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Case Report

Mobitz Type II Second-Degree Atrioventricular Block in a Pilot : To Pace or Not to Pace?

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Abstract

Background: Cardiac arrhythmia is one of the main disqualifiers for loss of flying license. Distinguishing between benign and potentially significant cardiac rhythm abnormalities remains a challenge. Atrioventricular (AV) block is a threatening condition that can lead to sudden loss of consciousness and death. If it happened to aircrew, surely would compromise the reliability of flight operations and safety. The present case describes the electrophysiological feature of a Mobitz type II second-degree AV block in an aircraft pilot.

Case illustration: A 60-year-old male commercial aircraft pilot presented with asymptomatic Mobitz type II AV block recorded from inflight Holter monitoring. He had never experienced any remarkable symptoms including near syncope but had history of elective percutaneous coronary intervention (PCI) with one stent at left circumflex (LCx) coronary artery. Electrophysiology (EP) study showed normal result. Stimulation with atrial pacing and adenosine triphosphate (ATP) showed prolongation of AH interval without changes in HV interval, concluding the presence of a supra-Hisian AV node dysfunction. The highly demanding physiological environment in aircraft elucidate the likelihood of vagotonic cause of his condition and pacemaker implantation was not warranted.

Conclusion: We reported a case of a senior aircraft pilot with asymptomatic high degree AV block with narrow QRS complex and prolonged P-P interval during ventricular asystole episode detected from 24-h inflight Holter monitoring, which increase the likelihood of a vagotonic atrioventricular block. Electrophysiology study was conducted and revealed a supra-Hisian AV node dysfunction, therefore pacemaker implantation was not performed.

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Keywords: aircrew, atrioventricular block, electrophysiology, pacing, vagal

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Introduction

Aircrews (pilot and non-pilot) are responsible for flight safety and reliable flight operations. Aircrew often operate within a demanding physiological environment that might possibly affect cardiovascular system. When cardiovascular disease is discovered, appropriate examination and management are required to ensure flight safety.[1] Loss of flying license for medical reasons in Western Europe mostly caused by cardiovascular disease and as much of 50% with cardiac arrhythmia as the main disqualifier. Aeromedical assessment is complicated further when trying to distinguish between benign and potentially significant rhythm abnormalities in aircrew.[2]

Atrioventricular (AV) block is an AV conduction disorder that can manifest in various symptoms and severity. Anatomically, AV block can be divided into supra-, intra- or infra-Hisian. Mobitz type I AV block tend to be from supra-Hisian block, whereas type II tend to be infra-Hisian. Supra-Hisian AV block are generally associated with a better prognosis, as the ensuing escape rhythm tends to be faster and more reliable.[3,4] The usefulness of intracardiac recording and stimulation techniques in humans was first realized during its application to patients with disorders of atrioventricular (A-V) conduction, known as electrophysiology study (EPS).[5] EPS allowed confirmation and further elucidation of the underlying mechanisms and site of block diagnosed by surface ECG.[4] Discrimination between second degree AV block Mobitz type I and II can be challenging from surface ECG, therefore invasive electrophysiology testing with measurement of the AH and HV interval may be helpful.[2] There are certain occasions on which an EPS is mandatory for establishing diagnosis and considering appropriate prophylactic pacing.[5]

