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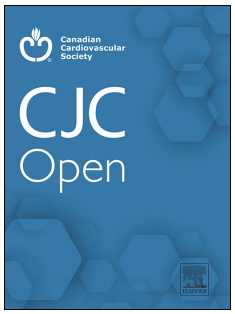

Leadless pacemaker with acute but transient elevation of lead impedance and pacing threshold

Hikaru Hagiwara, MD, PhD, Junpei Morimoto, MD, Toshifumi Tamura, MD, Akinori Takahashi, MD, Hirokazu Komoriyama, MD, PhD, Yoshiya Kato, MD, PhD, Toshihisa Anzai, MD, PhD

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CJC Open

Leadless pacemaker with acute but transient elevation of lead impedance and pacing threshold

Short title: Transient elevation of LPM pacing threshold

Hikaru Hagiwara, MD, PhD[a,b]*; Junpei Morimoto, MD[b]; Toshifumi Tamura, MD[b]; Akinori Takahashi, MD[b]; Hirokazu Komoriyama, MD, PhD[b]; Yoshiya Kato, MD, PhD[a,b] and Toshihisa Anzai, MD, PhD[a]

[a]*Department of Cardiovascular Medicine, Faculty of Medicine and Graduate School of Medicine, Hokkaido University, Sapporo, Japan*

[b]*Department of Cardiovascular Medicine, Kushiro city General Hospital, Kushiro, Japan*

***Corresponding author**: Dr. Hikaru Hagiwara

Department of Cardiovascular Medicine Faculty of Medicine and Graduate School of Medicine, Hokkaido University

Kita-15 Nishi-7, Kita-ku, Sapporo 060-8638, Japan

Email: hikaruh731@med.hokudai.ac.jp

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Brief summary for online listing

Elevated pacing-threshold may occur after leadless pacemaker (LPM) implantation, requiring device retrieval and replacement. After LPM implantation, an improvement in high impedance and pacing threshold was observed without invasive procedures. It is possible that a small thrombus temporarily formed between the LPM and myocardium. Loss of capture and high impedance following implantation may improve with follow-up, as in this case.

Leadless pacemakers (LPM) offer an advantage over traditional pacemakers that require creation of a generator pocket and connection of the transvenous leads, which may lead to complications. However, device dislodgement, cardiac perforation, and pacing-threshold elevation requiring percutaneous retrieval and device replacement have been reported as serious adverse events of the LPM.[1] Herein, we report the case of an LPM-implanted patient who experienced a transient and acute elevation of impedance and pacing threshold. These symptoms improved without requiring device replacement.

An 85-year-old man without structural heart disease underwent implantation of an LPM (Micra^{TM} AV, Medtronic, Minneapolis, MN, USA) for a complete atrioventricular block. The procedure was performed using a previously described technique.[2] After insertion of the femoral venous catheter, a 3000-U bolus of intravenous heparin was administered. The pacemaker delivery catheter was directed towards the right ventricular septum, using the gooseneck-shape technique, and deployed in the right ventricular septum. The time until the device deployment was slightly longer than usual, because the tip of the delivery catheter easily slipped and could not attach to the interventricular septum sufficiently. We performed a pull-and-hold test and confirmed that the two tines were engaged tissue. The measured electrical parameters were appropriate, with a sensed R wave of 8.0 mV, a pacing impedance of 520 Ω, and a pacing threshold of 1.63 V at 0.24 ms. Changes in electrical parameters are shown in **Table 1**. The patient was observed for 3 days with no complications. After 3 days, loss of capture was observed on an electrocardiographic monitoring. The measured electrical parameters were a sensed R wave of 3.0 mV, a pacing impedance of >2500 Ω, and a pacing

threshold of 4.61 V at 1.0 ms. The electrical parameters did not change in sitting and lying positions. Automatic electrode impedance measurement on the third day after LPM implantation was about 500 Ω. Chest radiography and fluoroscopic imaging showed stable device location in the right ventricle, similar to the intraprocedural location (**Fig. 1**). Fluoroscopic imaging also showed the swinging movement of the LPM. Reimplantation of the LPM was scheduled. However, the next day, manually measured electrical parameters showed a sensed R wave of 3.5 mV, pacing impedance of 400 Ω, and pacing threshold of 1.5 V at 0.4 ms. Automatic electrode impedance measurement at 2:30 AM on day 4 after LPM implantation was about 400 Ω, which was an acceptable level of impedance. The patient did not receive any oral anticoagulation therapy. We monitored the electrical parameters remotely without any further complications arising.

Discussion

In this case, we observed transient high impedance and high threshold in the implanted LPM. A previous study reported elevated pacing thresholds requiring device retrieval and reimplantation in 1.3% of patients with LPMs.[1] This is the first report showing that improvement in the elevated pacing threshold and impedance without the requirement for an invasive procedure.

