Automatic capture management may cause unnecessary battery depletion in selective His bundle pacing

Hung-Pin Wu, MD[1,2], Jan-Yow Chen, MD, PhD[1,2], Kuo-Hung Lin, MD[1,2], Kuan-Cheng Chang, MD, PhD[1,2]

1 Division of Cardiovascular Medicine, Department of Medicine, China Medical University Hospital, Taichung, Taiwan

2 School of Medicine, China Medical University, Taichung, Taiwan

Abstract

A modern implantable pulse generator is equipped with an automatic capture management (ACM) program that provides reliable pacing threshold management and potential device longevity benefit. However, an accurate His bundle pacing (HBP) lead threshold value is not always the same as the ACM algorithm measurement. We reported a patient who presented with a high ventricular pacing output that caused shortening of device longevity because of the wrong ACM algorithm HBP threshold measurement. Because of the time interval between pacing stimulation and the ventricular electrogram during HBP, the ACM algorithm considers “pacing capture loss” despite His bundle capture. The ACM algorithm overestimates an accurate HBP

threshold and unnecessarily changes pacing parameters to high ventricular pacing output. A routine change in the ACM algorithm from “adaptive” to “off or monitor” is needed to conserve device longevity.

Keywords: capture management, His bundle pacing, device longevity

Introduction

The number of patients with permanent His bundle pacing (HBP) has been increasing due to its feasibility and association with improved exercise capacity, ventricular synchrony, and better clinical outcome compared with those of right ventricular pacing (RVP).[1,2] However, at present, no implantable pulse generator (IPG) is available with a dedicated His pacing port. Special device programming is needed for HBP because of unique electrical parameters.[3,4] For example, most modern IPGs are equipped with automatic capture management (ACM) programs that provide reliable pacing threshold management and potential device longevity benefit.[5,6] However, an accurate HBP lead threshold value is not always the same as the ACM algorithm measurement. Here, we report about a patient who presented with considerably high ventricular pacing output that caused shorteningof device longevity because of an incorrect ACM algorithm HBP threshold measurement.

Case presentation

A 74-year-old patient with second-degree AV block and hypertrophic cardiomyopathy presented with recurrent syncope. We arranged a permanent dual-chamber pacemaker with HBP implantation for the patient. The patient was implanted with a pacemaker on the His bundle (Medtronic 3830 lead, Minneapolis, MN, USA) and on the right atrial appendage (Medtronic 5076 lead), and they were connected to a Medtronic Astra XT DR MRI SureScan generator. Selective HBP (S-HBP) was successfully achieved with a minimal threshold of <1.5 V at 0.4 ms (Fig. 1). Electrocardiogram (ECG) measurements obtained immediately after the operation revealed sinus rhythm with S-HBP. However, ECG on postoperative day 1 showed sinus rhythm with nonselective HBP (NS-HBP; Fig. 2). The pacemaker interrogation report revealed a high HBP lead threshold, and ventricular lead pacing output was programmed as 5.00 V at 1.00 ms spontaneously. The remaining longevity of the pacemaker was 3.3 years according to the current setting (Fig. 3A). Chest radiographs revealed no evidence of lead dislodgement. In fact, the HBP lead threshold was 0.5 V at 0.4 ms based on a manual test (Fig. 3B). Finally, we changed the ACM setting from “adaptive” to “monitor only” and fixed pacing output to 3.5 V at 0.4 ms initially to avoid unnecessary battery depletion.

Discussion

ACM is a programmable feature that allows automatic adjustment of pacing output in response to changing pacing thresholds. Previous studies have shown that automatic modulations of pacing output have been adjudicated appropriately in atrial, right ventricular, left ventricular, defibrillation, and epicardial leads.[5-7] In our case, the HBP lead inserted into the right ventricular port and ACM follow the ventricular capture management (VCM) algorithm. VCM automatically performs a ventricular pacing threshold search through insertion of test paces and observation of the evoked response in the ventricle. Because of the time interval between pacing stimulation and the ventricular electrogram during HBP, the VCM algorithm considers “pacing capture loss” despite His bundle capture. VCM increases pacing output until NS-HBP with the culmination of both the His bundle and ventricular capture. The VCM algorithm overestimates the accurate HBP threshold and unnecessarily changes pacing parameters to a high ventricular pacing output. Our recommended solution is programing VCM from “adaptive” to “monitor only,” and no automatic adjustments will occur.

