

Intraoperative Pacemaker Rate Changes Associated with the Rest Mode

Scott C. Streckenbach, M.D.*

ANESTHESIOLOGISTS frequently are required to provide perioperative management for patients with cardiac rhythm management devices. Here, I describe a case in which, despite efforts to ensure that the anesthesia care team understood the pacemaker and its settings, unanticipated pacing events occurred that created confusion about the status of the pacemaker in a pacemaker-dependent patient. The confusion was created by a relatively new function found in many current pacemakers, a rest mode.

Case Report

A 72-yr-old woman presented for right-sided breast lumpectomy. She had a right-sided DDDR Pacemaker (Identity ADX XL DR model 5386; St. Jude Medical, Minneapolis, MN), which was placed in 2005 for sick sinus syndrome. According to her preoperative assessment, she was pacemaker dependent. Her most recent interrogation was 6 weeks before the procedure, and everything was acceptable. In the preoperative area, she was connected to a five-lead electrocardiogram, and it revealed a paced rate at 60 beats/min. During interrogation with a St. Jude programmer, the patient had a sinus rhythm at a rate of 39 beats/min. The surgeon needed to use unipolar electrocautery, so the pacemaker was reprogrammed to DOO at a rate of 70 beats/min. The electrophysiology nurse making the changes did not mention the status of the rest mode.

Induction of general anesthesia occurred at 10:43 AM. At 11:07 AM, the pacemaker's rate decreased abruptly to 50 beats/min for approximately 3 min. It returned to 70 beats/min at 11:11 AM for another 2 min and then decreased to 50 beats/min again, before going back to 70 beats/min for the next 15 min. Near the end of the procedure, the pacer rate decreased temporarily to 50 beats/min for another few minutes (fig. 1). Throughout the pacer changes, the blood pressure remained essentially unchanged. No apparent stimulus for the pacer changes was identified.

During a period of time when the pacer was at 50 beats/min, a magnet was applied over the pacemaker to ascertain whether the device was going into a noise reversion mode. The pacemaker responded to the magnet by increasing the paced rate to 98 beats/min as expected for a St. Jude pacemaker, thus ruling out a noise reversion mode. During the case, I called our on-call electrophysiology fellow, who did not have an explanation for what was causing these changes. I then called our St. Jude representative, who suggested that the patient might have a rest mode programmed on. The representative did not believe that the pacemaker was malfunctioning.

* Assistant Professor of Anesthesia.

Received from the Department of Anesthesia and Critical Care, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts. Submitted for publication May 30, 2008. Accepted for publication August 6, 2008. Support was provided solely from institutional and/or departmental sources.

Address correspondence to Dr. Streckenbach: Department of Anesthesia and Critical Care, Massachusetts General Hospital, 55 Fruit Street, Boston, Massachusetts 02114. [sstreckenbach@partners.org](mailto:ssstreckenbach@partners.org). Information on purchasing reprints may be found at www.anesthesiology.org or on the masthead page at the beginning of this issue. ANESTHESIOLOGY's articles are made freely accessible to all readers, for personal use only, 6 months from the cover date of the issue.

In the recovery room, the pacemaker was interrogated by the electrophysiology nurse. Indeed, a rest mode was programmed on and set at a rate of 50 beats/min. The pacemaker was reset to the preoperative settings, and the patient did well postoperatively.

The case was noteworthy not for a negative outcome, but for the distraction the pacing changes caused. We were concerned about the unexpected changes in the paced heart rate in a patient who was relatively pacemaker dependent. We were concerned that the changes might have represented incipient pacemaker malfunction.

Discussion

The rest mode is a program designed to decrease the patient's paced rate when the patient is resting. It attempts to match the typical physiologic decrease in heart rate that occurs during rest or sleep. A slower heart rate at night may be beneficial for diastolic and systolic function.¹ Chew *et al.*¹ showed this in a small study of patients with DDD pacemakers. Patients' hearts were paced for 3 weeks at 80 beats/min and for 3 weeks at 50 beats/min. Diastolic and systolic function was impaired at the higher rate. Presumably, the heart benefits from a period of rest, just like the rest of the body. The patients in this study had normal left ventricular function. The negative effect of not allowing the heart to slow at night may be even more significant in patients with ventricular dysfunction.

