Validation of device algorithm to differentiate pacemaker-mediated tachycardia from tachycardia due to atrial tracking

James E. Ip, MD, FHRS, Bruce B. Lerman, MD, FHRS

From the Department of Medicine, Division of Cardiology, Cornell University Medical Center, New York, New York.

BACKGROUND Current cardiac devices cannot always differentiate between pacemaker-mediated tachycardia (PMT) and tracking of sinus or atrial tachycardia. We previously derived a novel algorithm for distinguishing the 2 mechanisms based on the specific termination response to postventricular atrial refractory period extension, atrial rates, and changes in atrial electrogram morphology.

OBJECTIVE The purpose of this study was to evaluate how this algorithm would have performed in a clinical setting based on previously recorded PMT events.

METHODS We applied our algorithm to a database of 122 de-identified stored electrograms that were classified as PMT by 43 remotely monitored devices.

RESULTS Of the 122 events stored as "PMT," 3 episodes were excluded because the device recording was consistent with atrial fibrillation. Of the remaining 119 episodes, our algorithm was able to correctly reclassify 92 events (77%) as tracking of sinus or atrial tachycardia rather than true PMT. The VAV response following postventricular atrial refractory period extension, which is specific to tracking of atrial or sinus tachycardia, was seen in 72% of these cases. Changes in atrial rate and atrial electrogram morphology were able to reclassify the remainder of episodes. Finally, we observed that 12 of 83 episodes (14%) misclassified as PMT in cardiac resynchronization devices resulted in loss of cardiac biventricular pacing.

CONCLUSION Applying a novel diagnostic algorithm to current cardiac devices improves the proper diagnosis of true PMT rather than tracking of atrial or sinus tachycardia. Enhanced accuracy of diagnosis reduces the likelihood of inappropriate clinical decisions.

KEYWORDS Pacemaker-mediated tachycardia; Atrial tachycardia; Cardiac resynchronization therapy; Device diagnostics; Postventricular atrial refractory period; Sinus tachycardia

(Heart Rhythm 2016;0:1–6)

Introduction

Pacemaker-mediated tachycardia (PMT), also known as endless loop tachycardia, is the most common cause of pacemaker-facilitated tachycardia.[1] PMT is caused by continuous retrograde AV nodal conduction following ventricular paced beats resulting in a repetitive sequence of atrial sensed–ventricular paced (AS-VP) beats. Although pacemaker/implantable cardioverter-defibrillator (ICD) algorithms are designed to recognize this phenomenon when the upper tracking rate of the device is approached, pacemakers often fail to distinguish sequential AS-VP events from tracking of atrial or sinus tachycardia, another form of pacemaker-facilitated tachycardia. Because current device algorithms are unable to differentiate between these 2 tachycardias, we previously derived an algorithm that distinguishes PMT from tachycardia due to tracking of sinus/atrial tachycardia based on the response to postventricular atrial refractory period (PVARP) extension (Figure 1).[2] In the presence of intact AV conduction, the V-A-V response [VP event followed by atrial refractory (AR) event followed by ventricular sensed (VS) event] is specific to atrial (or sinus) tachycardia (Figure 2), whereas the V-A-A-Vs response [VP event followed by AR event followed by atrial event followed by VS event] is specific to PMT. A VAAVp response [VP event followed by AR event, followed by atrial event, followed by VP event] can be seen in both PMT and tracking of sinus or atrial tachyardia. In the latter case, this occurs when intrinsic AV conduction is not intact or the programmed AV delay is shorter than intrinsic AV conduction. However, when a V-A-A-Vp response is observed, the difference in atrial rate during tachycardia and following PVARP extension is used to classify the mechanism. Finally, in the rare case of an isorhythmic atrial rate with a V-A-A-Vp response, the atrial electrogram morphology (or surface

