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Atrial pacing every other beat: Is it pacemaker malfunction?

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ABSTRACT

A 45 year old female with hypertrophic obstructive cardiomyopathy and a dual chamber ICD underwent left ventricular outflow and mid ventricular cavity myectomy and mitral valve replacement. On her 5th day after surgery, ECG shows electronic atrial pacing every other complex with monomorphic wide QRS rhythm. The explanation of this ECG pattern is discussed.

A 45 year old female with hypertrophic obstructive cardiomyopathy, Boston Scientific dual chamber ICD (ENERGEN E142/110613) implanted in 2013, underwent left ventricular outflow and mid ventricular cavity myectomy, excision of papillary muscles and subvalvular mitral apparatus and mitral valve replacement with On-X prosthetic mechanical heart valve 27 × 29 (CryoLife Inc. Kennesaw, GA). Following surgery, her telemetry showed ventricular-paced rhythm with significant ectopy. On her 5th day after surgery, her telemetry tracing was concerning for inappropriate pacing spikes. 12 lead ECG was recorded (Fig. 1).

Which of the following is this ECG most consistent with?

A. Electronic atrial pacing every other complex, suggesting atrial lead malfunction.
B. Atrial fibrillation with intermittent (every other complex) electronic ventricular pacing.
C. Accelerated Idioventricular rhythm with properly functioning ICD function.
D. Monomorphic ventricular tachycardia with anti-tachycardia pacing (ATP) attempt.

The correct answer is C. The ECG shows a monomorphic wide QRS rhythm at a rate of 62 bpm. The QRS complexes have a right bundle branch block with right superior axis configuration. Electronic pacemaker spikes are seen 0.08 s before every other QRS complex, followed by a P wave, suggesting electronic atrial pacing with capture (Figs. 1 and 2). The non-paced complexes are not preceded by a spontaneously conducted P wave. In contrast a retrograde P wave is seen after the QRS (Fig. 2). Her dual chamber ICD device was interrogated and revealed normal functioning.

The device was programed to pace at a lower rate limit (LRL) of 50 bpm (RR interval of 1200 ms), maximum tracking and sensing rate of 130 bpm, paced and sensed AV delay of 200–300 ms, post ventricular atrial refractory period (PVARP) of 260–360 ms and ventricular refractory period (VRP) of 230–250 ms.

Postoperatively, the patient developed a wide QRS rhythm (most probably an accelerated idioventricular rhythm, although junctional rhythm with aberrancy cannot be excluded) at 62 bpm. This Boston Scientific Dual chamber ICD was programed to have "modified atrial based timing" - meaning it will maintain A-A timing to LRL, but it will modify the interval if a ventricular-paced or spontaneous QRS complex is detected during the monitoring period. The difference between the AV delay interval and the actual AV interval between the atrial pacing and the intrinsic QRS (complex A) (Interval D) is applied to the next V-A interval to provide a smooth transition without changing the A-A intervals (Fig. 2).

The device paces the atrium (Fig. 2; A-pac) then there is a QRS complex at about 240 ms after the atrial pacing (A). The QRS is not preceded by electronic ventricular pacing, as it occurs earlier than the 300 ms programmed AV Delay (transparent bar). Moreover, the QRS morphology is identical to the preceding QRS complex. This is actually, "pseudo AV conduction" due to isorrhythmic dissociation of the atrial pacing and the intrinsic rhythm.

The next intrinsic QRS (B) occurs prior to the end of the 1200 ms LRL interval [AV delay (300 ms, transparent bar) + V-A interval (900 ms, black bar) ± interval D (The difference between the AV delay interval and the actual AV interval between the atrial pacing and the intrinsic QRS)]. This QRS is detected by the device and is viewed as a