The HBP lead had a higher capture threshold than the traditional RVP lead, which may lead to early battery depletion, necessitating early generator changes.[2,8] The default ACM algorithm in Medtronic IPG is “adaptive,” with program pacing output

at the twice-safety margin. Furthermore, experts suggest that changing the ACM algorithm from “adaptive” to “Off or monitor” conserves battery life.[1,3]

Conclusion

This case report confirms that the ACM algorithm may overestimate the accurate HBP threshold and cause unnecessary battery depletion in the default ACM algorithm of Medtronic IPG. Additionally, the HBP lead usually has a higher capture threshold than the traditional RVP lead. A routine change in the ACM algorithm from “adaptive” to “off or monitor” is needed to conserve device longevity.

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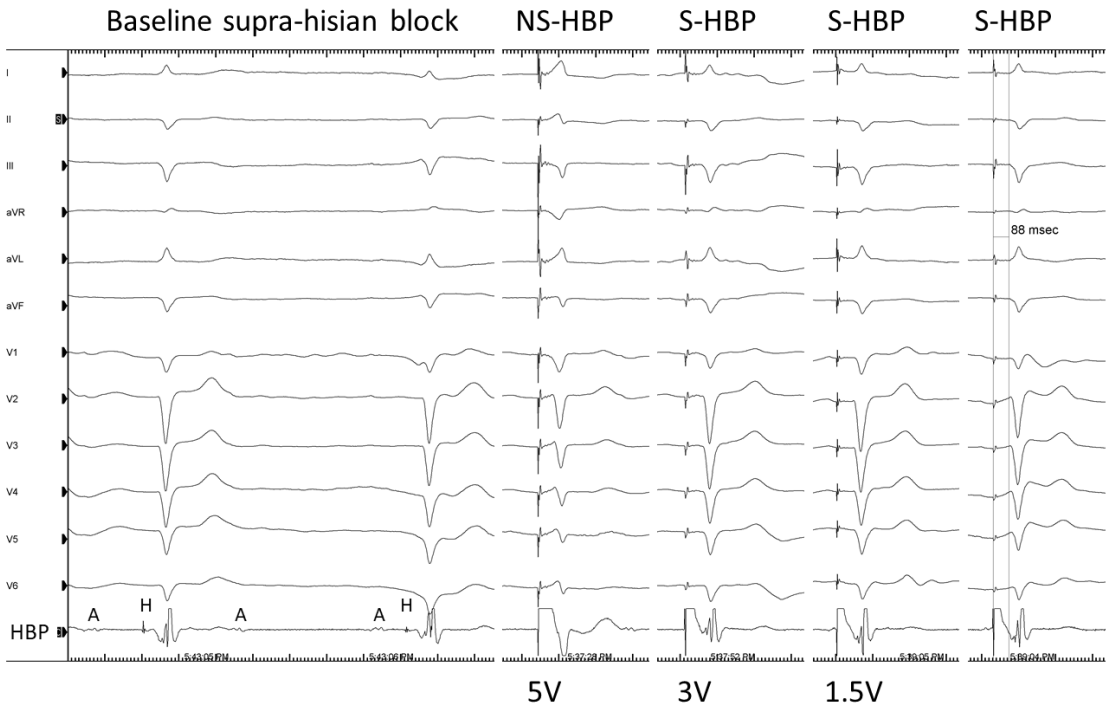

Fig 1: The 12-lead ECG and intracardiac electrograms obtained from the His-bundle pacing (HBP) lead are shown. (Left) Baseline sinus rhythm with supra-hisian block. (Right) With pacing at 5 V at 0.4 ms, nonselective HBP is noted with the culmination of both His bundle and ventricular capture. With pacing at 1.5–3.0 V at 0.4 ms, selective HBP is noted with a pacing stimulus to surface QRS onset interval of 88 msec.

