Atrial Demand Pacing in Patients with Symptomatic Sick Sinus Syndrome

Wen Lieng Lee, M.D., Chi Woon Kong, M.D., Jiann Jong Wang, M.D., Wan Leong Chen, M.D., Shih Pu Wang, M.D., and Mau Song Chang, M.D.

Summary

Atrial demand pacing provides a physiological, simply implemented, and less costly alternative of cardiac stimulation in symptomatic sick sinus syndrome (SSS) patients. Hindrance from widespread use stems mainly from the potential development of high degree AV block and persistent atrial fibrillation. A reappraisal of atrial pacing is now justified as we gain more clinical information. In this study we examined retrospectively the clinical course of 22 well-selected SSS patients paced in AAI mode for 30±29 months. Two patients had infrequent short-run atrial tachyarrhythmia before implantation. There was an early lead dislodgement which required repositioning later. Three acute threshold increments were noted which necessitated a change in atrial pacing site in one and short-term steroid use in the other two. No other sensing, pacing or operative complication occurred and all pacing systems performed well. All patients survived during follow-up and no patient developed congestive heart failure, though depressed left ventricular function was found in three preoperatively. No high degree AV block was encountered. Four patients presented paroxysmal atrial fibrillation (PAF) 25±16 months after the procedure, of whom one developed chronic atrial fibrillation. No single factor predicted the development of PAF. Resumption of normal pacemaker function always occurred immediately in the pause following cessation of PAF and no revision of pacing mode was required in the patient with chronic AF. Symptomatic relief was obtained in all patients. In summary, single chamber, single rate atrial pacing remains a physiologic, reliable, economic and easily implemented pacing modality affordable to a number of sick sinus patients. Maintenance of atrial pacing is feasible in the presence of paroxysmal/chronic atrial fibrillation. (Jpn Heart J 35: 625–633, 1994)

Key words: Atrial pacing AAI Sick sinus syndrome Paroxysmal atrial fibrillation

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PATIENTS with symptomatic sick sinus syndrome (SSS) constitute almost half of the population demanding permanent pacemakers. The majority of these patients were paced in the ventricular inhibited (VVI) mode, while some received AV sequential (DDD) pacemakers. Though dual chamber pacemakers provide better hemodynamics, exercise tolerance, and sense of well-being, they are procedurally more complicated, more costly and require more attention to re-programming in the presence of newly developed atrial tachyrhythmia. Single chamber, single rate, atrial demanding pacemakers (AAI) preserve AV synchrony in symptomatic sick sinus syndrome and provide an attractive alternative mode of cardiac pacing in suitable patients, avoiding the disadvantages of ventricular inhibited pacing such as loss of atrial kick and production of pacemaker syndrome. In patients with normal A-V conduction who are paced in DDD mode for SSS, the basic stimulation was still of the AAI mode. Ventricular demand pacemakers are indicated in patients with persistent frequent paroxysmal atrial tachyrhythmia, debilitated from disease and/or with limited life expectancy as they adversely affect hemodynamics and invite more congestive heart failure. However, considering the possibility of atrial lead dislodgement, exit block, sensing failure, occurrence of atrial fibrillation and future progression of atrioventricular conduction block, atrial demand pacemakers are used in only a minority of symptomatic sick sinus syndrome patients. A reappraisal of the simply implemented, single chamber, less costly, atrial inhibited pacemakers is now justified due to a more detailed knowledge of the natural history of sick sinus syndrome, better design in the atrial lead, use of steroid-tipped leads, and economic considerations. This study was designed to examine retrospectively the clinical outcome of our symptomatic patients paced for sick sinus syndrome in the AAI mode for a mean follow-up of 30 ± 29 months after implantation and to corroborate the feasibility of maintaining atrial pacing in the presence of paroxysmal/chronic atrial fibrillation.

METHOD AND MATERIAL

From January 1986 to November 1993 there were a total of 119 patients with documented symptomatic sick sinus syndrome who received permanent pacemakers in Veterans General Hospital, Taipei. Patients presenting with frequent attacks of tachy-bradycardia syndrome, more than two episodes of atrial tachyrhythmia of longer than five minutes duration on 24-hour ambulatory ECG recording, complete bundle branch block on surface ECG, or bradycardia due to carotid sinus hypersensitivity were excluded from receiving AAI pacemakers. A total of 22 eligible patients were paced in the atrial inhibited mode in this period and were included in this study. Of these, two had short-run atrial tachyrhythmia
on Holter monitor before implantation. Pre-operative electrophysiologic studies were performed on all 22 patients, and all had an AV conduction Wenchebach point at or shorter than 450 ms. None of their His-ventricular conduction times were longer than 55 ms. There were 14 males and 8 females with a mean age of 67 ± 8 years (range 44–78). The indication for pacing was bradycardia-related dizziness and general malaise in 20 and syncope in 10 patients. Coronary heart disease was found in 3 patients of whom two had previously undergone coronary bypass surgery. Nine had systemic hypertension. None of them had clinical manifestations of congestive heart failure. Depressed left ventricular function was found in three (patients 8, 14, 16). During the implantation procedure, atrial leads were inserted via the left cephalic or subclavian vein and positioned in the right atrial appendage. Nineteen received active fixation (screw-in) leads, and the other 3 passive fixation (tined) leads. Steroid-tipped leads were used in two patients, while unipolar atrial leads were used in 15. Mean pacing threshold was 0.8 ± 0.3 V at a pulse width of 0.5 ms and the P-wave amplitude was 3.8 ± 1.2 mv. After three more days in the hospital, patients were discharged and followed up at 1, 3 and 6 months intervals and twice annually thereafter at the pacemaker clinic. Each follow-up consisted of a detailed history taking, ECG rhythm strip and a 24-hour ambulatory ECG recording if clinically indicated by dizziness or discomfort thought to be related to cardiac rhythm disturbance.

