

Atrial Fibrillation in Patients with Permanent VVI Pacemakers: Risk Factors for Atrial Fibrillation

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Objectives: Atrial fibrillation (AF) does not only deteriorate the cardiac function and increases the thromboembolic risk but also triggers rapid and irregular ventricular rhythm in patients with atrial synchronous pacing. However, the risk factors for the development of AF in patients with pacemakers are not clearly determined yet. The present study was designed to determine the risk factors for AF in patients with VVI pacemakers.

Methods: This study included 80 patients (41 sick sinus syndrome, 39 AV block) who were followed for more than 6 months or developed AF regardless of the duration of follow-up after implantation of VVI pacemakers. Patients were divided into two groups according to whether or not AF developed during follow-up (mean: 25.7 ± 2.5 months): group A developed AF and group B did not. The underlying arrhythmias, cardiovascular risk factors, left atrial size, characteristics of P wave were compared between the two groups.

Results: The mean age of the patients was 58.9 ± 11.4 years and 28 (35%) were male. AF developed in 13 (16.3%) of 80 patients with VVI pacemakers. Sick sinus syndrome (SSS) as an underlying arrhythmia was significantly more frequent in group A than group B (84.6% vs. 44.8%, $p < 0.01$). P wave width was greater in group A (127.6 ± 24.8 ms) than in group B (110.7 ± 17 ms) ($p < 0.05$). There was, however, no significant difference in cardiovascular risk factors, left atrial size, P wave axis and amplitude between the two groups.

Conclusion: These results suggest that sinus node dysfunction and intra-atrial conduction delay may be the risk factors for AF in patients with VVI pacemakers. Further studies are needed to determine how sick sinus syndrome and intra-atrial conduction delay increase the risk for AF in patients with VVI pacemakers.

Key Words: VVI pacing, Atrial fibrillation, Sick sinus syndrome, AV block

INTRODUCTION

Cardiac pacing therapy has been shown to prevent sudden cardiac death and improve the quality of life in patients with symptomatic bradyarrhythmias since the artificial pacemaker was first

introduced in clinical practice in 1958. Cardiac pacing therapy is being widely used as the only definitive mode of therapy to treat symptomatic or significant bradyarrhythmia, such as sick sinus syndrome (SSS) and AV block (AVB)¹⁾. As a result of recent advances in pacemaker technology, the function and size of the artificial pacemaker is much improved. Now, highly sophisticated physiologic pacemakers capable of dual chamber pacing and/or rate-responsive pacing are available.

Atrial fibrillation (AF) is one of the major pro-

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blems developed in patients with permanent cardiac pacing therapy². AF does not only depress cardiac function with increasing thromboembolic risk but also makes it mandatory to change the pacing mode in patients with atrial tracking ventricular pacing mode, such as DDD and VDD. It is, therefore, very important to identify risk factors for AF to develop preventive strategies³. Pacing mode has been reported as a major risk factor for AF in patients with permanent pacemakers, based on the observation that AF developed more frequently in patients with VVI pacing mode than in patients with DDD pacing mode⁴. However, the risk factors for AF in patients with permanent pacemakers have not been clearly identified yet. The purpose of this study is to determine the risk factors for AF in patients with VVI pacing.

MATERIALS AND METHODS

One hundred and fifty three patients were implanted with permanent VVI pacemakers at the Chonnam University Hospital from August, 1983 through July, 1993. All pacemakers were implanted transvenously via the right or left subclavian vein. Among them, 80 patients (52.3%) who were followed for more than 6 months or who had complications with AF within 6 months after the implantations of a VVI pacemaker were enrolled in this study. All 80 patients had no prior history of AF. The eighty patients were divided into two groups according to whether or not AF developed during follow-up; AF developed in 13 patients (group A) but did not develop in the remaining 67 patients (group B).