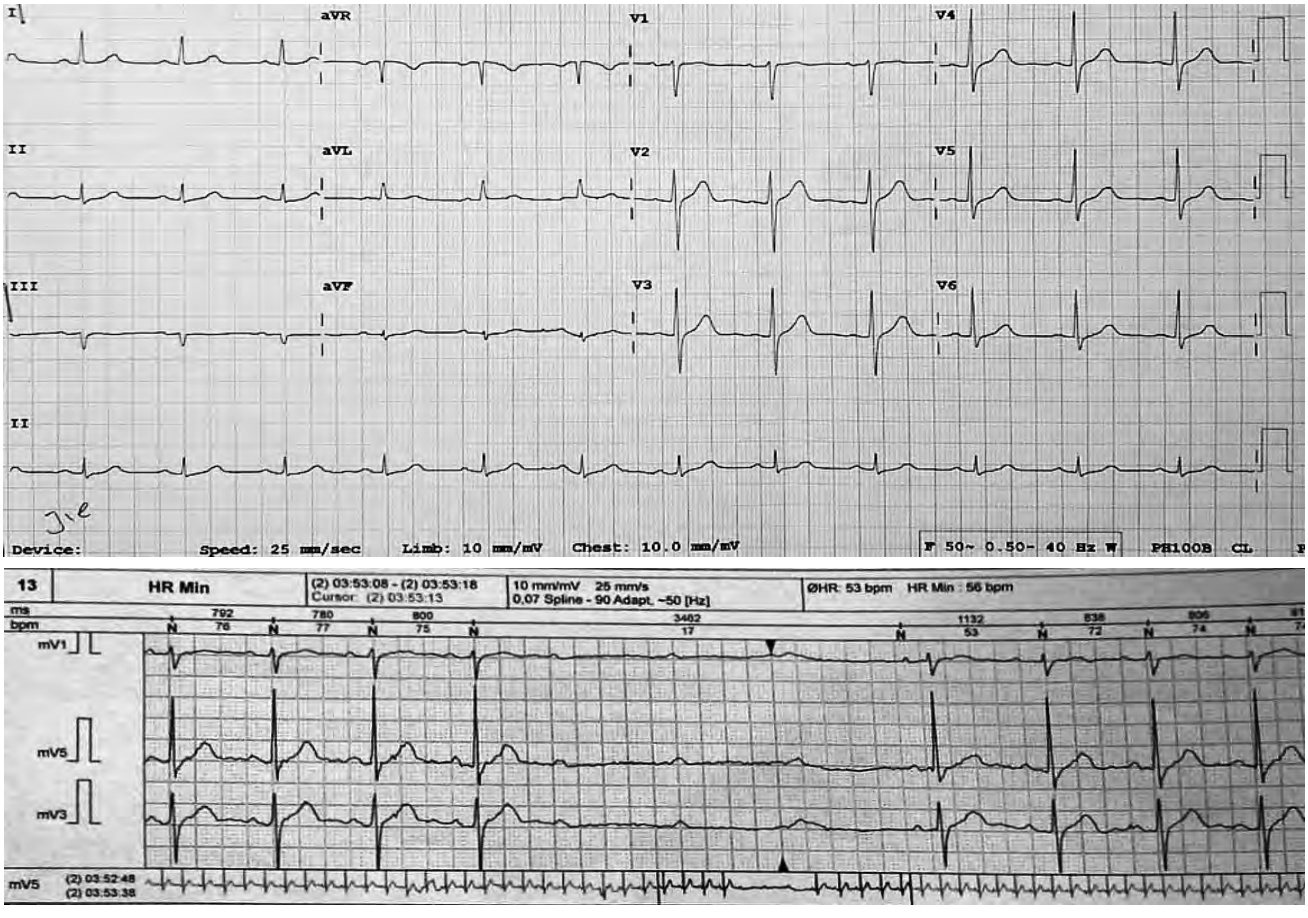

Figure 1. Patient's electrocardiogram (ECG): (a) Normal sinus rhythm ECG at outpatient clinic visit; (b) ECG strip from 24-h during inflight Holter monitoring showed three P wave were not followed by QRS complex.