The rest mode can also extend pacemaker battery life by decreasing the number of pacing impulses delivered every night. This can decrease the frequency of generator change. And the rest mode may also help patients to sleep better, because activation results in a sensation of a slower heart rate.

The rest mode in a St. Jude Medical pacemaker senses patient activity level 24 h a day using the same accelerometer used for the rate response mode. The accelerometer is situated within the electronic circuitry of the pulse generator. A small mass is suspended on a lever of the accelerometer. On acceleration, this mass deflects the lever by an amount proportional to the change in velocity and the direction of acceleration. Because the pulse generator moves with the patient, the accelerometer detects acceleration or deceleration associated with body motion.

St. Jude Medical's rest mode measures the variance in body motion. Not surprisingly, the variance in activity is much higher in an awake *versus* a resting patient. When the variance falls below a predetermined threshold, the pacemaker lowers the base rate to the programmed rest rate. The rest rate in the St. Jude device requires 15–20

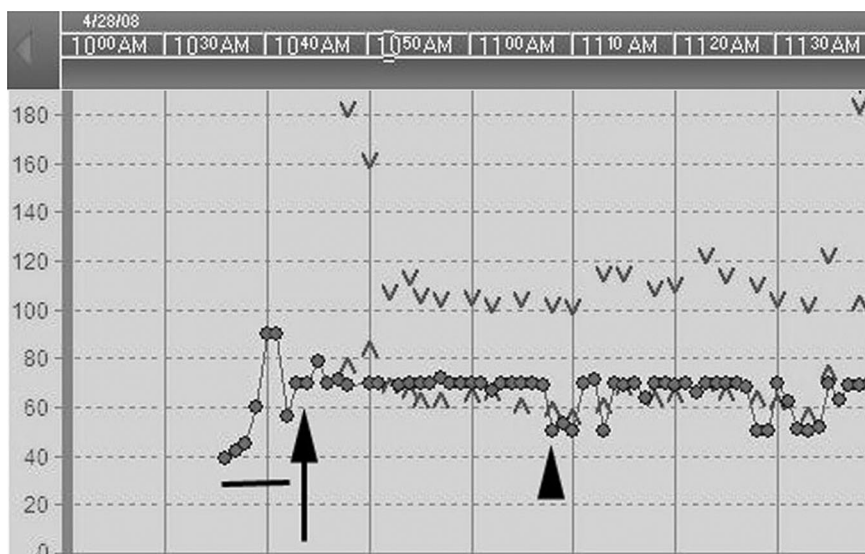


Fig. 1. Intraoperative anesthesia record. *Circles* indicate heart rate. *Line* denotes time when pacemaker was being interrogated. *Arrow* defines induction of anesthesia. *Arrowhead* defines first abrupt decrease in heart rate to 50 beats/min.

min for initial activation. The rest rate is canceled immediately when activity is sensed; pacing resumes at the base rate or sensor-indicated rate if a rate response mode is active. Therefore, if a patient gets up at night to use the restroom, the heart rate increases appropriately. Similarly, if a surgical patient whose rest rate is activated is moved enough such that the activity level exceeds the threshold, the rest mode will immediately terminate. Although I was not able to get specific proprietary algorithm information from St. Jude Medical technical support, it is clear from several studies that the rest rate can be reactivated quickly (much less than 15 min) after its initial activation.²⁻⁴

The rest rate is typically set 10–20 beats/min below the base rate.

We set the base rate for our patient to 70 beats/min preoperatively. When the activity level was reduced for 20 min during prepping, the rest mode activated and the rate decreased to 50 beats/min. Intermittent changes in the paced rate thereafter presumably reflected surgeon-induced motion detected by the accelerometer.

Medtronic (Minneapolis, MN) pacemakers and its next generation of implantable cardiac defibrillators have a feature similar to St. Jude's rest mode, termed a *sleep mode*. Unlike the St. Jude rest mode, the sleep mode works during programmed time periods, typically in the evening. The sleep mode rate is usually set 10–15 beats/min below the lower rate limit. For example, a patient with a sleep mode might have the following settings: DDDR with a base rate of 60 beats/min and a sleep rate of 50 beats/min between 9:00 PM and 5:00 AM. If the patient were pacemaker dependent and pacing at 60 beats/min at 8:59 PM, the rate would decrease to 50 beats/min at 9:00 PM. Currently, Boston Scientific (formerly Guidant, Natick, MA) pacemakers do not have a rest or sleep mode *per se*.