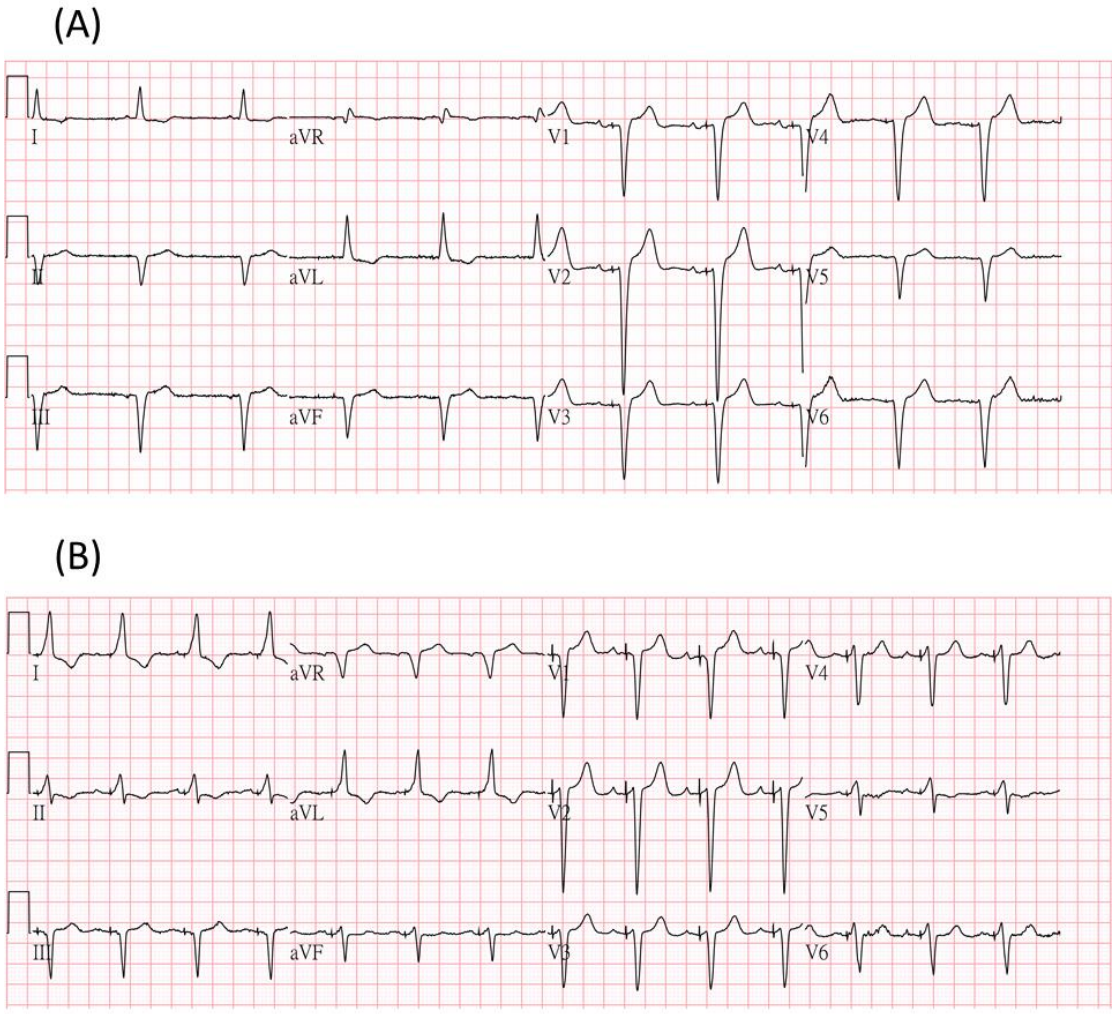

Fig 2: (A) The 12-lead ECG immediately after operation. The paced QRS morphology is the same as the native QRS morphology, with a pacing stimulus to QRS onset time delay. (B) The 12-lead ECG on postoperation day 1. The paced QRS morphology is wider than the native QRS morphology, with a pseudo-delta wave due to local ventricular capture.

