Rate-Responsive Pacing in Patients with Angina Pectoris

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Summary

One of the most unfavorable condition depending on rate responsive pacing is an inappropriate onset of angina pectoris in patients with concomitant ischaemic heart disease. The goal of the present study is to define the optimal parameters for rate adaptation, to ensure the maximal exercise tolerance and to preserve patients from attacks of angina pectoris. We made a clinical trial on 49 patients (28 male, 21 female, mean age 59 ± 11 and mean NYHA class of angina pectoris 2.8 ± 0.8 in the period between paroxysms of atrial fibrillation, mean follow up 16 ± 8.2 months). All the patients underwent AV-node radiofrequency ablation with consequent VVIR pacemaker implantation with motion activity sensor. According to the age, constitution, NYHA class and primary exercise tolerance basic rate, rate increase, sensor gain and maximum sensor rate (MSR) were adjusted. Preferable MSR was 125. Mean sensor gain 14 ± 6, mean rate increase 3.5 ± 1.8 ppm/s. In the long term follow up period 37 patients exhibited strong improvement of the life quality. Nine patients have not noticed significant changes in their life status. Three patients complained of worsening of their condition. Two of that three had undergone CABG procedure with good results and one died of non cardiac pathology.

Key Words

Rate-responsive pacing, angina pectoris, exercise test

Introduction

Costeas and Schoenfeld [1] have summarized the goal of rate-adaptive pacing as following: "...Because metabolic needs varies with different types of physical and psychological challenge, the heart must provide the appropriate output, not merely the maximum output. This concept of matching just enough cardiac output to the current metabolic needs is intrinsic to the heart's efficiency and to contemporary pacing efforts intended to replicate normal cardiac function."

The roots of activity-controlled pacing date back to the early 1970s [2]. At that time, several groups investigated the possibility of ventilation detection by means of a small piezoelectric sensor placed in the vicinity of the thorax. For practical purposes an intrathoracic implants were not feasible, and an extraventricular sensors yielded a variety of signals with a high component of what was considered to be unwanted noise. The signal representing respiration was found to be of a minor amplitude in comparison to noise. The primary idea of using a piezosensor for detection of ventilation was abandoned. In the early 1980s, the idea of using what was previously considered "a background noise" as an indicator of general body activity was explored and implemented in practice.

In 1987, the possibility of using acceleration forces for rate control was reported [3]. This new principle of pacing was based on the body acceleration due to the movement activity which was detected in the anteroposterior direction by means of a small accelerometer located within the hybrid electronic circuitry inside the pacemaker. Since late 1970s and early 1980s, a variety of sensors have been used for rate-adaptive pacing. Activity-guided rate-adaptive pacing has achieved a wide clinical acceptance as the primary rate-controlling principle.

One of the most unfavorable condition depending on rate responsive pacing is an inappropriate onset of angina pectoris in patients with concomitant ischaemic heart disease. At the high frequency pacing the diastolic time decreases. As the coronary blood flow occurs...
basically during a diastole the increased oxygen
demand versus its inadequate delivery might cause
ischaemia. Despite the advantages of coronary artery
bypass grafting, balloon angioplasty and stenting the
number of patients which are contraindicated for these
procedures on one hand and need for cardiac pacing on
the other hand is still high. Some investigators [4]
consider the coexisting coronary artery disease to be an
"a priori" contraindication for rate-responsive pacing
despite its obvious advantages.
The goal of the present study is to define the optimal
gain, maximum sensor rate) to ensure the maximal
eExercise and to preserve patients from attacks
of angina pectoris.

Methods

Patient Selection
We made a clinical trial on 49 patients (28 male, 21
female, mean age 59 ± 11 and mean NYHA class of
angina pectoris 2.8 ± 0.8 in the period between
paroxysms of atrial fibrillation, mean follow up 16 ±
8.2 months). All the patients underwent AV-node
radiofrequency ablation with consequent VVIR pace-
 maker implantation with motion activity sensor
(Metros TC 01, Biotronik, Germany).

Study

Adjusting the basic rate
The role of basic rate in coronary artery disease pat-
tients is not clear. According to the age, constitution and
NYHA class we primarily used three basic rates (62;
72; and 82 per min) [5]. A week after pacemaker
implantation all patients underwent 24 hours ECG
monitoring. In patients exhibiting ECG signs of angina
pectoris [6] and having basic rate 72 or 82 the latter
was reduced by 10. Moreover, if a patient in a six
months follow up period showed the impairment of life

quality parameters due to ischaemic heart disease the
basic rate was also reduced by 10 if previously has
been 72 or more.