Results

No patient was lost to follow-up during a period of 30 ± 29 months (range 3–96 months) (Table). All patients survived during this period. One atrial lead dislodgement occurred one day after the implantation procedure and required lead repositioning on the third day (patient 14). Acute threshold increment was noted in three patients, which necessitated a change in atrial pacing site in one patient (patient 18) and short term steroid use in the other two (patients 12, 13). No further pacing or sensing problem occurred in these four patients. No early or late operative complication was found in the other 18 patients. Symptomatic relief of dizziness and syncope was obtained in all 22 patients, though nonspecific dizziness not related to bradyrhythmia persisted in two patients. None of these 22 patients exhibited newly developed congestive heart failure. Transient nocturnal type I second degree AV block was noted on 24-hour ambulatory ECG recording in one patient five months after implantation. This patient remained asymptomatic in daily activities and no further deterioration in AV conduction occurred (patient 19). No high degree AV block was encountered. Paroxysmal atrial fibrillation (PAF) developed de novo in four of these patients 25 ± 16 months (range 3–39 months) after the procedure, with repetitive episodes occurring in
Table. Patient Characteristics

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<th>Age</th>
<th>PAF*</th>
<th>Syncope</th>
<th>Associated diseases</th>
<th>Threshold (in V)</th>
<th>P-ampl. (in mV)</th>
<th>Follow-up (months)</th>
<th>Onset-time (months)</th>
<th>Chronic AF</th>
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CAD = coronary artery disease; DM = diabetes mellitus; DVT = deep vein thrombosis; HTN = systemic hypertension; Meta Ca = metastatic carcinoma; PAF* = paroxysmal atrial fibrillation before implantation; PSVT = paroxysmal supraventricular tachycardia; SLE = systemic lupus erythromatosus

three. In one patient chronic atrial fibrillation persisted after a five-month period of frequent newly developed PAF, despite class Ia antiarrhythmic agent. In this patient ventricular response during chronic atrial fibrillation was adequate, and pacing spikes were seen intervening in the atrial fibrillatory activities on the rhythm strip due to undersensing. No mode revision was required. No atrial flutter was found. During the PAF events, resumption of effective pacemaker function always occurred in the pause immediately following cessation of the atrial fibrillatory activities (Figure). No patient ever experienced symptoms in the time spanning episodes of PAF. In these four patients, the P-wave amplitude was $3.7 \pm 1.3 \text{ mV}$ during implantation, the same as those without PAFs, and no evidence of P-wave undersensing was identified on any rhythm strip or 24-hour ambulatory ECG recording. The mean age of the patients was 69 ± 7 years, also similar to that of the patients without atrial fibrillation. The occurrence of paroxysmal atrial fibrillation could not be predicted by pre-operative PAF since none of the episodes were preceded by PAF before pacemaker implantation and nei-
Figure. In this two-channel 24-hour ambulatory ECG recording (modified V5 and V1 leads), atrial fibrillation with mild rapid ventricular response was seen in the initial nine beats (upper panel). There was atrial undersensing at the end of atrial fibrillation as evidenced by the first pacing spike which, however, is located in a period just following cessation of atrial fibrillation and invoked an atrial contraction. Normal pacing rhythm started thereafter.

ther of the patients presenting short-run PAF initially developed PAF during follow-up.

No patient suffered from cerebral vascular accident or peripheral embolism during the follow-up period and no active anticoagulation therapy except aspirin and dipyridamole was administered.

