

Concealed Sinus Node Dysfunction and Paradoxical Effect of Atropine during Arrhythmia Diagnostic Pharmacological Testing

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ABSTRACT: A 78-year-old male patient presented with repetitive fainting episodes. His electrocardiogram showed sinus rhythm with persistent ventricular bigeminy. Concealed sinus node dysfunction (SND) with consecutive bradycardia-induced ventricular hyperexcitability was suspected. Pharmacological testing with atropine resulted in accelerated junctional rhythm along with nearly total disappearance of the ventricular ectopy. The diagnosis of SND was retained, a dual chamber pacemaker was implanted, and consequently, ventricular hyperexcitability disappeared. The junctional rhythm was a paradoxical effect of atropine, and many explanations were provided. Discussion was made accordingly taking into account relevant data from the literature.

KEYWORDS: sinus node dysfunction, ventricular ectopy, concealed, atropine, paradoxical

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Introduction

Sinus node dysfunction (SND) is a relatively common cardiac condition in the elderly. It may present with different clinical and electrocardiographical forms. Standard and long-term electrocardiographical recording may exhibit persistent bradycardia, alternating bradycardia–tachycardia, sinus pauses, or sinus arrest. In this context, the appearance of ventricular hyperexcitability is often a bradycardia-induced arrhythmia,¹ and it may mask the classical electrocardiographical presentation of SND (concealed SND). Pharmacological autonomic blockage is sometimes used to unmask a concealed form of SND, also it may help to distinguish between intrinsic and extrinsic forms of SND. In this paper, we present a symptomatic patient with a concealed form of SND, in whom atropine testing yielded a junctional rhythm with a nearly total disappearance of premature ventricular complexes (PVCs). The appearance of accelerated junctional rhythm is a paradoxical effect of atropine, and discussion

was made according to the literature data. The patient has given his consent for publication of his medical information in this case report.

Case Presentation

A 78-year-old male patient presented with repetitive fainting episodes. He had no relevant medical history. Physical examination showed irregular heart beats, and carotid sinus massage was negative. Electrocardiogram and electrical monitoring showed sinus rhythm with persistent ventricular hyperexcitability in the form of ventricular bigeminy: monomorphic PVC with fixed coupling interval and fixed post-PVC cycle length (Fig. 1). Moreover, PVCs were “non-efficient” hemodynamically yielding a radial pulse estimated at ~30 bpm. Cardiac echogram revealed no structural heart disease. Also a coronary angiogram revealed no significant coronary artery disease. After a short-term (48 hours) beta-blocker therapy in an attempt to reduce ventricular ectopy,

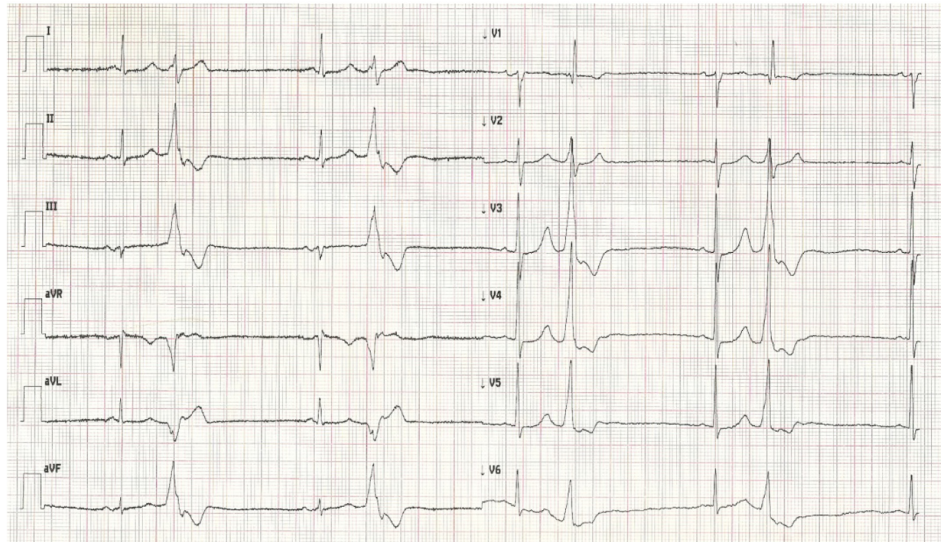


Figure 1. Baseline electrocardiogram (ECG); sinus rhythm with monomorphic PVC, bigeminy, fixed coupling interval, and long post-PVC pause. A retrograde P wave is seen merged with the T wave.