It has been reported that implantable cardioverter-defibrillator shock impedance gradually rises due to encapsulation fibrosis.[3] In a study of patients requiring LPM retrieval and replacement, encapsulation, and adhesion of LPM were considered contributing factors for elevated impedance.[4] However, the swinging movement was confirmed in these cases

since not enough time had elapsed since the implantation for adhesion and encapsulation to occur. In the previous report, high pacing impedance and absence of pacing capture were observed during LPM implantation. The transfemoral catheter delivery system was removed, and a thrombus coating the entire distal portion of the LPM, including the cathode, was observed.[5] In our patient, it is possible that a small thrombus formed between the LPM and the myocardium, temporarily elevating impedance and the pacing threshold before disappearing the next day. Nitinol tines tend to burrow into the myocardial tissue but Micra™ AV is designed with a slight distance between the nitinol tines and the electrodes. Therefore, we assumed there was a small gap between the electrode and the endocardial surface, in which a clot could form, or a foreign object could enter. The time to deploy the device was slightly longer than usual, which may have caused myocardial changes, including inflammation and edema, making it more likely to form a thrombus. It is possible that the reason why the sensing did not improve was because the sensing vector changed when the contact between the electrode and the endocardial surface slightly changed after the disappearance of a clot or foreign object. However, we could not determine whether high impedance and thrombus formation were related from only this single case, and the mechanism remains a matter for speculation; further investigations are needed.

If an LPM that has been stably pacing for several days shows a sudden loss of capture and high impedance, it may improve with a few days of follow-up, as seen in this case.

Novel Teaching Points

- Loss of capture and high impedance following leadless pacemaker implantation may

improve during follow-up due to the disappearance of a small thrombus that temporarily formed between the leadless pacemaker and myocardium

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Conflict of interest statement: The authors have no conflicts of interest to declare.

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Table 1. The timeline of the patient's electrical parameter measurements.

Time and event	Electrical parameters		
	Sensed R wave	Pacing impedance	Pacing threshold
LPM implantation (Day 0)	8.0 mV	520 Ω	1.63 V at 0.24 ms.
Day 3, 2:30 AM		500 Ω	
Day 3, 8:00 AM Observed loss of capture	3.0 mV	>2500 Ω	4.61 V at 1.0 ms
Day 3, 2:30 PM	3.0 mV	2150 Ω	4.61 V at 1.0 ms.
Day 4, 2:30 AM		400 Ω	
Day 4, 9:00 AM	3.5 mV	400 Ω	1.5 V at 0.4 ms

Underlined values are approximate values from automatic electrode impedance measurement

Figure Legends

Figure 1

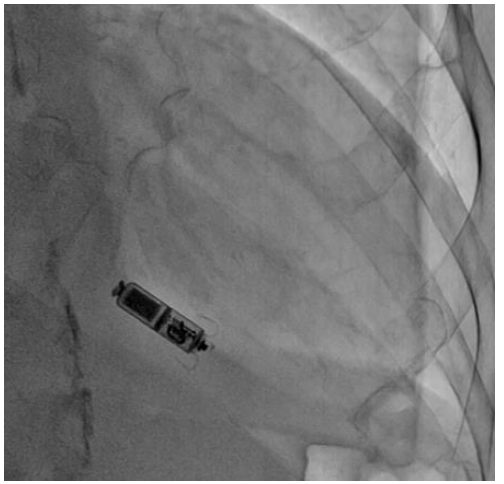
A: Posterior-anterior chest radiograph. **B**: Lateral chest radiograph showing the position of the final implant attempt. **C**: Posterior-anterior chest radiograph. **D**: Lateral chest radiograph showing the position of a leadless pacemaker 3 days after implantation. **E**: Right anterior oblique view and **F**: left anterior oblique view showing the position of the final implant attempt. The temporary pacing lead and telemetry are shown. **G**: Right anterior oblique view and **H**: left anterior oblique view showing the position of the leadless pacemaker 3 days after implantation.

A Post LPM implantation

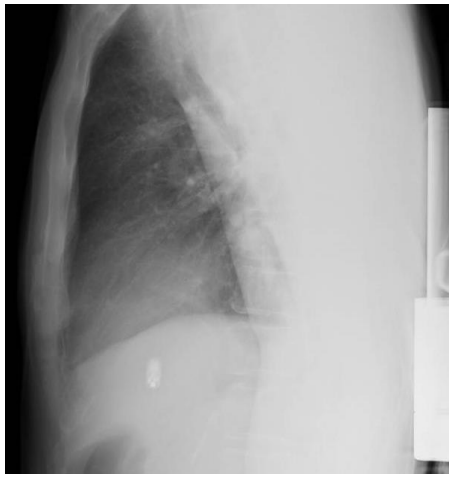
C Day 3 after LPM implantation

E Post LPM implantation

G Day 3 after LPM implantation

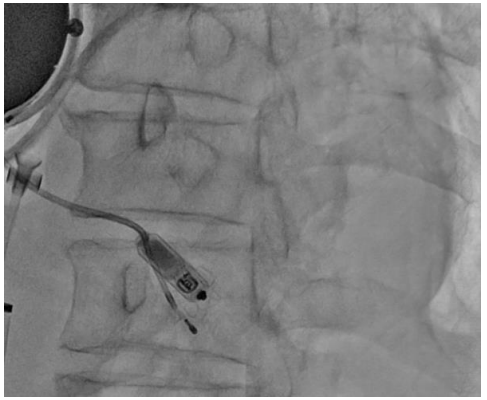


B Post LPM implantation



D Day 3 after LPM implantation

F Post LPM implantation



H Day 3 after LPM implantation