Clinically, the St. Jude rest mode can affect patients in the operating room at any time of the day. Medtronic's sleep mode, on the other hand, will typically only affect patients in the operating room at night. Of course, it is important to recognize that not all devices that have a rest or sleep mode will have that feature programmed on. Knowing that the pacemaker could make abrupt changes in the paced rate should be sufficient to treat a patient. However, if an anesthesiologist would like this function turned off perioperatively, the function can be turned off with a programmer or by applying a magnet. As in our case, it is not disabled by programming the pacemaker to a DOO mode.

To avoid intraoperative distraction, it is important for the anesthesiologist to know whether the pacemaker has a rest or sleep mode programmed on and, if so, what to expect from it. To address this concern, we recently added a question regarding the rest mode to our Pacemaker/Implantable Cardiac Defibrillator Preoperative Evaluation Form (appendix).

St. Jude Medical technical support has not recorded an event similar to the one reported here. However, all of the current St. Jude Medical pacemakers have the rest rate function. A company representative said that many patients have the rest rate mode programmed on. With the large number of pacemakers that are implanted each year, it would be surprising if more events like this do not occur in the future.

In summary, the rest mode on a St. Jude Pacemaker caused several abrupt changes in a patient's heart rate. Although the changes were not hemodynamically significant, they were distracting to the anesthesiologist taking care of the patient. The anesthesiologist should know whether a patient's pacemaker has an active rest or sleep mode and what that mode might do to the pacing rate perioperatively.

References

1. Chew P, Bush D, Engel B, Talan M, Abell R: Overnight heart rate and cardiac function inpatients with dual chamber pacemakers. *Pacing Clin Electrophysiol* 1996; 19:822-8
2. Duru F, Bloch K, Weilenmann D, Candinas R: Clinical evaluation of a pacemaker algorithm that adjusts the pacing rate during sleep using activity variance. *Pacing Clin Electrophysiol* 2000; 23:1509-15
3. Park E, Weienmann D, Block K, Kueffner J, Bornzin G, Candinas R, Levine P: Activity-controlled circadian base rate. *Pacing Clin Electrophysiol* 1998; 21:2182-6
4. Bornzin G, Arambula E, Florio J, Levine P, Hauck G: Adjusting heart rate during sleep using activity variance. *Pacing Clin Electrophysiol* 1994; 17:1933-8

Appendix: Massachusetts General Hospital Department of Anesthesia and Critical Care Pacemaker/Implantable Cardiac Defibrillator Preoperative Evaluation Form

Patient name: _____ Medical record number: _____
 Date of surgery: _____ Type and site of surgery: _____
 Cardiology Office—please complete the following and fax to:
 617-726-4489
 Device type (pacemaker or implantable cardiac defibrillator [ICD]): _____
 Anatomic location: _____
 Manufacturer: _____
 Model #: _____
 Manufacturer recalls: _____
 Indication for insertion: _____

Is the patient pacemaker dependent?
 What is the patient's underlying rhythm?
 Date of most recent interrogation:
 Any abnormal findings?
 Is the battery life adequate?
 Present settings of the pacemaker:
 How will the ICD/pacemaker respond to a magnet?
 If the device is an ICD, can the pacemaker be reprogrammed to DOO or VOO?
 If there is a rate response mode active, what is the physiologic sensor?
 Is there a mode switch active for atrial fibrillation? If yes, what will the pacer do?
 Does the pacemaker have a sleep/rest mode activated?
 What will happen to the device if it converts to the noise reversion mode?
 Name and number of patient's cardiologist:

Main or fax number 617-726-1643
 Boston Scientific Tech Support 800-227-3422
 St. Jude Medical Tech Support 800-722-3774
 Medtronic Tech Support (Pacers) 800-505-4636
 Medtronic Tech Support (ICDs) 800-723-4636

Used with permission from Massachusetts General Hospital, Boston, Massachusetts.