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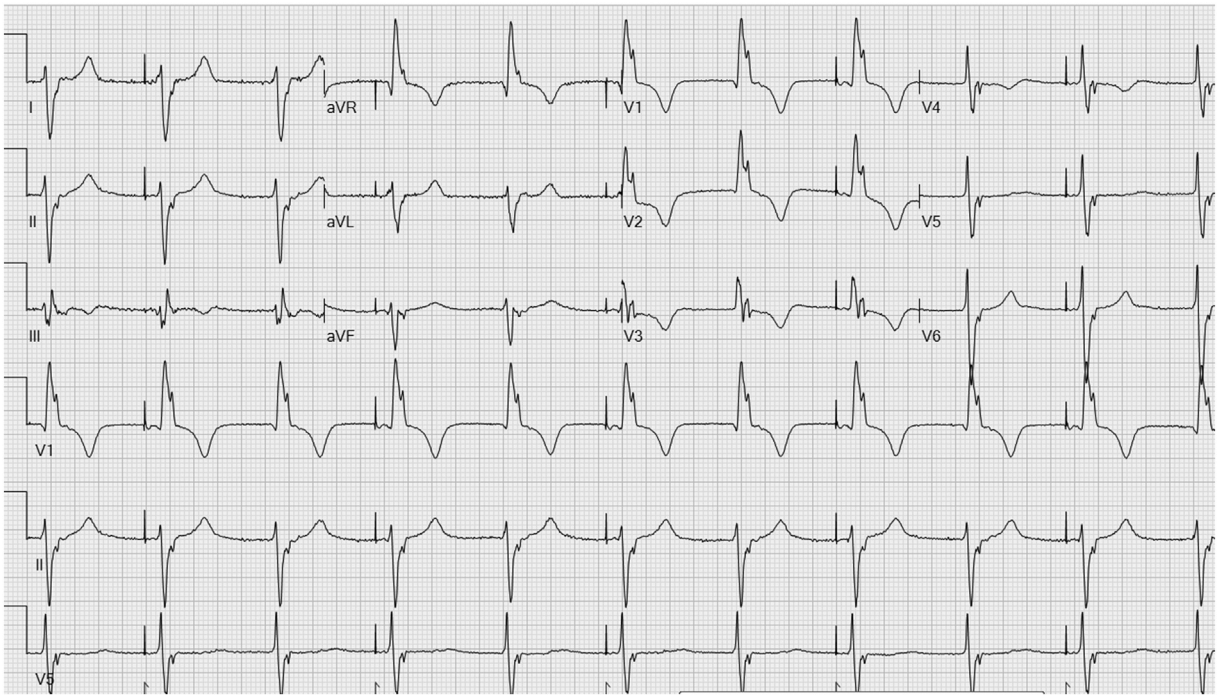

Fig. 1. Presenting ECG showing Electronic atrial pacing every other complex with wide QRS regular rhythm. The complexes preceded by electronic atrial pacing and those which are not preceded by the pacing stimulus seem identical.

spontaneously conducted complex. As this complex is not preceded by atrial activation, it is interpreted as premature ventricular complex (PVC) and the V-A interval (900 ms, black bar) is restarted once the QRS is detected. The next Atrial Pace occurs 900 ms after QRS complex B. Approximately 90 ms after QRS complex B there is a retrograde P Wave that falls into refractory period.

Her ICD Brady parameters were changed to an LRL of 70 bpm with an AV Delay of 200–300 ms to suppress the spontaneous idioventricular rhythm. Follow up ECG (Fig. 3) shows atrial pacing at a rate of 70 bpm followed approximately 240 ms later by wide QRS complexes with left bundle branch configuration. The change in the QRS morphology supports the fact that the original rhythm in Fig. 1 was an accelerated idioventricular rhythm and not a junctional rhythm.

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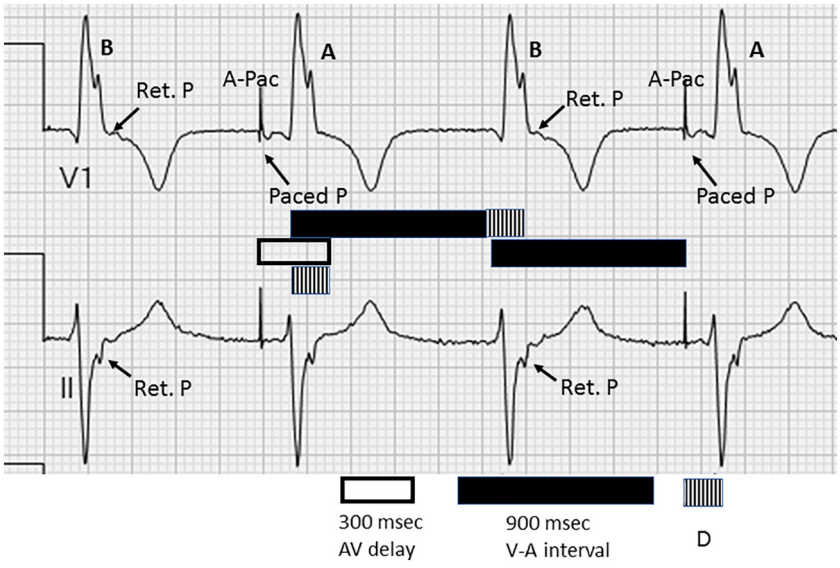