the patient was referred to the electrophysiologist who suspected a concealed SND as initial diagnosis. A bedside pharmacological testing with 0.5 mg atropine (bolus) was applied; there was a sinus arrest with a junctional accelerated rhythm within 40 seconds, along with relative disappearance of ventricular ectopy (Fig. 2). The patient was reluctant to any further invasive testing (electrophysiological testing), and the diagnosis of concealed SND was retained; accordingly, a dual chamber pacemaker was implanted with a programmed basic rate at 60 bpm. It allowed total

disappearance of symptoms and nearly complete fading of ventricular ectopy (Fig. 3).

Discussion

Concealed SND with bradycardia-induced PVCs was the most probable diagnosis initially retained given the absence of structural heart disease and the response to heart rate acceleration yielding nearly complete fading of ventricular ectopy. The second diagnostic hypothesis was primary ventricular hyperexcitability with consecutive post-PVC pauses, probably

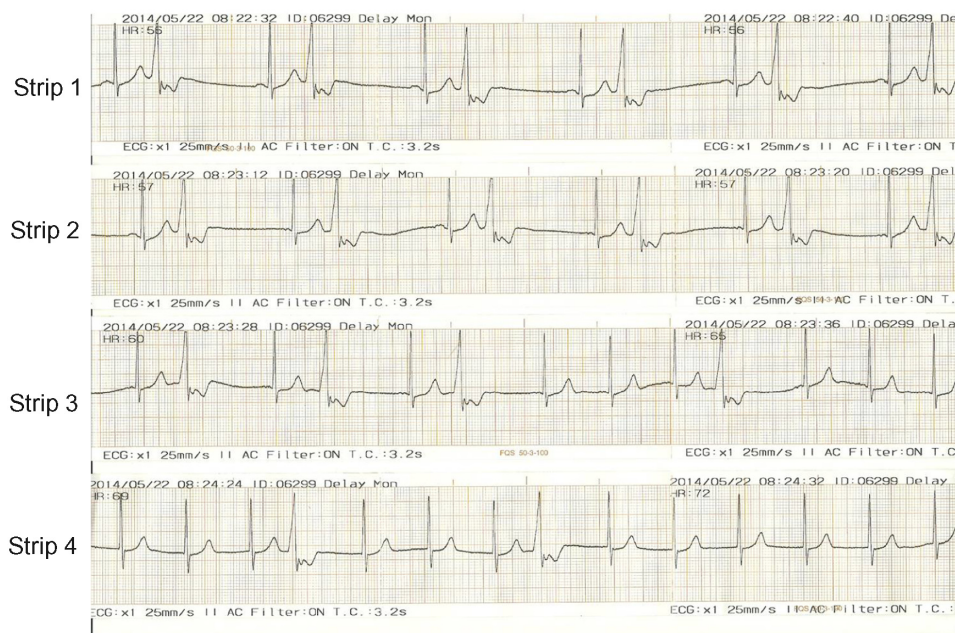


Figure 2. Monitoring (single lead) EKG; strip 1: baseline rhythm, permanent ventricular bigeminy, and administration of 0.5 mg atropine; strip 2: “non-sinus” rhythm (second beat) with persistence of PVC; strip 3: junctional rhythm with decrease in PVC; and strip 4: disappearance of PVC at the end of the strip with persistent junctional rhythm.