The diagnosis of AF was made by analyzing standard 12-lead electrocardiogram recorded at each follow-up visit. If atrial rhythm was difficult to evaluate, we analyzed atrial rhythm after slowing the pacing rate of the pacemaker down to 40-50/min temporarily using the programmer. In order to investigate the risk factors for AF, underlying cardiac rhythm and cardiovascular risk factors, such as smoking, hypertension, hyperlipidemia and diabetes mellitus, were evaluated and the left atrial size and characteristics of P wave, including mean

electrical axis, amplitude and duration, were measured. Left atrial size was measured as an antero-posterior diameter of the left atrium in the M-mode echocardiogram recorded at the left parasternal border under the guidance of 2-dimensional echocardiography. The maximum amplitude and duration of P wave were taken as the values of P wave amplitude and duration and P wave axis was considered abnormal if the axis was not within 0-90 degrees.

Statistical analysis was done using Student's t-test or Chi-square test and $p < 0.05$ was considered significant.

RESULTS

Mean age of the 80 patients was 58.9 ± 11.4 years, 28 (35%) were male. Mean follow-up period was 25.7 ± 2.5 (range: 1-99) months (Table 1). Indications for permanent pacemaker implantation were sick sinus syndrome (SSS) in 41 (51.3%), second-degree AV block (AVB) in 5 (6.3%), and third-degree AVB in 34 (42.5%) patients. Thirteen (16.3%) patients developed AF during the follow-up period.

Eleven (84.6%) of 13 patients in group A and 30 (44.8%) of 67 patients in group B were sick sinus syndrome, showing that AF developed significantly more frequently in patients with SSS than AVB ($p < 0.01$, Table 2). Left atrial size measured using M-mode echocardiography was 40.1 ± 3.6 mm in group A and 36.6 ± 5.7 mm in group B, showing no significant difference between the 2 groups (Table 2). Number and distribution of the cardiovascular risk factors were similar in both groups (1.4 ± 0.3 in group A vs. 1.5 ± 0.5 in group B) (Table 2). In 12-lead electrocardiogram, recor-

Table 1. Baseline Characteristics of the 80 Patients with VVI Pacemakers

Mean age, years	58.9 ± 11.4
Male/Female	28/52 (1:1.9)
Underlying arrhythmias	
Sick sinus syndrome	41 (51.3%)
AV block	39 (48.8%)
- 2nd degree	5 (6.3%)
- 3rd degree	34 (42.5%)
Follow-up duration, months	25.7 ± 2.5

Table 2. Comparison of Clinical Characteristics Between the Patients Complicated with AF (group A) and no AF (group B) During the Follow-up Period

	Group A (n=13)	Group B (n=67)	P value
Age, years	55.1±4.3	59.6±11.9	NS
Sex (M/F)	3/10 (1:3.3)	25/42 (1:1.7)	NS
Indication (%)			<0.01
Sick sinus syndrome	11 (84.6)	30 (44.8)	
AV block	2 (15.4)	37 (55.2)	
Follow-up, months	26.4±6.0	25.6±2.8	NS
No of CV risk factors	1.4±0.3	1.5±0.5	NS
Left atrial size, mm	40.1±3.6	36.6±5.7	NS
Characteristics of P waves			
Abnormal axis (%)	2 (15.4)	6 (9.0)	NS
Amplitude, mV	0.22±0.06	0.23±0.10	NS
Duration, ms	127.6±24.8	110.7±17.0	<0.05

M: male, F: female, CV: cardiovascular, No: number, NS: non-significant

ded before pacemaker implantation, the incidence of abnormal P wave axis and P wave amplitude were similar in the 2 groups. However, P wave duration was greater in group A than group B (127.6±24.8 ms vs. 110.7±17.0 ms, $p<0.05$) (Table 2).

DISCUSSION

Cardiac pacing therapy is a mainstay in the treatment of symptomatic or severe bradyarrhythmia due to sinus node dysfunction or AV conduction disturbance. It has been shown that the permanent pacemaker significantly decreases the morbidity and mortality of SSS and AVB^{1, 5)}. The implantation of a permanent cardiac pacemaker is widely performed in many secondary or tertiary hospitals since the first permanent cardiac pacemaker was implanted in Korea in 1968⁴⁻¹²⁾. In recent days, the improvement of technology makes available highly sophisticated cardiac pacemakers that automatically regulate cardiac pacing according to metabolic demands of patients as the normal sinus node do.