Fig. 2. Magnification of a segment of the ECG in Fig. 1. There is electronic atrial pacing (A-Pac) every other complex. There are small retrograde P waves after the QRS complexes (B) that are not preceded by atrial pacing (Ret. P). The AV delay (300 ms) is marked by the transparent bar. The V-A interval (900 ms) is marked by the solid black bar. The lower rate limit (LRL) of 50 bpm (RR interval of 1200 ms) is the sum of the AV delay and the V-A interval. The difference between the AV delay interval and the actual AV interval between the atrial pacing and the intrinsic QRS (complex A) (Interval D) is applied to the next V-A interval to provide a smooth transition without changing the A-A intervals.

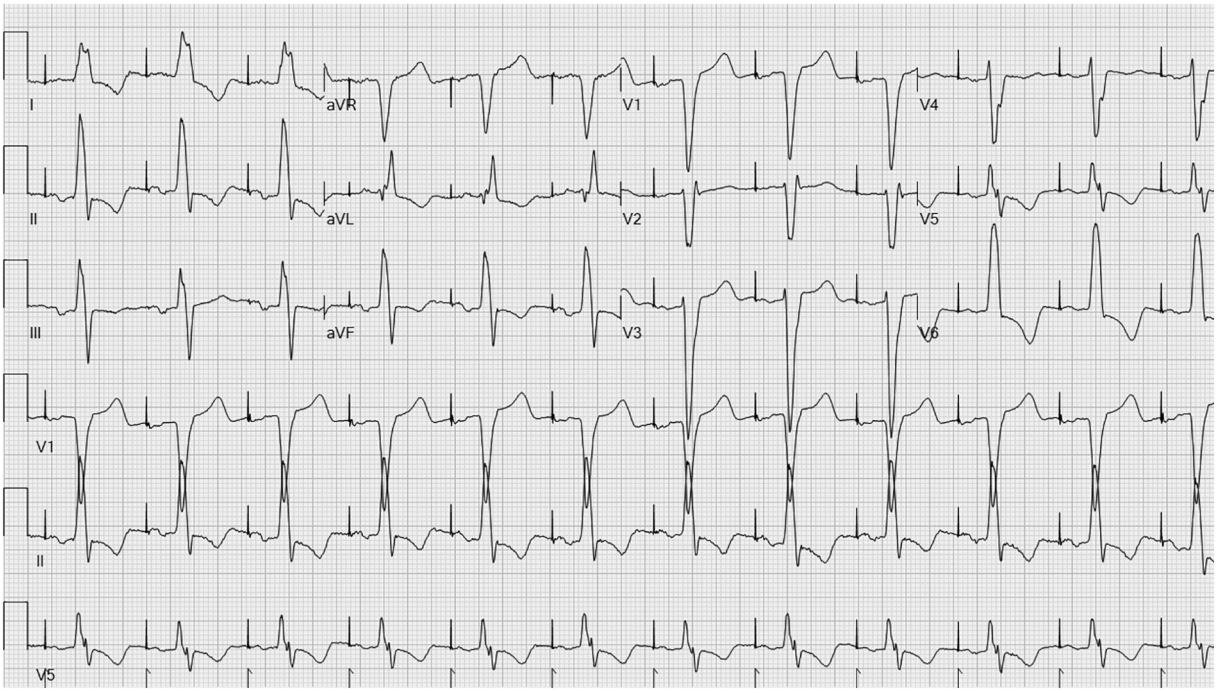

Fig. 3. Subsequent ECG after changing the device programing shows electronic atrial pacing every complex followed by wide QRS complexes with left bundle branch configuration after an AV delay of 240 ms.