Efficacy of Consistent Atrial Pacing Algorithm for Suppression of Atrial Arrhythmias in Patients With Sick Sinus Syndrome and Atrial Fibrillation

Yuko MIKI,1 MD, Toshiyuki ISHIKAWA,1 MD, Noriko INOUE,1 MD, Youhei YAMAKAWA,1 MD, Tsukasa KOBAYASHI,1 MD, Kohei MATSUSHITA,1 MD, Katsumi MATSUMOTO,1 MD, Minoru TAIMA,1 MD, Masami KOSUGE,1 MD, Shinichi SUMITA,1 MD, Kazuaki UCHINO,1 MD, Kazuo KIMURA,1 MD, and Satoshi UMEMURA,1 MD

SUMMARY

Atrial overdrive provides the best opportunity to suppress atrial arrhythmias. Atrial preference pacing (APP) algorithm has been designed to achieve a high percentage of atrial pacing. The aim of this study was to assess the efficacy of APP algorithm in patients with implanted pacemakers and tachycardia-bradycardia syndrome.

The subjects were 17 patients (mean age, 71.7 ± 9.0 years old, 4 males) implanted with a DDDR pacemaker Thera DR (Medtronic, Minneapolis, MN, USA). All patients had sick sinus syndrome and paroxysmal atrial fibrillation before pacemaker implantation. Informed consent was obtained from each participant before enrollment. DDDR and mode switch or APP were randomly programmed. After two weeks, the pacing mode was switched to another mode. The percentage of atrial pacing was significantly higher in APP than in DDDR (97.7 ± 1.4 versus 52.3 ± 30.8, P < 0.0001). Atrial premature beat counts were significantly greater in DDDR than in APP (30689 ± 42534 versus 7717 ± 10700, P < 0.005). There was no significant difference in mode switch episode counts between DDDR and APP (2.6 ± 5.5 versus 8.4 ± 19.2, NS).

Although there was no significant difference in mode switch episode counts between DDDR and APP, APP algorithm can successfully prevent atrial premature beats in patients with tachycardia-bradycardia syndrome. (Int Heart J 2008; 49: 273-280)

Key words: Atrial preference pacing (APP) algorithm, Atrial arrhythmias, Atrial pacing, Atrial premature beat, Premature atrial complexes (PACs), Tachycardia-bradycardia syndrome, Sick sinus syndrome, Paroxysmal atrial fibrillation, Mode switch, DDDR pacemaker, Holter function

ATRIAL fibrillation (AF) is a highly prevalent arrhythmia and a recognized risk factor for stroke and excess mortality. In patients with permanent pacemakers, AF

From the 1 Department of Medical Science and Cardiorenal Medicine, Yokohama City University School of Medicine, Kanagawa, Japan.
Address for correspondence: Yuko Miki, MD, Department of Medical Science and Cardiorenal Medicine, Yokohama City University School of Medicine, 3-9 Fukaura, Kanazawa-ku, Yokohama 236-0004, Japan.
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is also an important cause of morbidity and mortality.\textsuperscript{1} As some studies have showed, atrial pacing in itself might play a role in the prevention of AF.\textsuperscript{2} There is evidence that atrial pacing in pacemaker patients reduces the incidence of atrial tachyarrhythmias compared to VVI pacing.\textsuperscript{3-5} Moreover, in a recent study rapid atrial pacing was found to be slightly more beneficial for preventing AF than the usual rate of 60 bpm.\textsuperscript{6} These findings may be related to a reduction of the effective refractory period.\textsuperscript{7} However, in other reports a pacing algorithm for overdrive suppression prevented atrial ectopic activity but did not change the frequency of sustained AF.\textsuperscript{8,9} Thus, overdrive right atrial pacing has been used to prevent AF, but its efficacy in AF prevention remains uncertain.

Atrial preference pacing (APP) algorithm developed by Medtronic Inc. (Minneapolis, MN, USA) allows the pacemaker to maintain the pacing rates slightly higher than the sinus rates, and was designed to achieve a high percentage of atrial pacing. This software can be downloaded into the pacemaker memory. However, there is still no consensus with regards to the evaluation to APP. We attempted to investigate the efficacy of the APP algorithm at suppressing the incidence of atrial tachyarrhythmias. The aim of this study was to assess the efficacy of APP algorithm in patients with implanted pacemakers and AF. If successful, the therapy could reduce the number of PACs, as well as the burden and frequency of atrial tachyarrhythmias.

