Severely malfunctioning defibrillator with cardiac resynchronization therapy showing no abnormalities during testing with the programming head in place

Preben Bjerregaard1* and Timothy Brown2

1Department of Cardiology, VA Medical Center, 915 N Grand, St Louis, MO 63106, USA; and 2Medtronic Inc., Minneapolis, Minnesota, USA

* Corresponding author. Tel: +1 314 2896445, Email: preben.bjerregaard@va.gov

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Case report

In June 2005, a 78-year-old man with complete AV block and junctional escape rhythm in the setting of idiopathic cardiomyopathy with NYHA class III symptoms underwent a pectoral implantation of a Model InSync Maximo 7303 (Medtronic, Inc., Minneapolis, MN, USA) dual chamber implantable cardioverter defibrillator with cardiac resynchronization therapy (CRT-D).

The LV lead was placed in the great cardiac vein.

In June 2007 at a clinic visit, the Cardiac Compass Trends Report showed that an abrupt change had taken place on 1 December 2006 (see August 2007 Cardiac Compass Trends Report, Figure 1). From only a few per cent previously, atrial pacing was now 100%, resulting in DDD pacing at a constant rate of 60 bpm, and based upon the activity indicator, a decline in patient activity. The patient was complaining of fatigue and dyspnoea on exertion, but no dizziness or syncope. A decision to turn rate responsiveness on resulted in a return to the previous level of physical activity and an increase in the heart rate as evidence of at least intermittent ventricular capture. The daily automatic impedance measurements were all normal and stable, but there were no P wave amplitude measurements after 1 December 2006. Whether atrial pacing (competing with spontaneous sinus rhythm) was intermittently captured or atrial exit block was present cannot be derived from the ‘Cardiac Compass’ data. The thresholds for pacing were always low.

Figure 1 Cardiac Compass Trends Report from the ICD August 2007 showing an abrupt change in per cent pacing/day in the atrium from approximately 7 to 100 on December 2006 followed by constant AV pacing at 60 bpm until July 2007 when rate response was turned on (see text for more details).
during clinic visits, and the device outputs were kept at least twice the voltage threshold for pacing. No acoustic alert had been activated.

In August 2007 during echocardiography, which had been requested because of increased dyspnoea on exertion, a 12-lead ECG showed incomplete entrance block and complete exit block on the atrial level, and entrance block and inconstant right and left ventricular exit block on the ventricular level (Figure 2). The astonishing observation in the ECG was a complete normalization of sensing in the atrium and of pacing in all three chambers the moment the programming head was positioned over the device and telemetry established (Figure 3). A 24 h Holter without the programming head in place showed constantly changing patterns of erratic pacing and sensing. The CRT-D was replaced the following day.

Device analysis

Initial bench testing by the manufacturer with the programming head over the device and a 500 V load connected across the ventricular pacing output programmed at 6 V and 1.5 ms showed an output with an amplitude of 5 V instead of 6 V, which was programmed. When the programming head was removed, the pulse amplitude gradually diminished. Upon opening of the titanium can for further testing, a power-on-reset (an automatic device operation to recover from a disruption in device memory and control circuitry; parameters will be set to electrical reset values specific for each device) occurred, and the failure cleared. Several procedures were exercised to re-introduce the original failure, but all were unsuccessful.

Discussion

Despite a mean annual ICD malfunction rate ranging from 7.9 to 38.6 per 1000 implants, only a few case reports showing some of the manifestations of a malfunctioning ICD have been published and ours is the first of the type shown in this paper and the first of a CRT-D. It illustrates the possibility of concealment of malfunctioning pacing/sensing function of an ICD when telemetry is established by placing the programming head over the device. A surface ECG without the programming head in place led in our case to the

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**Figure 2**: Twelve-lead ECG (August 2007) without programming head in place over the device. The ventricular rate is only 40 bpm despite a lower rate of pacing of 60 bpm. There is atrial entrance block. None but one of the P waves appears to be sensed (the first P wave after the second paced QRS appears to inhibit atrial pacing). None of the atrial stimuli appears to be captured (the third stimulus coincides with a spontaneous P wave) and hence complete atrial exit block is present. The first spontaneous QRS does not initiate a VA interval, indicating ventricular entrance block. Out of nine ventricular stimuli, four clearly produce ventricular depolarization, but with different paced QRS morphologies, indicating presumed biventricular capture of only two stimuli and RV capture after two stimuli. In contrast, two stimuli occur directly before an intrinsic ventricular depolarization and three are obviously not capturing (one stimulus is seen at the end of a T wave and possibly within the ventricular refractory period).
diagnosis, mainly because the patient was constantly being paced. In situations where a patient would not be paced, even a surface ECG would not have been able to reveal the problem. In order to be well guarded against failing to detect such a problem during a clinic visit, it is, therefore, important to always record a surface ECG without the programming head in place over the device programmed in such a way that pacing is taking place. In patients without the need for pacing, such a malfunctioning would be difficult to detect otherwise and could remain unnoticed for a very long time. In retrospect, the sudden changes in the Cardiac Compass Trends Report should, in our patient, have led to further scrutiny of the patient’s symptoms and the atrial rhythm.

In our case, it was not possible to determine with certainty where the malfunctioning was, but it was thought to be in a digital circuit such as a latch, which might have been stuck in an intermediate transitional state, which is known to lead to high-current demand. Since there normally is an increase in current demand during telemetry, a charge pump will provide a surplus of current whenever telemetry takes place. Therefore, circuit operations that may be affected by minor current starve conditions can begin to function normally during telemetry operation.

Conflict of interest: none declared.

References

Figure 3 Twelve-lead ECG (August 2007) with the programming head in place over the device. Biventricular VAT pacing with an atypical QRS orientation due to the unusual LV lead position is restored.