

Another scenario of DDD cardiac pacemaker inhibition. Is it always caused by unipolar leads?

Inny scenariusz hamowania kardiostymulatora typu DDD.
Czy zawsze winne są elektrody unipolarne?

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Abstract

We present 24-hour electrocardiography recording with observed DDD pacemaker pacing inhibition. Discussed Holter monitoring findings are puzzling and may result from pacemaker sensing malfunction. However, its aetiology may be diverse. The detailed explanation of underlying mechanisms is provided and literature is reviewed.

Key words: pacemaker inhibition, DDD mode

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Introduction

Analysis of electrocardiography (ECG) recording in patients with cardiovascular implantable electronic devices (CIED) may be challenging. We would like to approach this issue in a problem-based learning manner.

An 80-year-old woman with a history of arterial hypertension, dyslipidaemia, hypothyreosis, and a dual-chamber pacemaker (DDD, St. Jude Medical Verity ADx XLDR) presented to clinic for routine follow-up. She reported worse disposition, weakness and dizziness for 2 months. Her pacemaker was interrogated. The pacemaker was programmed to DDD pacing mode. Table 1 shows the basic pacing programming of the device.

DDD pacemaker was implanted due to significant bradycardia and sick sinus syndrome. Active fixation, bipolar, ventricular lead (Medtronic, CapSureFixNovus) was implanted into right ventricular outflow tract (RVOT) through left subclavian vein puncture, while another passive fixation,

Table 1. Programmed device parameters

Mode	DDD
Base rate [beats/min]	60
Paced atrioventricular delay [ms]	170
Sensed atrioventricular delay [ms]	150
Ventricular refractory period [ms]	280
Hysteresis	Off
Night program	Off
Pacing	Unipolar
Sensing	Bipolar

bipolar (Biotronik, Synox SX 53 JBP) atrial lead was located within right atrial appendage using left cephalic vein venesection. The Holter ECG monitoring was performed and its selected parts are shown on Figure 1. What caused the

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Figure 1. Holter electrocardiography (ECG) monitoring results. Predominant cardiac rhythm from DDD pacemaker ca. 60 beats/min. After first and fifth heartbeat, pacemaker inhibition is present, reaching over 1.4 second and 1.8 second. There is no artefact associated with myopotentials in this ECG recording

pacemaker inhibition? Does the patient need any further clinical evaluation or management?

Discussion

In pacemaker-dependent patients, pacemaker inhibition may result in syncope, imbalance and/or dizziness recurrence. This finding may be recorded during Holter ECG monitoring [1]. Very similar ECG recordings can be seen with different mechanisms. Most physicians know that it may be the result of myopotentials noise in the presence of unipolar leads or when unipolar sensing is turned on [2]. Presented patient history suggests pacemaker malfunction, but no unipolar lead was implanted. In the presence of bipolar leads, inhibition of pacemaker programmed into bipolar sensing should not occur [3]. However, pacing inhibition during bipolar sensing may take place when the lead is damaged [4] or when some algorithms promoting endogenous ventricular depolarization are turned on [5, 6].

Exact interpretation of recorded findings in our patient is possible in the context of basic DDD pacemaker time intervals understanding, which include:

- lower rate interval (LRI) – the longest interval, during which no sensed events are observed; it is measured from paced or sensed ventricular event to the following paced ventricular stimulus;
- paced atrioventricular interval (PAVI) – timeframe between atrial pacing and programmed ventricular pacing;
- atrial escape interval (AEI), also called V-A interval – timeframe measured from sensed or paced ventricular event to atrial stimulus, provided that no atrial or ventricular event is sensed ($AEI = LRI - PAVI$);

- ventricular refractory period (VRP) – interval that begins with ventricular event during which ventricular lead sensing is blocked, therefore no LRI may begin.

Movements of the pacemaker pocket region during pacemaker control may help to put the right diagnosis. Figure 2 shows resting ECG and EGM which reveal DDD pacemaker inhibition during this practical manoeuvre. Due to damaged ventricular lead, pacemaker lead movements caused noise oversensing, which was interpreted by the pacemaker as ventricular activity (VS, visible in marker channel) and led to pacemaker inhibition (both atrial and ventricular pacing was inhibited). Atrial lead was in working order and did not read noise from ventricular lead (marker channel), from the heart or damaged atrial lead (which would lead to only atrial pacing inhibition).

