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Rare but significant cognitive effects of second-degree atrioventricular block

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1. Case presentation

A 49-year-old male General Practitioner was referred for symptoms of progressively worsening lethargy, short term memory loss, cognitive impairment and reduced mood over several months with periods of nocturnal agitation, to the extent of requiring time off work, reduced work hours and reduced consultation frequency (3/hour). His past medical history is significant for seronegative psoriatic arthritis on short-term methotrexate and prednisolone. There was no previous cardiac history.

Prednisolone was initially thought to be the culprit and was therefore weaned. Although symptoms of nocturnal agitation settled, his cognitive impairment worsened. He self-referred for general cardiac assessment due to ongoing lethargy and a recent diagnosis of ischaemic heart disease in a first degree relative. Specialist clinical examination and transthoracic echocardiogram (TTE) were unremarkable. A Holter monitor however demonstrated a predominantly nocturnal but also occurring during daytime second degree atrioventricular (AV) block of both Wenkebach and 2:1 AV block (Fig. 1A), and a sleep study did not demonstrate obstructive sleep apnoea. Although felt unlikely to explain the cognitive impairment, a pacemaker was implanted in hope to alleviate symptoms of lethargy.

Following the pacemaker implantation in DDD mode (ADVISA™ Medtronic Inc), there was a significant patient-reported improvement in energy levels and cognitive sharpness. Unfortunately, these perceived improvements were short-lived, and symptoms of fatigue, mental fogginess and cognitive impairment set in again after a few months when Managed Ventricular Pacing (MVP) was turned on to reduce ventricular pacing burden.

At this stage, a neuropsychiatric aetiology was considered, with a provisional diagnosis of early-onset dementia. However, following several comprehensive geriatric and neuropsychiatric assessments, including inflammatory screen and brain magnetic resonance imaging, no cause was found, and no definite diagnosis could be reached.

For completeness, a Holter monitor was repeated, which demonstrated persistent episodes of second-degree AV block (Fig. 1B). This was subsequently identified as a shortfall in the Managed Ventricular Pacing (MVP) mode in ADVISA devices. Following programming changes back to DDD, there was a complete resolution of lethargy, and full recovery of cognitive function and mental stamina, and return to work on full-time hours.

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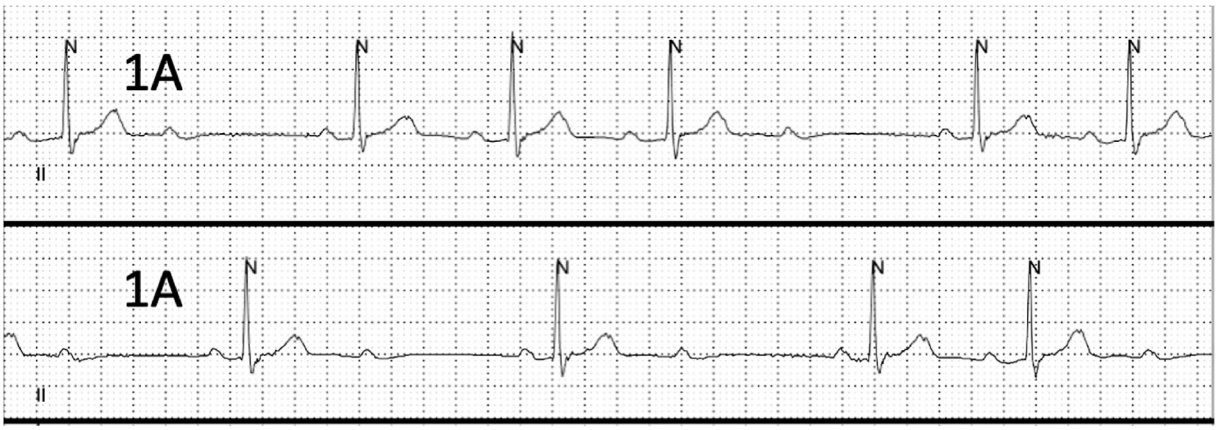

Fig. 1A. Initial Holter tracing demonstrating AV conduction disease.