Adjusting the maximum sensor rate (MSR)
The MSR adjustment was carried out after the basic
rate establishment. The most common method of esti-
mating the patient's maximum rate is subtracting the
patient's age in years from 220: age-predicted
maximum heart rate = 220 - age (years) [7]. According
to our experience, this method is not quite appropriate
in patients with CAD as it does not evaluate the coro-
nary artery lesions and LV function. Practically to
define MSR value we had to choose between 100 bpm,
125 bpm and 150 bpm. We used the following algo-

rithm. Firstly, in patients with NYHA class 4 and in
those elder then 70 years of age with NYHA class 2-3
we established the MSR 100 bpm. In all remaining
patients, we established MSR 150 bpm and they under-
went exercise testing.

1. 6 minutes of walking on level ground at a rate of to
steps per seconds.
2. 1.5 minutes of climbing stairs at a rate of one step
per second.
3. 1.5 minutes of descending stairs at a rate of one step
per second.
4. 0.5 minutes of sit-ups at a maximum individual
rhythm.

Heart rate was monitored continuously using portable
pulseoximeter.

Once ECG signs of ischaemia appeared, the exercise
test was stopped and the patient received the MSR no
more than 0.7 of the rate which caused test termina-
tion.

If exercise test termination occurred due to fatigue or
shortness of breath before MSR was achieved, we
changed sensor gain and rate increase in order to reach
MSR more rapidly and vice versa, if MSR was reached
inappropriately fast the sensor gain and rate increase
was adjusted as well.

Table 1. Results of basic rate adjusting.

<table>
<thead>
<tr>
<th>Basic rate</th>
<th>Post operatively</th>
<th>After ECG monitoring</th>
<th>6 months follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>62</td>
<td>16</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>72</td>
<td>29</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>82</td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2. Results of the maximum sensor rate adjusting.

<table>
<thead>
<tr>
<th>Max. sensor rate (bpm)</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>13</td>
</tr>
<tr>
<td>125</td>
<td>32</td>
</tr>
<tr>
<td>150</td>
<td>4</td>
</tr>
</tbody>
</table>
If exercise test was carried out successfully at the MSR 150 bpm, it was repeated the day after at the MSR 125 bpm. Within absence of significant difference, the last meaning remained.

**Results**

The adjustment of the basic rate after 24 h ECG monitoring was necessary in 6 patients. Seven patients demanded basic rate adjustment after 6 months follow up period (Table 1). Preferable MSR was 125 bpm. Mean sensor gain 14 ± 6, mean rate increase 3.5 ± 1.8 ppm/s. In the long term follow-up period, 37 patients exhibited strong improvement of the life quality. Nine patients have not noticed significant changes in their life status. Three patients complained of worsening of their condition. Two of that three had undergone CABG procedure with good results and one died of non cardiac pathology.

**Discussion**

Despite exercise tolerance increasing and improvement of the life quality the VVIR pacing has some limitations and «dark sides».

1. Maximum sensor rate is a fixed value, failing to adjust for disease progression, changes in the hemodynamic state, or variation in the emotional status of the patient. This statement seems obvious, however, we consider that appropriate long term follow up including in time correction of somatic status on one hand and creating a physiological pacemakers adjusting the heart rate not only to emotional changes but to inotropic and metabolic demands of the myocardium on the other hand might maintain the highest possible life quality level [8].

2. Some studies [9] demonstrated that RV apical pacing was associated with reduced local myocardium perfusion at the site of pacing as was detected by TI-201 scintigraphy. These perfusion abnormalities may have been due to alteration in myocardial activation and contraction in RV apical pacing, and the incidence of impaired perfusion increased with time. In the long term, these perfusion deterioration may lead to regional wall motion abnormalities, resulting in impaired global left ventricular function as was noted on radionuclide ventriculography. Unfortunately the lack of long term follow up of the patients with VVIR pacemakers associated with CAD does not permit to draw a conclusion on their mortality, morbidity and quality of life. That is the special field of our scientific interest and demands the further analysis.

**Limitations of the study**

The present study has following limitations:

1. Some points of this article regarding the adjustment of rate responsive settings are presented briefly and are planned to be reported in details in the future.
2. The more accurate approach to the problem demands additional analysis of LV function as well as metabolic parameters of the myocardium.
3. The clinical trial should include not only patients after RFA of His bundle, but all patients with CAD demanding pacemaker implantation.
4. In order to draw a reliable conclusions it is necessary to extend long term follow up.

**References**


