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Automatic Mode Switch (AMS) Causes Less Synchronization

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Abstract

Introduction: Cardiac resynchronization devices are part of modern heart failure management. After implantation, we analyze and program devices in an attempt to ensure their success. Biventricular pacing should be 98% or more for the lowest mortality and best symptom improvement.

Case Presentation: In this case series, we present a combination of far field sensing and automatic mode switching (AMS) in six patients. It is found that this combination causes ventricular sensing (VS) episodes with wide QRS and no synchronization. We turn off the AMS and alleviate the problem.

Conclusions: Switching AMS off may increase biventricular pacing in some patients.

Keywords: Biventricular Pacing, Automatic Mode Switch, Cardiac Resynchoronization Therapy

1. Introduction

Cardiac resynchronization devices have improved the symptoms of heart failure (1). Implantation of a biventricular device is challenging, but the analysis and programming of such a device after it is implanted is even more important when it comes to determining the effect of the intervention (2).

To maximize the effect of such devices, we should have higher percentages of pacing (2, 3). The most common causes of lack of ventricular pacing episodes are arrhythmia, loss of left ventricular capture, and atrial lead dislodgement (4).

Implanted electronic devices need regular analysis and reprogramming. These procedures comprise verification of several elements, as follows: battery status, lead integrity, sensing and threshold status for each chamber, and accuracy of programming. Response: cardiac resynchoronization therapy (CRT) devices involve additional steps for optimization. These include fine-tuning of response: atrio-ventricular (AV) and left ventricle-right ventricle (VV) timing to achieve the best cardiac output, as well as a trial to reach biventricular pacing of over 98% (2). Attainment of 100% pacing requires shorter AV timing, treatment of arrhythmia, and use of a faster rate for the upper tract in many instances. In this article, we aim to show shat switching off the automatic mode may be an option for this purpose.

