Monitoring equipment induced tachycardia in patients with minute ventilation rate-responsive pacemakers

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Minute ventilation-sensing pacemakers enable the paced heart to respond to an increased workload. Two patients with such a pacemaker developed pacemaker-driven tachycardia when connected to an electrocardiogram (ECG) monitor also capable of documenting ventilatory frequency and ECG lead disconnection. This tachycardia stopped when the ECG leads were removed. These pacemakers and monitors emit a low-amplitude electrical current and measure the resultant impedance signal across the chest. When patients are connected to the monitor the pacemaker sensor summates both impedance signals and the paced heart rate is increased as a result.

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With their ability to vary the heart rate with changes in minute ventilation, minute ventilation rate-responsive pacemakers enable the paced heart to mimic the normal cardiac response to increased workload.1 To date this has been one of the most successful physiological sensors in enabling the cardiac output to be increased proportionally with workload. These pacemakers have been documented to improve patient exercise tolerance and well-being. Minute ventilation is calculated by detecting changes in transhoracic impedance derived from low-amplitude electrical pulses from the pacemaker. Such impedance plethysmography is also used to enable display of the patient’s ventilatory frequency and detect disconnection of the electrocardiogram (ECG) by monitors used in the operating suite and intensive care unit. Recently we encountered two patients; both of whom had a specific type of minute ventilation rate-responsive pacemaker who developed inappropriate paced heart rate increases when connected to such a monitor used in our operating room recovery unit. This communication describes what happened and discusses the appropriate management of patients fitted with such pacemakers.

Case reports

The first patient, a 73-yr-old man, had a Telectronics Meta 1254 minute ventilation rate-responsive pacemaker implanted 5 yr previously after complete heart block developed following radiofrequency ablation for chronic atrial fibrillation. In the operating room he underwent uneventful dental extraction under general anaesthesia comprising a propofol induction and anaesthetic maintenance with sevoflurane, nitrous oxide and oxygen, and minimal amounts of fentanyl.

The second patient was a 77-yr-old man who was implanted with the same brand of pacemaker for complete heart block secondary to ischaemic heart disease. To evaluate a possible recurrence of his prostate cancer he underwent a transrectal needle biopsy of the prostate and cystoscopy under sedation using fentanyl, midazolam and propofol.

Our cardiac monitors in the operating rooms do not use impedance plethysmography, and both patient’s heart rates were pacemaker controlled at 60–70 beats per min during the procedures. The Hewlett-Packard (Burlington, MA, USA) Omnicare cardiac monitors in our postoperative recovery room do use impedance plethysmography. Immediately upon ECG lead connection to this monitor, both patients’ paced heart rate rapidly increased to 120 beats per min. Immediate access to a pacemaker interrogator with the first patient revealed that this upper rate pacing was controllable by altering the pacemaker settings. Disconnection from the monitor resulted in the paced heart rate in both patients decreasing to their baseline rate. Neither patient sustained harm from this transient iatrogenic increase in heart rate (Fig.1).

Discussion

The Telectronics Meta 1254 minute ventilation rate-responsive pacemaker (Telectronics has recently been purchased by St Jude Pacing Company, Sylmar, CA, USA) was
Minute ventilation rate responsive pacemakers also produce myocardial ischaemia and haemodynamic compromise. If this potential is recognized before the patient is connected to such monitors, reprogramming the pacemaker to a non-rate-adaptive pacing mode would avoid inappropriate sensor-driven pacing. When such preventative management has not been used and tachycardia on connection to the monitor does occur, as happened in our patients, the correct treatment is to remove and disconnect the monitor.

This potential problem has been recognized and documented previously, and the Federal Drug Administration (FDA) has recently issued an advisory notice to manufacturers of monitoring equipment. We have informed the Medical Devices Agency of the UK Department of Health about our experience. It is important that physicians working with such patients in the operating suite and ICU be familiar with this scenario. These previous reports, like ours, documented the problem with the Telectronics pacemaker, and to date, this has not been reported with similar pacemakers produced by other manufacturers. Other devices using electrical impedance plethysmography, such as echo-cardiography equipment, apnoea monitors and external defibrillators, could potentially exert a similar effect on the function of these pacemakers. Because these pacemakers function by their ability to detect and process voltage changes, they are also vulnerable to other externally produced currents, produced, for example, by electrocautery and radio frequency catheter ablation. Controlled manipulation of the patient’s minute ventilation has also been reported to produce unwanted change in heart rate with these pacemakers.

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