Logic analysis of arrhythmia triggered by a pace on PVC and ventricle standby safety functions of a pacemaker- a case report of a 38-year-old patient

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Abstract

Dual-chamber pacemaker is a fully automatic pacemaker with the function of simulating human physiological pacing. It regulates pacing by programming different refractory periods and various special functions, which are closely related to arrhythmia. After in-depth understanding of these special functions, regular ECG follow-up analysis is required to provide individualized optimal program control and so is appropriate administrations of special functions of pacemaker so as to better provide optimal clinical guidance for patients with arrhythmia.

Introduction

In practice, patients with implantation of earlier pacemakers have chances of PMT, which pushes the advances and enrichments in pacemaker special functions[1]. Producers developed PVARP extension mechanism to avoid detection of the retrograde P wave in order to prevent PMT occurrence[2]. Such innovations greatly help to prevent the PMT brought by the pacemakers. Yet, the special functions of pacemakers also induce unexpected arrhythmia in patients.

We reported one complex but not rare case that presented the negative outcomes derived from the combined functions of PVC and VSS of pacemakers.

Case report

This report was approved by the Ethical Committee of Xuzhou Central Hospital and the patient signed informed consent willingly to support this study. The 38-year-old female patient was implanted with St. Jude dual-chamber pacemaker (Victory XL DR 5816) 3 years ago in Cardiac Diagnosis and treatment Center of Xuzhou Central Hospital after diagnosed with viral myocarditis, sinus bradycardia, and atrioventricular block II. After palpitation for 1 month, the patient came for re-diagnosis and we conducted pacemaker program control and 24-hour dynamic ECG tracking.

Details of pacemaker program control: operating mode, DDD; Basic frequency,60 times/min; the rest frequency was 45 times/min; PAV, 275ms; SAV, 250ms; AP accounted for 13% of total heart beats, and VP accounted for 9.1% of total heart beats.

A pace on PVC option by this specific pacemaker: upon the occurrence of PVC event, the PVARP interval of 480ms will be on. The first 150ms of PVARP is ARP and the latter 330ms is RRP. If P wave is sensed within the RRP, it is called retrograde P wave and AP will be released at 330ms behind this retrograde P wave (Figure 4).

Normal sinus rhythm. DDD, VAT and AAI modes. AP accounted for 15% of the total heart beats, VP 9.0%, frequent PVC 3.2% and occasional PVC 73.3%.

Through ECG interrogation, pacemaker has aberrant responses to occasional PVC: PVC was marked in Figure 1 and 2, where and pointed at. After PVC, sinus P wave was transmitted to ventricle and PVC recurred at . At the end of T wave after this PVC, spontaneous P wave was seen clearly. However, this P wave didn't trigger VP of the pacemaker and it took 720ms from this PVC to the next AP, shorter than VA interval.

At , the retrograde P wave occurred within the RRP(330ms period marked in the Figure 1) after PVC, defined as AR event. Due to A pace on PVC, the pacemaker could sense the retrograde P wave and release AP at 330ms after AR without triggering VP.

displayed a different response from . P wave after PVC occurred within the ARP (the former 150ms in the PVARP interval) and couldn't be sensed by the pacemaker, which consequently resulted in the AP release during the VA interval. This happened at 04.03 am at the rest status with heart beats 45 times/min, VV interval 1340ms, PAV 275ms and VA 1065ms. ECG showed the patient had occasional PVC or VPB with three typical patterns as below: sinus P wave was transmitted to ventricle, a pace on PVC response by the pacemaker and AP was triggered during VA interval after PVC.

Furthermore, a double pulse appeared after PVC(, Figure 3) and the interval was 275ms. The first pulse was AP. The QRS wave after PVC occurred within the PAVB interval and remained undetected. Thereafter, VP was released at 275ms after the AP and occurred in the VVP of sinus QRS. Besides, this AP was 330ms after the AR event and the P wave was over 280ms later than the QRS wave.

AP-VP sequence was also detected after PVC and the interval was 120ms. The first pulse was AP and was overlapped with the spontaneous sinus QRS wave, which occurred within CDW and thus triggered the VSS function, forming an AP-VS-VP sequence. The pacemaker could not tell whether the signal was crosstalk or spontaneous and released an early VP to avoid asystole. The AR event was 330ms earlier than the AP and the former QRS wave was over 280ms earlier than this AR event due to a pace on PVC option. The ECG results disclosed the combined outcomes of both functions of a pace on PVC and VSS of the pacemaker. Therefore, after the ECG interrogation, we turned off A pace on PVC option and asked the patient to take 47.5mg Metoprolol Succinate Sustained-release Tablets once every day. 1 month later, the follow-up results showed that arrhythmia was alleviated significantly (Figure 5).

Discussion

The PVC response option is meant to avoid PVC-triggered PMT by the pacemakers. The major principle is to extend PVARP after PVC so as to curb the atrial arrhythmia caused by competitive AP[3]. A Pace on PVC function from St. Jude[4-6].

In this case report, Victory XL DR 5816, the Dual Chamber Pacemaker from St. Jude was implanted into the patient 3 years ago before this reported arrhythmia. The patient got interposition PVC frequently, triggering the special PVC response of the pacemaker. Resultantly, Sinus P wave lied within PAVB and then VP released in AVP, contributing to serious arrhythmia. Further, the sinus P wave occurred in CDW, which induced VSS, aggravating the arrhythmia symptoms.