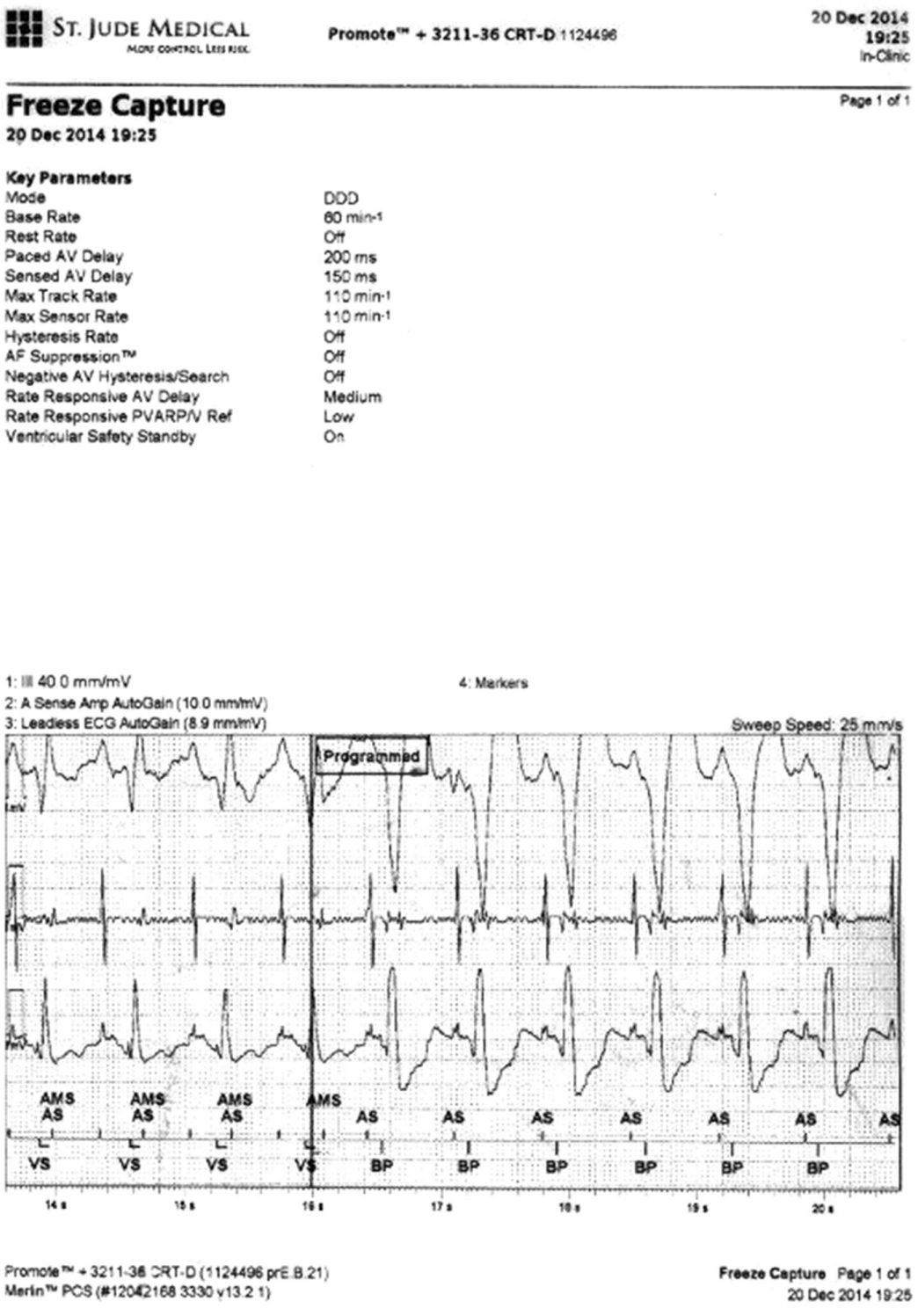
2. Case Presentation

From January 2014 to November 2014, an analysis of about 1796 devices was carried out at Faghihi hospital, Shiraz University of Medical Sciences. Among them, 236 analyses focused on cardiac resynchronization devices. We found 16 cases with many automatic mode switch (AMS) episodes (5), Which made the biventricular pacing percentages lower than expected. About 10 cases exhibited supraventricular tachycardia, especially in terms of atrial fibrillations, which were treated accordingly. In the other six patients, we found no real supraventricular arrhythmia. The atrial lead was able to carry out far field sensing of the ventricle.

This oversensing problem in the atrial lead result in incorrect diagnosis of supraventricular arrhythmia. The device starts with AMS, and this is a DDI mode. In this mode, atrial sensing does not start pacing in the ventricle. This incorrect AMS causes ventricular depolarization due to the patient's atrio-ventricle node (AVN) and a wide QRS morphology, as expected. To overcome this problem, we switched off the AMS.

After turning off the AMS, the sensing episodes disappeared and response: biventricular pacing (BVP) increased to more than 98% in all six patients. Switching off the AMS caused the wide complex to become narrower, as shown in Figure 1 ; the demographic and clinical data of the six patients are summarized in Table 1. Other pos-

sible solutions were changing the sensitivity of the atrial leads, increasing the post-ventricular atrial blanking, and re-implanting the atrial lead. We performed fluoroscopy for the six patients to assess location of the atrial leads, but there was no implant near the tricuspid valve, so invasive correction by re-implantation seemed infeasible.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Key Parameters	
Mode	DDD
Base Rate	60 min-1
Rest Rate	Off
Paced AV Delay	200 ms
Sensed AV Delay	150 ms
Max Track Rate	110 min-1
Max Sensor Rate	110 min-1
Hysteresis Rate	Off
AF Suppression™	Off
Negative AV Hysteresis/Search	Off
Rate Responsive AV Delay	Medium
Rate Responsive PVARP/V Ref	Low
Ventricular Safety Standby	On

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Merlin™ PCS (#1204.2168.3330 v13.2.1)

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Figure 1. Turning off AMS and Resumption of Biventricular Pacing

Table 1. Demographic and Clinical Data of Patients With AMS Without Clinical Arrhythmia

No.	Gener	Age	Device Type	Pre-Implant EF, %	Etiology	Time From Implant
1	M	42	Promote+	20	DCM	2 months
2	M	65	Promote+	15	ICM	9 months
3	M	24	Promote+	30	DCM	5 days
4	M	78	Promote+	25	ICM	8 months
5	F	64	Promote+	10	ICM	1 month
6	M	34	Promote+	20	DCM	5 months

Abbreviations: DCM, dilated cardiomyopathy; EF, ejection fraction; F, female; ICM, ischemic cardiomyopathy; M, male.

3. Discussion

Although implanting CRT is technically challenging, post-implant management is also critical for clinical success (6). Simple parameters should be checked and corrected. These include the following:

- Sensing, especially in the atrial channel;
- Capturing thresholds in the left and right ventricular leads in particular;
- Selecting a proper atrioventricular delay to secure the ventricular pacing.

There is also more fine-tuning of the device that should be carried out by echocardiography for the best AV and VV timing; this is called CRT optimization (7). Moreover, in addition to the above routines, it is important to minimize ventricular sensing (VS) episodes. These episodes may be due to ventricular arrhythmia, sinus tachycardia, or supraventricular tachycardia.