DISCUSSION

In this study we confirmed the applicability of atrial inhibited pacemakers to patients with sick sinus syndrome in the presence of repetitive episodes of newly developed PAF, low incidence of advanced AV block in well selected patients and good hemodynamic outcome. Atrial tachyrhythmias are often present in patients with sick sinus syndrome, either presenting as tachycardia-bradycardia syndrome at initial evaluation or appearing de novo in the natural course of sick sinus syndrome or due to increasing age later on after implantation.8,14 Its occurrence after cardiac pacemaker implantation is strongly predicted by PAF before procedure and the mode of pacing.8-10,15-18 Ventricular demand pacing precipitates chronic atrial fibrillation, cerebral vascular accidents and CHF.15 In patients paced for sick sinus syndrome chronic AF was significantly
lower in those paced in the atrial demand or AV sequential mode than those
paced in the ventricular demand mode.\textsuperscript{11,14,16,17,19-21} This difference was more
evident when comparison was made in patients with documented atrial
tachyrhythmia before implantation. Considering the high incidence of AF in the
natural course of sick sinus syndrome,\textsuperscript{5} atrial pacing was proposed to reduce the
possibility of this untoward entity, especially in those with bradycardia-dependent
atrial tachyrhythmias.\textsuperscript{22} Two of our patients who presented with PAF before
implantation did not develop atrial fibrillation later during follow-up. In the pres-
ence of paroxysmal tachyrhythmia (including AF), frequent reprogramming or
special designs such as automatic mode switch and different upper rates are
needed for dual chamber pacemakers and these devices are more expensive and
less affordable.\textsuperscript{23} However, the presence of PAF does not contraindicate AAI
pacing as was well illustrated in this report and does not require frequent repro-
gramming or special software design. Even development of chronic AF does not
subject the atrially paced patients to a mode change to ventricular demand, as
long as ventricular response is adequate.\textsuperscript{8,10,24} This was shown in one of our
patients. In fact, there are arguments that development of stable AF indicates an
end stage of sick sinus syndrome and provides a self cure of this disease.\textsuperscript{17,25}
However, the development and persistence of atrial fibrillation may still present
an obstacle to maximal medical control of heart rate in the absence of electrical
ventricular support in patients paced atrially only. This is one of the reasons why
AAI pacemakers are not widely used in SSS patients, particularly those with
frequent pre-operative paroxysmal atrial tachyrhythmias.

Another concern in the implementation of atrial inhibited pacemakers is the
possibility of the future development of an AV conduction abnormality. Though
previously reported to exist in a large portion of patients with sick sinus syn-
drome,\textsuperscript{21,26-28} these abnormalities include prolongation of AV conduction time,
bundle branch block, hemiblock and of course high degree AV block. Currently
there is accumulating favorable evidence showing that the occurrence of ad-
vanced AV block is slow and limited to only a minority of patients, and progres-
sion to high degree AV block may be predicted by the presence of an advanced
conduction abnormality in the AV node, prolonged H-V interval on EP study,
complete bundle branch block or bifascicular block at the time of initial evalua-
tion, and sick sinus due to carotid hypersensitivity syndrome.\textsuperscript{8-11,19,29-35} Though it
is influenced by autonomic activity and could not afford an accurate estimation
of future occurrences of AV block, the Wenchebach point remains widely used in
the initial assessment of AV nodal function.\textsuperscript{8,11} The low incidence of AV conduc-
tion abnormality in our well-selected patients is probably due to our strict criteria
in the pre-operative selection of AAI patients.

Though prior studies reported a similar prognosis in those paced
ventricularly compared to those nonpaced,\textsuperscript{36,37} the difference in morbidity and/or mortality between atrially paced and ventricularly paced populations is significant.\textsuperscript{12,19} In patients with sick sinus syndrome and AAI pacing, patient survival approaches that of the normal population.\textsuperscript{8,14,15} In one report DDD pacing reduced patient mortality in those with congestive heart failure compared to patients paced in the VVI mode.\textsuperscript{38}

It thus appears that, whenever feasible, atrial pacing is the preferred way to implement permanent electric stimulation in suitable symptomatic sick sinus syndrome candidates, especially those having signs of heart failure. Single chamber AAI pacing is the least elaborate and most economic choice to obtain the utmost benefits. The most serious limitation is the possibility of future AV block which can be circumvented by implantation of another ventricular lead and changing the mode to dual chamber pacing when it occurs and may be minimized when patients are appropriately screened. It thus appears that AAI pacing can be used in more patients than previously thought.

\textbf{Conclusion:} In patients with infrequent paroxysmal symptomatic sick sinus syndrome, VVI with a low rate and long hysteresis suffices. Among those with frequent paroxysmal atrial tachyrhythmia, VVI, VVIR, DDI or DDIR is suggested. In patients presenting with binodal dysfunction, complete BBB, prolonged H-V on initial EP study, or carotid hypersensitivity, dual chamber pacing (DDD, DDDR, DDI, DDIR) is the mode of choice. In patients with symptomatic sick sinus syndrome with less than frequent atrial tachyrhythmia, single chamber, single rate AAI pacing is a physiological, reliable, easy and less costly practice affordable to a number of selected patients. Atrial pacing is feasible in the presence of paroxysmal atrial tachyrhythmia.

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