Recent years witness the increasing special functions of pacemakers, all intended for the improvement in functions and safety. However, the connections between special functions and arrythmia make the ECG analysis more complicated. Clinical doctors need to get in-depth understanding of special functions of pacemakers and value the follow-up programming controls as well as logic analysis so as to enable themselves to customize the optimal programming control for each patient. Only by doing this, clinicians can provide optimal treatment for arrhythmia patients.

Acknowledgement

None

Statement of Ethics

It is shown in the attachment

Availability of data and materials

None

Conflict of Interest Statement

None

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Reference:

1. Monteil, B., et al., *Pacemaker-Mediated Tachycardia: Manufacturer Specifics and Spectrum of Cases.* Pacing Clin Electrophysiol, 2015. **38** (12): p. 1489-98.

2. Strik, M., et al., *Accuracy of the pacemaker-mediated tachycardia algorithm in Boston Scientific devices.* J Electrocardiol, 2016. **49** (4): p. 522-9.

3. Barold, S.S., F. Van Heuverswyn, and R.X. Stroobandt, *Automatic mode switching of a dual chamber implantable cardioverter-defibrillator induced by a ventricular escape rhythm.* J Electrocardiol, 2013.**46** (2): p. 136-9.

4. Ip, J.E., et al., *Differentiating pacemaker-mediated tachycardia from tachycardia due to atrial tracking: utility of V-A-A-V versus V-A-V response after postventricular atrial refractory period extension.* Heart Rhythm, 2011. **8** (8): p. 1185-91.

5. Barold, S.S. and R.X. Stroobandt, *Using devices with a variable postventricular atrial refractory period for cardiac resynchronization.*Herzschrittmacherther Elektrophysiol, 2012. **23** (1): p. 52-5.

6. Wass, S.Y., et al., *Proarrhythmic effects from competitive atrial pacing and potential programming solutions.* Pacing Clin Electrophysiol, 2020.

Figure legends

Figure 1. sinus P wave was transmitted to ventricle and PVC occurred.

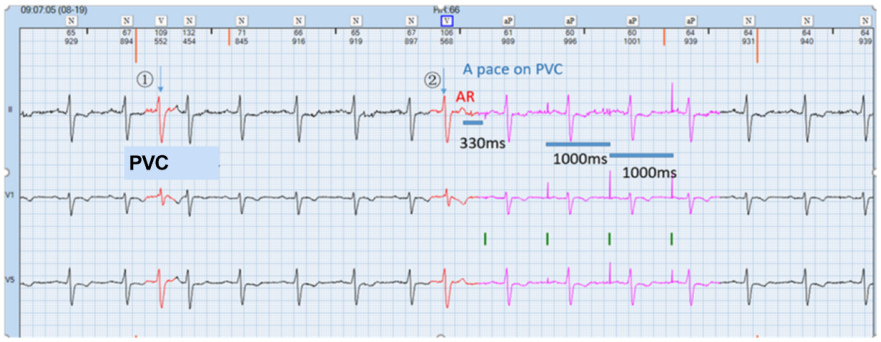
Figure 2. P wave occurred in ARP and AP was released in VA.

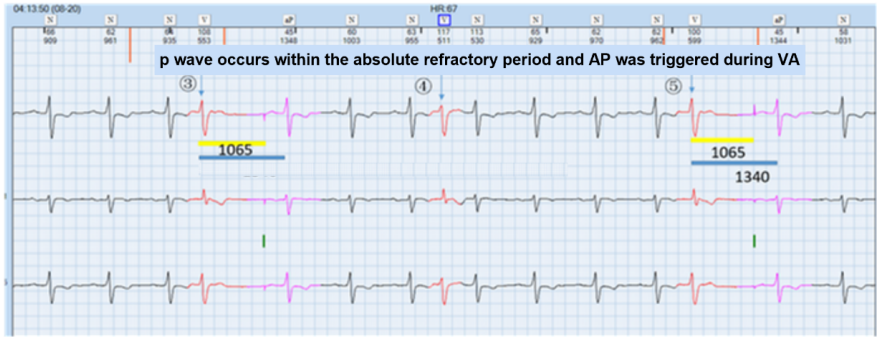
Figure 3. AP overlapped with sinus QRS wave within CDW and VSS function was triggered.

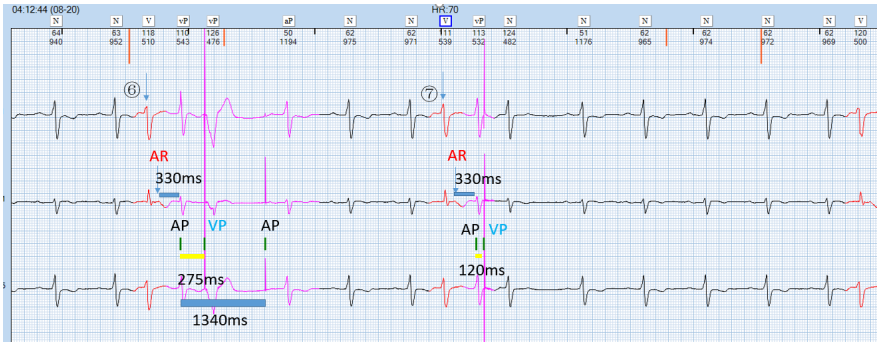
Figure4 Demonstrations of the special function, A pace on PVC of the pacemaker.

When PVC occurs, 480-ms PVARP happens thereafter during which the absolute refractory period is 150ms and the relative refractory period is 330ms. If the P wave occurs during the relative refractory period, the P wave is called retrograde P wave and AP will be released at 330ms after the retrograde P wave.

Figure 5. ECG of the patient after turning off the special function of A pace on PVC and taking medicine.







A pace on PVC