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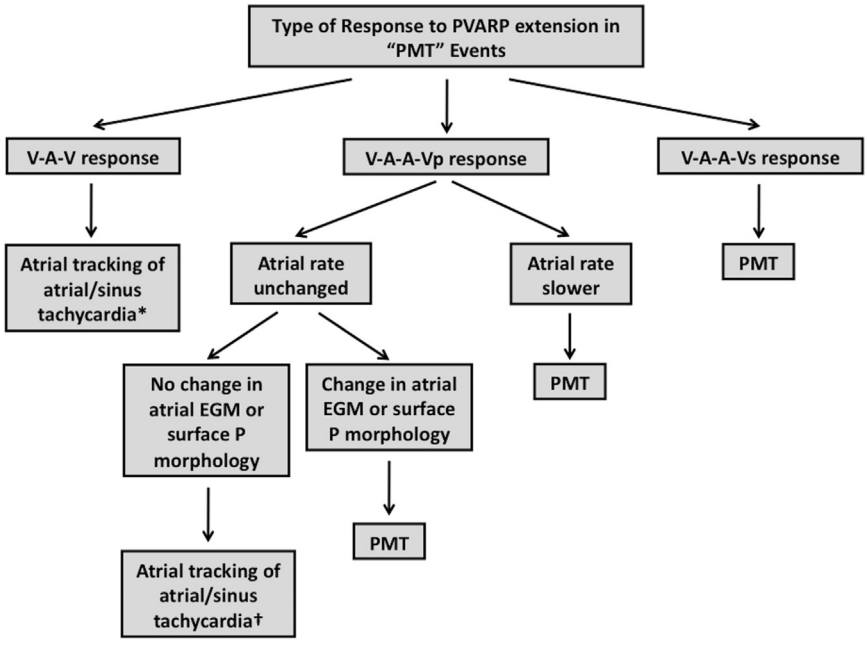

Figure 1 Algorithm for differentiating between the 2 types of pacemaker-facilitated tachycardia classified as "PMT" events: atrial tracking due to atrial (or sinus) tachycardia vs pacemaker-mediated tachycardia (PMT). *Except in the case of PMT and dual AV nodal pathways or a coincidentally timed premature ventricular complex. †V-A-A-V response only occurs when there is absent or delayed intrinsic AV conduction. See text for discussion. EGM = electrogram; PVARP = postventricular atrial refractory period; Vp = ventricular paced event; Vs = ventricular sensed event. (Reproduced with permission from Ip JE, Markowitz SM, Liu CF, Cheung JW, Thomas G, Lerman BB. 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;8:1185–1191.)

P-wave morphology) can distinguish PMT from atrial tracking. The algorithm was validated using a virtual simulator of 35 scenarios.[2]

We previously highlighted the importance of diagnostic accuracy, especially when decisions are made regarding patient treatment plans, such as extending PVARP parameters

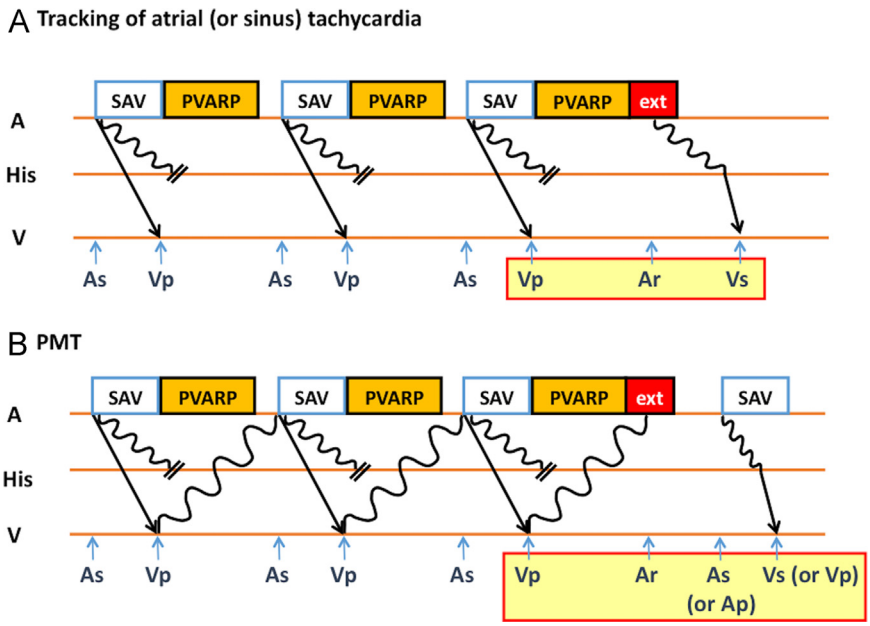

Figure 2 Response after single postventricular atrial refractory period (PVARP) extension. **A:** During atrial tracking in DDD mode of atrial (or sinus) tachycardia, PVARP extension transforms the atrial event into an Ar event and tracking no longer continues. This results in a V-A-V response and termination of wide complex tachycardia in the case of intact AV conduction. **B:** During pacemaker-mediated tachycardia (PMT), PVARP extension beyond the retrograde atrial event can no longer trigger an SAV delay and the tachycardia terminates, resulting in a V-A-A-V response. See text for discussion. Ar = atrial refractory event; As = atrial sensed event; Ap = atrial paced event; ext = extension; SAV = sensed atrioventricular delay; Vp = ventricular paced event; Vs = ventricular sensed event. (Reproduced with permission from Ip JE, Markowitz SM, Liu CF, Cheung JW, Thomas G, Lerman BB. 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;8:1185–1191.)