Complicated Holter tracing with an incidence of inappropriate mode switch due to sensing abnormalities in a patient with dual-chamber pacemaker

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Abstract
24-hour Holter monitoring of a 59 year-old man with DDDR pacemaker (programmed mode: DDD) implanted for sick sinus syndrome with paroxysmal atrial fibrillation was performed one month after implantation, due to palpitations. Several episodes of rapid pacing of decreasing rate were detected. Intracardiac recording stored in the pacemaker memory had shown episodes of atrial lead oversensing, which led to the mode switch, resulting in DDIR mode. Signals which caused oversensing were not seen in Holter tracing. (Cardiol J 2011; 18, 1: 94–96)

Key words: DDD pacemaker, Holter monitoring, mode switch, atrial oversensing

Introduction
A 59 year-old male patient who had been implanted with the Medtronic Kappa KDR 901 DDDR pacemaker for symptomatic sick sinus syndrome, underwent 24-hour Holter monitoring (24HM) due to palpitations, which occurred one month after implantation, especially when he moved his left arm. Programmed pacemaker (PM) parameters during 24HM are shown in Table 1. 24HM revealed: numerous episodes of atrial fibrillation (AF) lasting from seconds to minutes, with the ventricular rate from about 70 beats/min to 150 beats/min, numerous premature supraventricle complexes and dual chamber pacing — DDD: Ap-Vp and As-Vp.

Several ECG stripes recorded in 24HM monitoring could not be explained with PM programmed parameters. The examples are shown in Figures 1–3. Episodes started from rapid ventricular pacing, which could not be explained by the preceding ventricular rate, or by apparent atrial activity, which potentially might have triggered ventricular pacing. Ventricular pacing was of continuously decreasing rate, and then some beats with sequential pacing started and continued with decreasing rate as well. Episodes ended with the supraventricular (sinus?) beat and with markedly lower heart rate thereafter. In a few episodes, some artifacts difficult to precise analysis could be seen.

The PM was interrogated with a programmer and 12 episodes of the high atrial rate with subsequent mode switch interventions were revealed. Analysis of the stored EGMs showed that detected high atrial rate episodes were actually due to atrial oversensing (Fig. 4). The patient’s description of events suggested that oversensing episodes and
subsequent mode switch interventions were caused by the sensing of the skeletal muscles activity due to the unipolar-sensing programmed device. The decreasing rate of pacing was due to DDIR mode, which is routinely activated in Medtronic DDD pacemakers, as the result of the mode switch intervention, regardless of whether the sensor was activated before the intervention, or not. Since oversensing was caused by the patient’s physical activity, the sensor was activated just after the mode switch, and then (due to the halt of activity) deceleration occurred, resulting in a decrease of the pacing rate.

The problem was solved by reprogramming both atrial and ventricular sensitivity to bipolar. Thereafter, it never recurred.

**Discussion**

Only a few papers have assessed the function of the single and double chamber pacemakers in the early post-implantation period [1, 2]. In the presented

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**Table 1. Pacemaker parameters during Holter monitoring.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>DDD</td>
</tr>
<tr>
<td>Lower rate</td>
<td>60 bpm</td>
</tr>
<tr>
<td>Upper tracking rate</td>
<td>130 bpm</td>
</tr>
<tr>
<td>Paced AV delay</td>
<td>150 ms</td>
</tr>
<tr>
<td>Sensed AV delay</td>
<td>120 ms</td>
</tr>
<tr>
<td>Post ventricular atrial blanking</td>
<td>180 ms</td>
</tr>
<tr>
<td>PVARP</td>
<td>AUTO</td>
</tr>
<tr>
<td>Minimum PVARP</td>
<td>410 ms</td>
</tr>
<tr>
<td>Pacemaker mediated tachycardia intervention</td>
<td>Off</td>
</tr>
<tr>
<td>Mode switch</td>
<td>On, 140 bpm</td>
</tr>
<tr>
<td>Atrial lead amplitude/sensitivity</td>
<td>3.5 V (0.4 ms)/0.5 mV; unipolar/unipolar</td>
</tr>
<tr>
<td>Ventricular lead amplitude/sensitivity</td>
<td>3.5 V (0.4 ms)/2.8 mV; unipolar/unipolar</td>
</tr>
</tbody>
</table>

*PVARP — post ventricular atrial refractory period*

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**Figure 1.** The beginning of the episode, with rapid ventricular pacing in spite of sufficient cardiac automaticity and conduction, then decreasing pacing rate; some inconclusive artifacts preceding the episode and occurring during the first part of the episode can be seen.

**Figure 2.** The beginning of the episode.
case, 24HM was a helpful tool, allowing more ade-
quate programming.

Normally, mode switch is interpreted as a sur-grogate marker of the total AF duration and their re-
currence. However, in our patient it was used in an inap-
propriate manner due to oversensing [3, 4]. It
seems reasonable that in modern PM, sensing in
atrial lead should be bipolar. It has been reported
that oversensing of ventricular far-field signals (tail
end of the QRS complex) represents one the com-
monest causes of false positive mode switching,
whereas this is rarely caused by miopotentials, as
in our case [4].

The additional goal of PM implantation, beyond
treating arrhythmias, is to improve the quality of
life, and in our patient this goal was not achieved
after implantation [5]. Only 24HM and intracardiac
stored electrograms helped to solve the problem
and helped the patient.

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