(A)

Device Status (Implanted: 14-Feb-2020)

Remaining Longevity 3.3 years (17-Feb-2020)

(based on initial interrogation)

	Atrial(5076)	**RV**
Lead Impedance	285 ohms	380 ohms
Capture Threshold	0.500 V @ 0.40 ms	High
Measured On	17-Feb-2020	17-Feb-2020
Programmed Amplitude/Pulse Width	3.50 V / 0.40 ms	5.00 V / 1.00 ms
Measured P/ R Wave	1.4 mV	- - -
Programmed Sensitivity	0.30 mV	0.90 mV

(B)

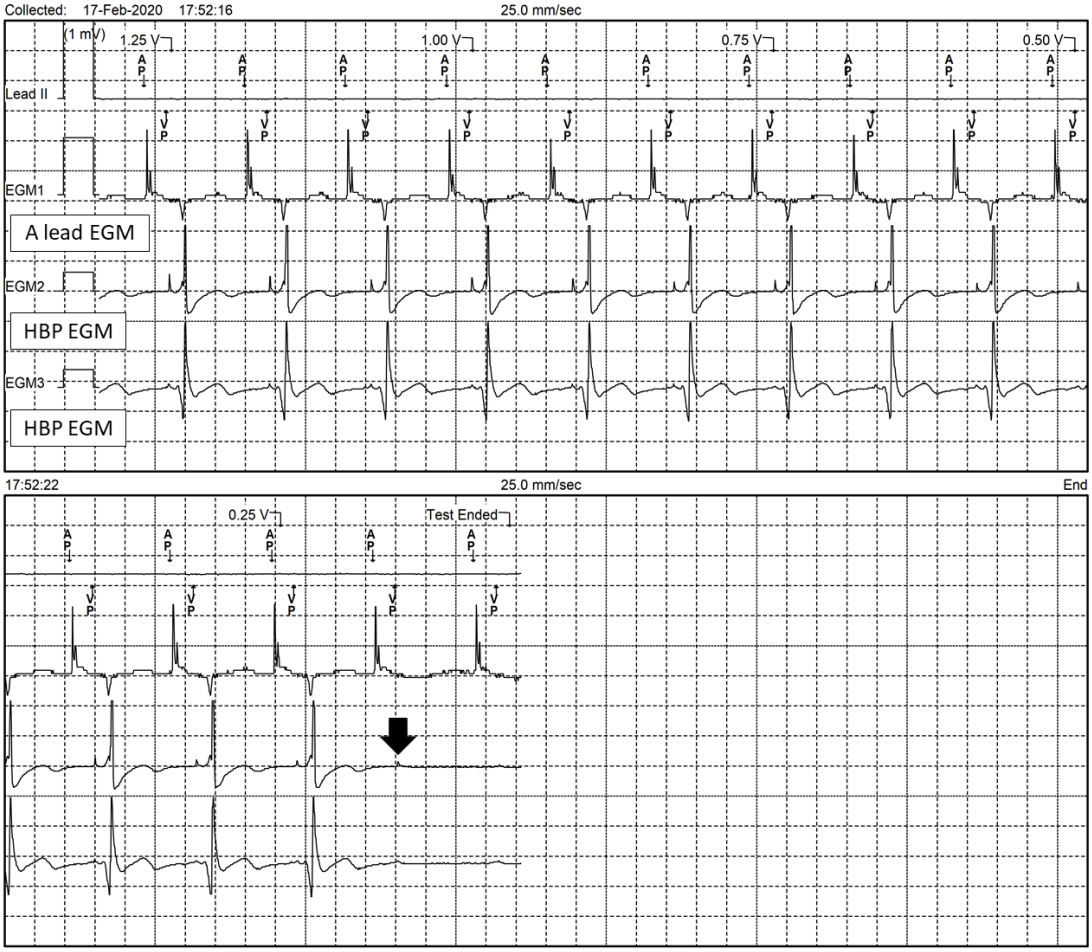

Fig 3. (A) Device interrogation data on postoperative day 3. The automatic capture management (ACM) algorithm revealed a high ventricular capture threshold, and ventricular lead pacing output was programmed as 5.00 V at 1.00 ms spontaneously.

The estimated remaining generator longevity with the current device setting was 3.3 years. (B) The His bundle pacing (HBP) lead threshold was tested manually during DDD pacing. Selective-HBP with a pacing stimulus to the local ventricular electrogram time interval delay and pacing capture loss at 0.25 V at 0.4 ms (arrow). The ventricular capture management (VCM) algorithm performs a pacing threshold search through insertion of test paces and observation of the evoked response in the ventricle. At selective-HBP, the VCM algorithm considers “pacing capture loss” because pacing stimulus does not evoke ventricular response immediately.