Pacemaker inhibition may be caused by old and efficient unipolar leads (or new ones programmed to unipolar sensing) which may read myopotentials from the thoracic or even abdominal muscles [7]. Against pacemaker inhibition by myopotentials or electromagnetic field, in this case, is the fact, that artefacts were present only in the ventricular channel. This would not be possible, when both unipolar leads would be implanted. On the other hand, in the case of algorithms promoting endogenous ventricular depolarization (i.e. Medtronic's Minimal Ventricular Pacing algorithm) no noise would be observed.

In our case, pacing system included new (ca. 10-year-old) bipolar leads which advantage should be resistance towards reading noise from skeletal muscles myopotentials and from external electromagnetic fields. The cause of pacemaker inhibition was ventricular lead damage. Which could be also suggestive, it is more common when

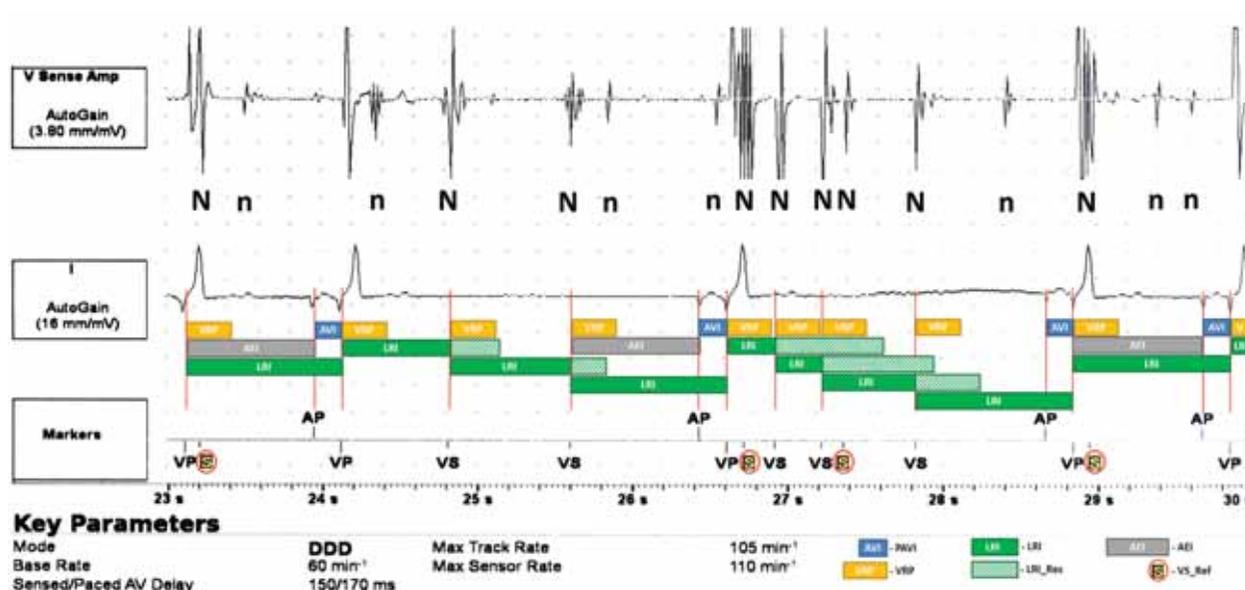


Figure 2. Electrocardiography and IEGM during pacemaker control. Letters N and n indicate ventricular lead noise. Noise marked with letter N (beyond VRP) was interpreted as ventricular activity (VS) from which the pacemaker started to count AEI and subsequently paced the atrium. Ventricular lead noise marked with letter n indicates noise which amplitude was too small to be detected by pacemaker as ventricular activity. LRI_Res = remaining part of lower rate interval (LRI) after sensed ventricular event; VS_Ref = ventricular event sensed during ventricular refractory period. Other abbreviations are defined in the text

the lead is implanted using subclavian vein puncture, than through cephalic vein venesection. Presented recordings confirm that bipolar pacemaker may be inhibited by myopotentials, which usually is associated with lead

damage and should influence patient management. Our patient underwent transvenous lead extraction and during the same procedure new ventricular lead was implanted.

Streszczenie

Przedstawiono zapis 24-godzinnego monitorowania elektrokardiograficznego metodą Holtera z obserwowanymi zahamowaniami stymulacji kardiostymulatora typu DDD. Dyskutowane wyniki monitorowania holterowskiego są zagadkowe i mogą wynikać z zaburzeń wyczuwania kardiostymulatora. Ich etiologia może być jednak zróżnicowana. Zaprezentowano szczegółowe wytłumaczenie mechanizmów oraz przegląd literatury.

Słowa kluczowe: hamowanie kardiostymulatora, tryb DDD

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