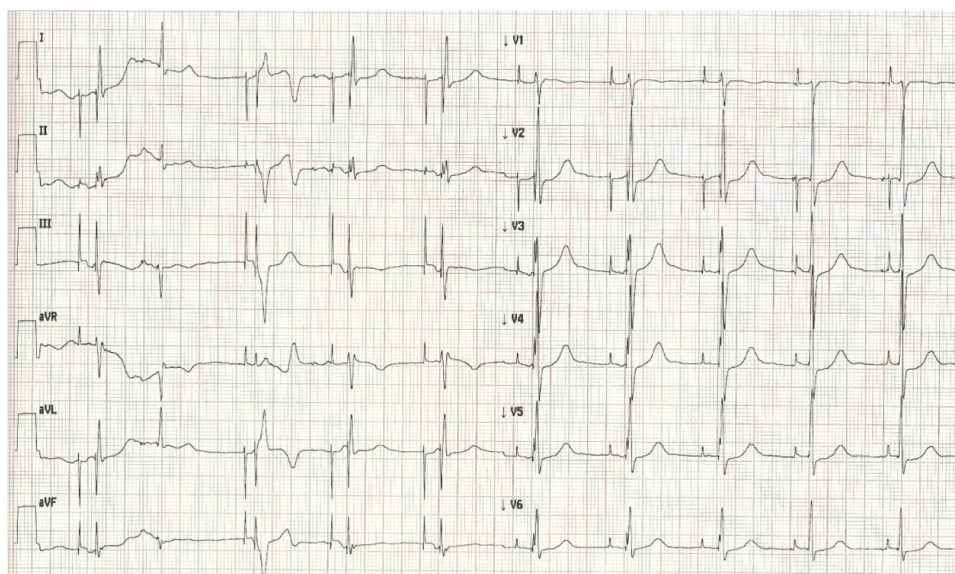


Figure 3. A dual chamber pacemaker (DDD) pacemaker was implanted, programmed at 60 bpm; of note, the second beat was a conducted premature atrial complex; the third beat showed a paradoxical atrioventricular (AV) delay shortening because of PVC sensing inside the AV period yielding a safety pacing; ventricular hyperexcitability in the form of bigeminy disappeared.

expanded by retrograde conduction. However, the response to atropine with fading of PVCs is rather suggestive of concealed SND with secondary ventricular hyperexcitability; in this context, the mechanism of PVCs is either triggered activity or increased automaticity.¹ The concept of concealed SND is not quite new²; however, it is important to recall this phenomenon given its rare and atypical presentation.

Of note, beta-blocker therapy was given in an attempt to suppress PVCs. This therapy was not efficient. Also it could have worsened the bradycardia; patients with SND have frequently a compensatory sympathetic regulation to improve the impaired intrinsic automaticity, and beta-blocker therapy may suppress this adrenergic compensatory mechanism.³

SND may be totally asymptomatic, and pacing indication is only recommended in symptomatic patients; herein the decision for pacing was not only to suppress the symptoms but also to reduce/suppress the related ventricular hyperexcitability. Moreover, a probable atrioventricular nodal conduction disease is present. The absence of retrograde P waves when a junctional rhythm appeared – despite atropine administration – favors this hypothesis⁴; an electrophysiological study (non-performed because of patient reluctance) could have confirmed this hypothesis.

The occurrence of paradoxical sinus arrest is already documented with atropine, and the exact mechanism is poorly elucidated^{5,6}; however, many assumptions have been proposed: (1) atropine with its vagolytic effect may exert a “stress test” on the “P cells” of the sinus node (already diseased in SND), and this may yield a sinus arrest; (2) atropine at low doses (≤ 0.5 mg) may result in paradoxical vagotonic effect at the level of the sinoatrial node and a vagolytic effect at the level

of the atrioventricular node with consequently the appearance of junctional rhythm; and (3) atropine may lead to peripheral vasodilatation with hypotension, and a consecutive reflex hypervagotonia may occur; the phenomenon is similar to the cardioinhibitory or vasodepressive response observed with drug challenge during tilt testing. Also it is similar to the phenomenon of sinus arrest observed during induction of general anesthesia when associated with “massive” peripheral vasodilatation.⁶ At low doses (≤ 0.5 mg), atropine exerts a vagotonic stimulation of the central nervous system with probable cholinesterase inhibition, and this phenomenon is thought to be a possible cause of the paradoxical effect of atropine.⁵ At higher doses (≥ 1 mg), the central vagotonic effect of atropine may be masked by its muscarinic blockade.⁷

Conclusion

Concealed SND may present as ventricular hyperexcitability, and such atypical presentation can compromise the diagnostic and therapeutic processes. Paradoxical response to atropine in SND may consist of sinus arrest and junctional escape rhythm; such paradoxical effect may be related to either primary central vagotonic effect of atropine or secondary reaction related to the vasodilatory effect of atropine.

Author Contributions

Conceived the concepts: MK, AK. Analyzed the data: MK, AK. Wrote the first draft of the manuscript: MK, AK. Contributed to the writing of the manuscript: MK, AK. Agree with manuscript results and conclusions: MK, AK. Jointly developed the structure and arguments for the paper: MK, AK. Made critical revisions and approved final version: MK, AK. Both authors reviewed and approved of the final manuscript.



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