**METHODS**

The trial was performed as a one-center study at Yokohama City University Hospital, Yokohama, Japan. The subject population consisted of 17 patients (mean age, 71.7 ± 9.0 years old, 4 males) with a DDDR pacemaker Thera DR (Medtronic Inc. Minneapolis, MN, USA). All patients had sick sinus syndrome and paroxysmal atrial fibrillation before pacemaker implantation and were not administered an antiarrhythmic agent. There were 4 patients with IHD, 2 with valvular heart disease, and 5 with hypertension. Informed consent was obtained from each participant before enrollment. DDDR and mode switch or APP were randomly programmed. The detailed APP algorithm was described previously as a consistent atrial pacing.\textsuperscript{10} APP algorithm downloaded into the pacemakers provides continuous overdrive pacing at rates slightly above the patient’s intrinsic rate. The algorithm increases the pacing rate whenever an intrinsic beat occurs and then decreases the pacing rate to search for intrinsic beats. Following a non-refractory atrial sense, the pacing interval is decreased by a programmed interval “CAP AS Delta”. This continues until pacing is achieved. After a programmed number of atrial pace “CAP/ARS Search Beats” have occurred, the pacing interval is increased by the programmed interval “CAP AP Delta”. This increase will
occur after each number of “CAP/ARS Search Beats” until a nonrefractory sense occurs, at which time the pacing interval will be decreased by programmed interval “CAP AP Delta”. The lower rate was set at 70 beats/minute. After two weeks, the pacing mode was switched to another mode. The percentages of atrial pace, premature beat counts, and mode switch (> 15 seconds) episode counts were determined.

Measured variables are expressed as the mean ± SD. The changes in given parameters in the same patient were analyzed using the paired Student’s t-test. P values < 0.05 were considered to be significant.

RESULTS

Percent atrial pacing was significantly higher in APP than in DDDR (97.7 ±

![Atrial Pace%](image)

**Figure 1.** Atrial pace % in DDDR and in CAP. In CAP, atrial pace % was significantly higher than in DDDR.
Figure 2. Premature beat count in DDDR and in CAP. In CAP, the premature beat count was significantly reduced compared to DDDR.

Figure 3. Mode switch episode counts > 15 seconds in DDDR and in CAP. There was no significant difference between the two pacing techniques.
Figure 4. Mode switch duration in DDDR and in CAP. There was no significant difference between the two pacing techniques.

Figure 5. Premature beat count in 80 ppm overdrive pacing and in CAP. There was no significant difference compared to 80 ppm.
1.4 versus 52.3 ± 30.8, \( P < 0.0001 \)) (Figure 1). Atrial premature beat count was significantly greater in DDDR than in APP (30689 ± 42534 versus 7717 ± 10700, \( P < 0.005 \)) (Figure 2). There was no significant difference in the number of mode switch episode counts between DDDR and APP (2.6 ± 5.5 versus 8.4 ± 19.2, NS) (Figure 3). There was no significant difference in mode switch duration in DDDR and in APP (2930 ± 7971 seconds versus 18,957 ± 33,669 seconds) (Figure 4).

There was no significant difference in premature beat count in 80 beats/minute overdrive pacing and in APP (Figure 5).

**DISCUSSION**

In the present study we utilized the Holter function of pacemakers to analyze mode switch episode counts, mode switch duration, premature beat counts, and atrial pace. There have been no studies of AF preventive algorithms that demonstrated AF suppression with the Holter function of pacemakers.

It was reported in the Atrial Dynamic Overdrive Pacing Trial (ADOPT) that overdrive atrial pacing with the AF suppression algorithm decreases symptomatic AF burden in patients with sick sinus syndrome and paroxysmal AF.\(^{11}\) In the ADOPT study, only patients who had symptomatic AF and not those who had asymptomatic AF were examined. However, in our study patients who had not only symptomatic AF but also asymptomatic AF were enrolled. The difference in efficacy with AF suppression algorithm between these studies may be explained in terms of the presence of patients with or without symptoms.

It was reported that the PAC number increases significantly before AF.\(^{12-15}\) The increased number of PACs by itself provokes a dispersion of atrial refractoriness and conduction velocities, and this could cause the onset of AF.\(^{16}\) Pacing algorithms to prevent PAF are mainly based on the suppression of premature atrial complexes (PACs), which play an important role in its initiation. The APP algorithm has been designed to achieve a high percentage of atrial pacing as a means to suppress atrial arrhythmias. Atrial overdrive proposes that the combination of an atrial paced complex and stable atrial rate provide the best opportunity to suppress atrial arrhythmias by prediction of dispersion of atrial refractoriness and suppression of PACs. In the present study, PACs were reduced by APP algorithm but AF was not inhibited fully. There have been previous studies on APP algorithm. One study reported that PACs were reduced, while AF burden and AF episodes were not reduced by addition of the APP algorithm.\(^{17}\) In another study, PACs were critically decreased and AF episodes were reduced by the addition of APP algorithm.\(^{18}\) The results of the efficacy of APP algorithm were not consistent among these studies. One reason is believed to be that PACs are not the only trigger of AF. If the mechanisms of initiation of AF are unrelated to PACs, AF
might not be suppressed. A study that examined the initiation of AF reported that PACs were related to the onset of AF in only 43% of the patients, while the onset was related to bradycardia in 22% and to reinitiation in 27% of the episodes.\footnote{19} The proportion of initiations in AF related to PACs might be different among these studies in APP algorithm. It is not certain if the Holter function of pacemakers is reliable. Another reason is that the number of patients in the present study was limited, and differences in substrate in the atrium may be related to this.

**Conclusion:** Although there was no significant difference in the mode switch episode counts between DDIR and APP in our study population, APP algorithm can successfully prevent atrial premature beats in patients with tachycardia-bradycardia syndrome.

**Study limitations:** Only a small number of patients were enrolled in the present study and observations were only conducted for one month. A randomized control study in a larger number of patients and with a longer observation period may be required.

**REFERENCES**