central Hospital corroborated significant improvements in symptoms, quality of life, and cardiac function following dual-chamber pacemaker implantation [2]. Indeed, dual-chamber pacing is the preferred treatment for serious bradyarrhythmias arrhythmias due to its benefits in reducing heart failure frequency, hospital admissions for heart failure, and all-cause mortality compared to single-chamber devices [9], [14], [15].

One of the significant limitations of our study is the small sample size. Moreover, the cross-sectional nature of the study precludes causal inferences. The short follow-up period also limits our ability to fully assess the long-term safety and efficacy of permanent pacemaker implantation in patients with bradyarrhythmias and hypertension.

V. CONCLUSION

The early outcomes of permanent pacemaker implantation in patients with bradyarrhythmias and concurrent hypertension were predominantly positive. However, advanced age, female sex, and the use of single-chamber pacemakers were associated with an increased likelihood of moderate to poor treatment outcomes.

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