PEDIATRIC ELECTROPHYSIOLOGY

COMPLEX CASE STUDY

Pacemaker Optimization with Forced Ventricular Pacing Improves Cardiac Performance in a Pediatric Patient with First Degree Atrioventricular Block and Right Bundle Branch Block

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ABSTRACT. We present a case of a boy with first-degree atrioventricular (AV) block and right bundle branch block (RBBB) after cardiac surgery for congenital heart disease. He was asymptomatic with NYHA functional class I symptoms but had a suboptimal performance on an exercise test. Our patient responded very well to individualized optimization of pacemaker settings, as seen by improvement of echocardiographic and exercise data.

KEYWORDS. pacemaker, pacemaker optimization, implantable devices, dyssynchrony, postoperative atrioventricular block.

Introduction

Pacemakers are being used more frequently in pediatric patients, most commonly for congenital and postoperative atrioventricular (AV) block. There are few published data regarding the importance of individualizing pacemaker settings. We describe the use of pacemaker optimization in a pediatric patient with first-degree AV block and right bundle branch block (RBBB) after cardiac surgery. Although he was without symptoms and was functional NYHA class I, he had an impaired performance on an exercise test. He demonstrated dramatic improvement in cardiac function and exercise performance with individualization of his pacemaker settings in order to force ventricular pacing.

Case report

This boy, now age 14 years, was born with pulmonary atresia with intact ventricular septum and Ebstein’s anomaly of the tricuspid valve and underwent pulmonary valvotomy at 3 days of age. He then underwent right ventricular outflow tract reconstruction with insertion of a transannular monocusp patch at 6 weeks of age. He remained asymptomatic until approximately 9 years of age, when he developed decreased exercise tolerance. Cardiac magnetic resonance imaging (MRI) at that time showed marked right atrial and right ventricular dilation with significant tricuspid and pulmonary regurgitation and normal left ventricular function. He underwent tricuspid valvuloplasty and resection of tricuspid valve accessory cords, placement of a tricuspid annuloplasty ring, closure of multiple atrial septal defects, insertion of a 25-mm pericardial pulmonary valve, and insertion of a permanent dual-chamber pacemaker with an epicardial right ventricular lead. The pacemaker was placed because of the high risk for AV node injury with this surgical intervention. Postoperatively, he was asymptomatic. Follow-up electrocardiogram (ECG) showed normal sinus rhythm, first-degree AV block with a PR interval of 370 ms and RBBB with a QRS duration of 160 ms (Figure 1).

As part of routine follow-up the patient underwent serial cardiopulmonary exercise tests, which were all done using the standard Bruce protocol. In September of 2010, at age 11 years, an exercise test performed in his intrinsic rhythm demonstrated cardiac limitation to exercise (Table 1).
February of 2011, echo optimization using aortic velocity–time integral (VTI) was performed because of the concern that the patient’s intrinsic rhythm was adversely affecting his hemodynamics. It was found that an atrial sensed and ventricular paced (AsVp) rhythm had improved VTI compared to his intrinsic rhythm. His pacemaker was therefore programmed to a sensed AV delay of 150 ms in order to force ventricular pacing. With ventricular pacing, his QRS duration was also 160 ms (Figure 2). Approximately 1 month later, in March of 2011, the patient underwent a repeat stress test with improved results. The patient remained asymptomatic, but during a routine exercise test in April of 2013, at age 13 years, he had loss of ventricular pacing at a heart rate of 120 bpm. He then remained in his intrinsic rhythm with first-degree AV block and RBBB for the remainder of exercise and into recovery. Results of this study revealed cardiac limitation to exercise (Table 2). Loss of his paced rhythm was felt to be secondary to pacemaker-mediated tachycardia (PMT) intervention, which was therefore inactivated.

Two weeks later, in May of 2013, a repeat exercise test was performed. The patient’s rhythm remained 100% atrial sensed and ventricular paced during exercise with significant improvement in exercise data. Since this pacemaker adjustment, the patient has clinically done well with continued good exercise tolerance.

Discussion

We present a case of pacemaker optimization in a pediatric patient with a DDD pacemaker that was placed during repair of his congenital heart disease. We hypothesized that his markedly prolonged PR interval caused significant AV dyssynchrony and that he was therefore a good candidate for forced ventricular pacing. Optimization of this patient’s settings with forced ventricular pacing resulted in a significant improvement in exercise data. Multiple episodes over time demonstrated reproducible improvement in exercise perfor-

Table 1: Results of serial cardiopulmonary exercise tests showing improvement with change in pacemaker settings to force ventricular pacing

<table>
<thead>
<tr>
<th></th>
<th>September 2010</th>
<th>March 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise Duration</td>
<td>9 minutes 45 seconds</td>
<td>10 minutes 18 seconds</td>
</tr>
<tr>
<td>VO2 max (ml/kg/min)</td>
<td>25.9</td>
<td>40.6</td>
</tr>
<tr>
<td>Percent of predicted VO2 max</td>
<td>54</td>
<td>90</td>
</tr>
<tr>
<td>Rhythm</td>
<td>Intrinsic</td>
<td>AsVp</td>
</tr>
</tbody>
</table>
Pacemaker Optimization with Forced Ventricular Pacing

Figure 2: Electrocardiogram following pacemaker reprogramming. Tracing shows a sensed atrioventricular delay of 150 ms to force ventricular pacing and a QRS duration of 160 ms.

Table 2: Results of serial cardiopulmonary exercise tests demonstrating improvement with pacemaker optimization by disabling pacemaker-mediated tachycardia intervention

<table>
<thead>
<tr>
<th></th>
<th>April 2013</th>
<th>May 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercise duration</td>
<td>9 min 6 s</td>
<td>12 min 29 s</td>
</tr>
<tr>
<td>VO$_2$ max (mL/kg/min)</td>
<td>19.8</td>
<td>28.2</td>
</tr>
<tr>
<td>Percent of predicted VO$_2$ max</td>
<td>43</td>
<td>61</td>
</tr>
<tr>
<td>Rhythm</td>
<td>AsVp at onset, intrinsic during increasing exercise</td>
<td>AsVp</td>
</tr>
</tbody>
</table>

Performance with manipulation of pacemaker settings. The improvement in exercise data is clearly not related to QRS shortening as the patient had a QRS duration of 160 ms in both intrinsic and paced rhythms. This case highlights the effects that optimization of AV synchrony can have, even in a patient with NYHA functional class I symptoms. It also illustrates that a physiologic PR interval with ventricular pacing may be preferable to intrinsic ventricular activation with a suboptimal PR interval in certain patients. Individualization of pacemaker settings for optimal hemodynamics should be considered in all patients with pacemakers and especially those with underlying structural heart disease.

References