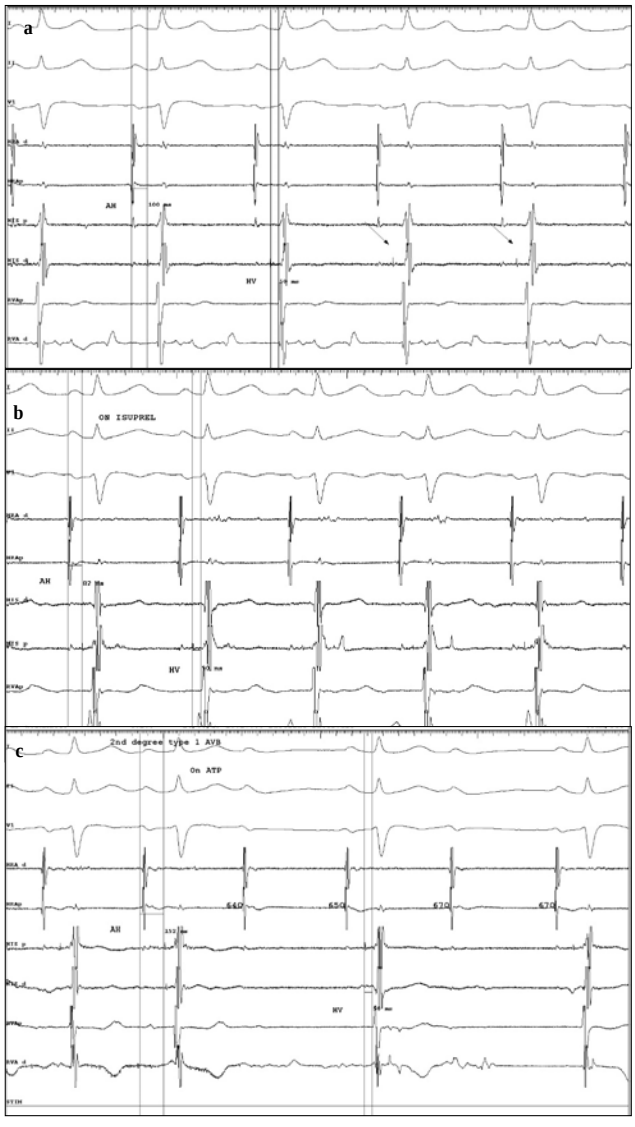

Figure 2. Electrogram (EGM) result from electrophysiology study: (a) normal AH and HV baseline interval, arrow indicated His electrical activity; (b) Isuprel stimulation showed improvement in AH conduction and unchanged HV nterval; (c) ATP stimulation induced second degree type 1 AV block with normal HV interval.

This presentation aimed to describe the electrophysiological feature of a Mobitz II AV block in an aircraft pilot.

Case Illustration

An asymptomatic 60-years-old male with a profession as commercial aircraft pilot was referred to outpatient clinic with Mobitz type II atrioventricular (AV) block

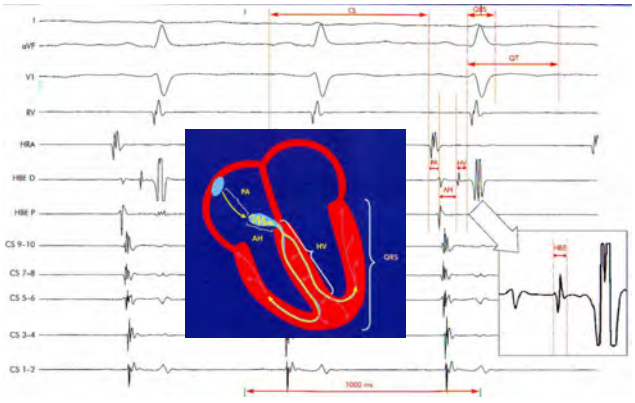

Figure 3. Basic interval measurements from EP study, showing together PA, AH and HV interval indicate what proportions of the PR interval can ascribed to conduction in the atrium, AV node and His-Purkinje system.