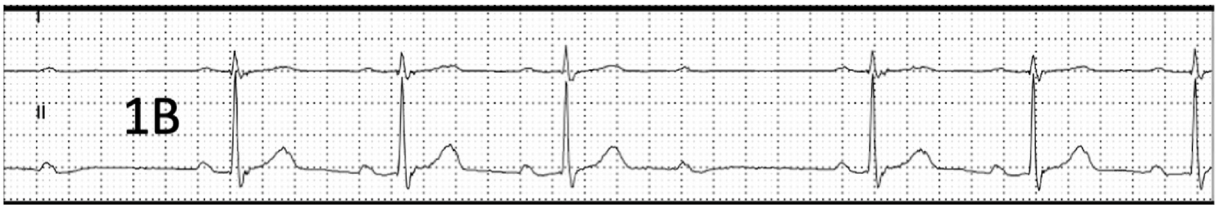

Fig. 1B. Holter tracing post-pacemaker insertion in DDD mode with MVP enabled, demonstrating persistent second-degree AV dysfunction.

2. Discussion

This case offers two salient learning points. Firstly, cognitive impairment from high burden of second-degree heart block is a rare but important symptom to recognise. Secondly, second-degree AV block can persist when MVP is turned on in ADVISA generators.

The most likely physiological explanation for cognitive impairment is the compromise of brain perfusion during periods of atrioventricular dysfunction. On the severe end, patients can present with syncope in the setting of complete heart block. However, milder forms of cognitive impairment from milder degrees of heart block are often less recognised. According to pacemaker interrogation, the burden of second-degree heart block was estimated at roughly 23%, and although the periods of dropped ventricular conduction were intermittent, the overall burden of disease was significant enough to result in cognitive impairment.

Secondly, Managed Ventricular Pacing (MVP™) [1] is a feature on Medtronic pacemakers that is able to provide atrial-based pacing modes. High burden of ventricular pacing is associated with higher risk of heart failure hospitalisation [2] and atrial fibrillation [3,4]. Atrial-based pacing modes can also be seen in other manufacturers, such as AAISafeR® in MicroPort CRM-Sorin devices, Ventricular Intrinsic Preference (VIP®) in St Jude Medical devices, AV Search Hysteresis (AVSH®) in Guidant devices, Vp Suppression and Intrinsic Rhythm Search (IRSplus®) in Biotronik devices, and Rhythm IQ® in Boston Scientific devices.

In MVP, when the device is running in AAI mode, when two of the four most recent A-A intervals do not have corresponding ventricular events, the pacemaker will switch to DDD. And while the device is in DDD mode, after the first minute, it conducts a one-cycle check for AV integrity (atrial signal followed by ventricular event). If AV conduction is intact, it will resume atrial-based AAI pacing mode. Conversely, if the test fails, subsequent checks will be conducted at progressively longer intervals. In this case, the device will be primarily running in AAI mode.

This operational algorithm presents a specific dilemma for patients with an ADVISA™ generator with intermittent symptomatic second-degree AV block of either Mobitz types, specifically 3:1, 4:1 or more sporadic forms of AV non-conduction. In this scenario, because non-conduction are single beats, it will not satisfy the criteria to switch to DDD, and the V–V interval between the preceding conducted beat, and the ensuing conducted beat could be twice as long as the A-A interval. If these long V–V intervals are frequent enough, the overall burden of dropped beats may contribute to ongoing symptoms, in this case cognitive effects resembling dementia.

A solution in patients with ADVISA™ is to keep the device in DDD mode, and adjust the device sensed AV and paced AV intervals, to strike a balance between encouraging intrinsic conduction and losing ventricular support for the intermittent AV losses. This strategy will ensure that there will be no missing ventricular event in each A-A cycle.

For patients with intermittent AV block requiring a de novo implant, consideration should be given to either implant a Medtronic AZURE™ generator, or use an alternative device option such as Boston Scientific. The AZURE™ has an updated MVP algorithm in that if an atrial beat is not conducted, it will deliver an atrial pace with a paced AV interval of 80 ms, thereby avoiding long V–V intervals in the event of a non-conducted atrial events. Boston Scientific generators' propriety Rhythm IQ algorithm works slightly differently but also addresses this dilemma, by always providing a VVI backup at 15 bpm slower than lower rate limit to avoid undesirably long V–V intervals.

In this particular case, disabling MVP resulted in the resolution of lethargy, and full recovery of cognitive function and mental stamina.

3. Conclusion/novel teaching points

This unique case study allowed an appreciation of the rare cognitive effects of second-degree atrioventricular heart blocks that can be easily overlooked. In addition, Managed Ventricular

Response (MVP) in patients with Medtronic ADVISA™ pacemakers should be used with caution in patients with intermittent second-degree AV dysfunction, and alternative pacing modes may need to be considered.

Contributor roles statement

Chow CL Writing – Original draft, review and editing, **Rattray-Wood** C Writing – Review and editing, **Rayoo** R Writing – Review and editing, **Lim** H Conceptualization, writing – review and editing.

Declarations of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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