AF, an irregular and very rapid atrial tachyarrhythmia, evokes hemodynamic and thromboembolic complications due to rapid and irregular ventricular rhythm and a loss of atrial mechanical contraction. In addition, AF in patients with atrial tracking dual chamber pacing mode such as DDD or VDD may provoke serious problems by trig-

ering irregular and rapid ventricular pacing. Those pacing modes with atrial tracking function should be changed into VVI if AF develops de novo after implantation of pacemakers, and dual chamber pacing with atrial tracking function should be avoided in patients with persistent AF. Thus, AF is a very important arrhythmia in candidates for pacemaker implantation as well as in patients with pacemakers, and determination of risk factors for AF is very useful to develop preventive measures and to guide pacing therapy³⁾. Previous studies have suggested that the development of AF in patients with cardiac pacemaker is mainly influenced by underlying arrhythmia¹⁴⁻¹⁷⁾.

This study was performed to determine risk factors for AF in patients with VVI pacemakers for SSS or significant AVB. Our study suggests that SSS as an underlying arrhythmia and prolongation of P wave are risk factors for AF.

In our study, AF developed de novo in 13 (16.3 %) of 80 patients with VVI permanent pacemakers during the follow-up period. The incidence of AF in SSS was 26.8% and 5.6% in AVB. This significantly higher incidence of AF in SSS was consistent with the previous studies. Grimm et al.¹⁸⁾ reported that AF was more frequent in patients with SSS than in patients with AVB. The development of AF, in patients with VVI pacemakers, is thought to be related to excessive loading of the atria, due to dissociation between

atrial and ventricular contractions, or atrial contraction against the close AV valves, due to retrograde conduction of paced ventricular impulses to the atria, and development or progression of atrial disease itself^{4, 19, 20}. Therefore, the higher incidence of AF in SSS than in AVB may reflect that SSS is more frequently associated with atrial disease and AVB with retrograde ventriculo-atrial conduction block. Several studies have shown that DDD or AAI pacing has less chance to have AF during the follow-up than VVI pacing²¹⁻²³. DDD or AAI pacing is preferable to VVI pacing, particularly in high risk patients for AF, for lowering the incidence of AF after pacemaker implantation.

This study demonstrated that intra-atrial conduction delay is also a risk factor for AF. Snoeck et al.²¹ reported that the future occurrence of AF could be predicted by P wave recorded before pacemaker implantation, and AF was hardly induced in patients with the width of the widest P wave less than 100 msec. In our study, the width of P wave in patients with AF was significantly wider than that in patients without AF (127.6 ± 24.8 ms vs. 110.7 ± 17.0 ms). But, the electrical axis and the amplitude of P wave were similar whether AF developed or not. Our observation that P wave duration, reflecting intra-atrial conduction time, is a risk factor for AF is not unusual in that AF is induced and maintained by 4-6 reentrant wavelets in the atria and conduction delay, in addition to unidirectional block, is a prerequisite for reentry. Recently, signal-averaged P wave duration, which is measured by the signal-averaging technique of P wave, has been proposed as a rapid and noninvasive marker of AF²⁴. Atrial dilatation is known to be a risk factor for AF. So, we examined the left atrial size using M-mode echocardiography under the guidance of 2-dimensional echocardiography. However, contrary to our expectation, left atrial size was not significantly different between patients with and without AF. This finding suggests that atrial size does not influence atrial vulnerability to AF until it reaches a certain degree.

In conclusion, the risk factors for atrial fibrillation in patients with VVI pacemakers are sick sinus syndrome and intra-atrial conduction delay. Further

studies are needed to determine how sick sinus syndrome and intra-atrial conduction delay increase the risk for AF in patients with VVI pacemakers.

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