We use drugs and ablation in most scenarios, but antiarrhythmic options are also available in devices. Among these, anti-atrial fibrillation (AF) options are more famous among them and include competitive pacing and AMS. AMS involves starting modes with ventricular pacing like VVI or DDI. These modes pace the ventricle regardless of the atrial events (8).

In this case series, we found that the combination of far-field sensing of a ventricular event by the atrial lead and AMS causes VS episodes. These VS periods of decrease the synchronization and may worsen heart failure symptoms and mortality (2). We can overcome these sensing problems in a few ways, as described below, where each approach has its own advantages and disadvantages.

First, we may decrease the sensitivity of the atrial lead. Its weak point is incorrect diagnosis of supraventricular arrhythmia as ventricular tachycardia. Inappropriate shocks and their consequences will follow.

Second, we may lengthen post-ventricular atrial blanking. This restricts the upper track rate and increases the chance of 2:1 AV block during exercise, thereby making physiological pacing difficult.

Third, we may change the polarity of the atrial sensing. However, all had a Promote+ device from the St. Jude Company; the option of changing polarity was not available on this device.

Fourth, we may re-implant the atrial lead. This is an invasive procedure and involves its own risks. In addition, the increased risk of infection in repeated pocket opening is a significant concern.

Fifth, we may increase the rate of AMS. The time between the atrial event and ventricular pacing is short (about 100 - 110 ms). It is necessary to define a rate of 600 beats per minute for AMS, which effectively removes the possibility of using this option.

Sixth, we may change the DDI mode of AMS to VVI. In this mode, AV dissociation occurs along with its consequences.

Seventh, we may turn off AMS. This may cause a high rate during supraventricular episodes, particularly atrial fibrillation.

We decided on the seventh option, since we did not have an atrial high rate in the six case patients.

3.1. Conclusion

After implanting CRT, the ventricular pacing should be increased if possible. In some devices, far-field sensing of the ventricular events by the atrial lead and subsequent AMS may cause wide QRS sensing episodes. Turning off the AMS is a simple and effective solution for these patients.

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Footnotes

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References

1. Abraham WT, Hayes DL. Cardiac resynchronization therapy for heart failure. *Circulation.* 2003;**108**(21):2596–603. doi: 10.1161/01.CIR.0000096580.26969.9A. [PubMed: 14638522]
2. Hayes DL, Boehmer JP, Day JD, Gilliam FR, Heidenreich PA, Seth M, et al. Cardiac resynchronization therapy and the relationship of percent biventricular pacing to symptoms and survival. *Heart Rhythm.* 2011;**8**(9):1469–75. doi: 10.1016/j.hrthm.2011.04.015. [PubMed: 21699828]
3. Monica YL, Owen AO. Maximizing Cardiac Resynchronization Therapy in Patients With Atrial Fibrillation. *J Innovations Card Rhythm Manag.* 2011;**2**:584–93.
4. Colchero T, Arias MA, Lopez-Sanchez FA, Pachon M, Dominguez-Perez L, Puchol A, et al. Loss of continuous biventricular pacing in cardiac resynchronization therapy patients: incidence, causes, and outcomes. *Rev Esp Cardiol (Engl Ed).* 2013;**66**(5):377–83. doi: 10.1016/j.rec.2012.11.001. [PubMed: 24775820]
5. Passman RS, Weinberg KM, Freher M, Denes P, Schaechter A, Goldberger JJ, et al. Accuracy of mode switch algorithms for detection of atrial tachyarrhythmias. *J Cardiovasc Electrophysiol.* 2004;**15**(7):773–7. doi: 10.1046/j.1540-8167.2004.03537.x. [PubMed: 15250860]
6. Mullens W, Grimm RA, Verga T, Dresing T, Starling RC, Wilkoff BL, et al. Insights from a cardiac resynchronization optimization clinic as part of a heart failure disease management program. *J Am Coll Cardiol.* 2009;**53**(9):765–73. doi: 10.1016/j.jacc.2008.11.024. [PubMed: 19245967]
7. Brabham WW, Gold MR. The role of AV and VV optimization for CRT. *J Arrhythmia.* 2013;**29**(3):153–61.
8. Maurizio Santomauro MD, Carlo Duilio MD, Carla Riganti MD. Different Automatic Mode Switching in DDDR Pacemakers. In: Mithilesh K. D., editor. *Modern Pacemakers -Present and Future.* In-Tech; 2011. pp. 25–35.