Pacemaker malfunction or non-physiological ventricular pacing?

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Pacemaker manufacturers have developed new algorithms to preserve intrinsic conduction in order to reduce unnecessary stimulation and looking for physiological pacing. This case report highlights some of the new challenges related to these algorithms which include possible ECG misinterpretations and inaccurate programming leading to potential negative consequences.

Keywords Physiological pacing

Case summary

A 72-year-old woman was admitted to the trauma department for an elbow fracture after a casual fall. She had received a dual chamber pacemaker 2 weeks ago due to a paroxysmal atrioventricular block. The second day after admission she referred dizziness related to postural changes. A 12-lead ECG was performed (Figure 1). A pacemaker malfunction was diagnosed by the internist and a cardiology evaluation was then requested. Figure 1 shows the 12-lead ECG obtained after initial evaluation.

Commentary

The 12-lead ECG shows pacing stimuli at 70 beats per minute which seems to capture in the atrium followed by a regular intrinsic ventricular response at 70 bpm. The atrioventricular (AV) interval is prolonged. At this point, differential diagnosis includes: (i) inadvertent programming to AAI(R) mode; (ii) crosstalk [ventricular sensing (VS) of the far-field atrial stimulus resulting in inhibition of the ventricular output and resetting of the atrial escape interval]; (iii) an inaccurate AV interval programming which seems improbably because the estimated AVI is near 400 ms; and (iv) finally, it could be a case of a pacemaker pseudodysfunction, that is, a misinterpretation of normal function. A second ECG performed a few minutes after initial evaluation gave us the answer (Figure 2).

The second ECG shows again atrial pacing at 70 bpm with a progressive prolongation of AV interval and intrinsic ventricular events until one of the atrial stimulus is not conducted to the ventricle, that is, a 4:3 Wenckebach phenomenon. Then, an atrial stimulus followed by a ventricular paced event with a very short AV interval can be seen reinitiating the Wenckebach phenomenon (Figure 2).

The patient had received a Medtronic Inc. device with MVP (managed ventricular pacing) algorithm and the pacemaker had an adequate functioning. MVP algorithm is designed to avoid unnecessary VP preserving intrinsic conduction. It is an atrial-based pacing mode that looks for any consecutive A–A intervals without associated ventricular events. The algorithm allows prolonged AV intervals and occasional, single, non-conducted normal atrial contractions (sensed or paced). After a first A–A interval with no conducted VS, a backup VP is delivered 80 ms after the AP stimuli (Figure 2). MVP switches from AAI(R) operation to DDD(R) operation when there is evidence of persistent loss of AV conduction. The criterion to switch is loss of AV conduction for two out of the last four pacing cycles (the four most recent A–A intervals). This allows fast switch to DDD(R) mode but does not cause false switching on a single non-conducted atrial event.

Since there is no limit for the AV interval in the MVP algorithm, it is possible to see patients with first degree AV block, long AV interval (400 ms in our case), and an AAIR operation. This seems not to be a real physiological pacing mode because of the possible consequences of such a long AV interval in the LV filling pattern. For that reason, it is recommended to switch from AAIR to DDDR in these cases.

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Discussion

Algorithms to preserve intrinsic AV conduction and avoid unnecessary RV pacing have emerged looking for physiological pacing and trying to minimize the possible negative consequences of right ventricular apical pacing in selected patients.\(^1\)\(^-\)\(^2\) Two strategies have been proposed with this respect: the first one includes the optimization of timing cycling operations and changes in pacing mode in order to preserve intrinsic AV conduction; the second one consists in the search for alternative pacing sites in those patients who do not have intrinsic AV conduction and really need permanent VP.\(^3\)
This case report brings us some important lessons. First, we will have to change our traditional concepts about pacemaker ECG interpretation: until the appearance of these new algorithms the presence of an atrial event (sense or paced) without conduction to the ventricle implied a pacemaker malfunction. Misinterpretation of pacemaker ECGs will be more frequent considering the increasing number of new algorithms, especially for general physicians and even for clinical cardiologists who are not in contact with devices in their daily clinical practice. On the other hand, although algorithms like MVP have demonstrated utility in reducing cumulative per cent ventricular paced, clinical benefits have not yet been proven4–5. Therefore, and taking into account the possible harmful effects (a long AV interval can disturb the LV filling pattern), the use of these algorithms in all patients with paroxysmal AV block could be questioned. An accurate selection of candidates to receive an MVP algorithm and an adequate programming of the pacemaker functions could minimize these situations.

Conflict of interest: none declared.

References