Modified from: Murgatroyd FD, et al. The Basic Electrophysiology Study.
In:Handbook of Cardiac Electrophysiology

revealed from 24 hours inflight Holter monitoring. He denied any symptoms such as dyspnea, fatigue, dizziness nor syncope. He had history of smoking, hypertension, dyslipidemia and stable asymptomatic coronary artery disease diagnosed from treadmill test. Stenting with one drug eluting stent (DES) at left circumflex (LCx) coronary artery was performed at 8 months ago. Due to his profession requirement to acquire flight license after 6 months of coronary stenting, he had to undergo inflight 24 hours Holter monitoring. His previous medication history was antiplatelet, statin, dihydropyridine calcium channel blocker and angiotensin receptor blocker.

Physical examination at outpatient clinic showed a fully alert patient with blood pressure of 140/67 mmHg, heart rate of 75 beats per minute, respiration rate of 18 times per minute, and 99% peripheral oxygen saturation in room air. Other physical examination did not show any remarkable findings. Electrocardiogram (ECG) examination at outpatient clinic showed sinus rhythm, normal axis, normal P wave and QRS duration with no ST-T changes (Figure 1a). Meanwhile, the 24-hour ECG monitoring at 3.53 AM showed sinus rhythm with Mobitz type II AV block, with only one episode of three P wave were not followed by QRS complex. Prolonged P-P interval during ventricular asystole was also noted (Figure 1b). Patient mentioned that during the block episode he felt nothing while sitting and chatting with his friends in relaxed circumstances. Echocardiogram

revealed normal heart chambers, good left ventricle systolic function with ejection fraction of 76%, global normokinetic wall motion and good right ventricular contractility.

Patient was then diagnosed with asymptomatic Mobitz II AV block and referred for further examination. Electrophysiology study was conducted and revealed P-P interval of 807 ms, AH interval of 105 ms, HV interval of 50 ms, PR interval of 172 ms, RR interval of 807 ms, QRS interval of 102 ms, QTc 434 ms. AV node effective refractory period of 280 ms, Wenckebach point of 330 ms, sinus node recovery time of 1080-1190 ms and corrected sinus node recovery time 390-450 ms, suggesting normal EP study. Stimulation with atrial pacing and adenosine triphosphate (ATP) showed prolongation of AH interval without changes in HV interval and episodes of second-degree type I AV block, indicating the presence of a supra-Hisian AV node dysfunction (Figure 2). There was also no inducible tachycardia. Patient was not advised for pacemaker implantation and avoid AV blocking agents. Treadmill test, nuclear perfusion study with thallium scanning and 6-month Holter evaluation consistently showed good result with no symptom nor any syncopal episode.

Discussion

Flying is often an exhilarating and adrenaline provoking quest, hence involve vagal stimulation or suppression. In addition with sustained acceleration from positive gravitational force from head to feet (+Gz), is a highly arrhythmogenic environment to those with pre-existing susceptibility.[1] Benign dysrhythmias such as sinus arrhythmia, low degree atrioventricular (AV) block, and premature atrial or ventricular beats are commonly observed as a physiological response to acceleration during centrifuge training.[2] If aircrew can mount an appropriate physiological response to stress (as demonstrated on an exercise stress test), mild ECG abnormality are usually regarded as acceptable in a high adrenaline flying environment.[1]

Second-degree atrioventricular block is sub-classified into Mobitz I (Wenckebach conduction) and Mobitz II. Mobitz I block occurs after gradual PR prolongation and Mobitz II does not. The ECG will show group beating as a result of "dropped" QRS complexes.[4] Mobitz II, high-degree, or advanced atrioventricular block refers to situations where ≥2 consecutive P waves at a normal rate are not conducted without complete loss of atrioventricular conduction.[6] Abnormalities of A-V conduction may result from conduction disturbances in any region of the heart, although certain patterns of block can be localized to specific sites (Table 1).[4] According to the site of block, AV block is divided into supra-Hisian, intra-Hisian (within the His bundle itself), and infra-Hisian (below the His bundle). Mobitz Type I AV blocks tend to be from supra-Hisian blocks, whereas Type II AV blocks tend to be infra-Hisian. Supra-Hisian AV blocks are generally associated with a better prognosis, as the ensuing escape rhythm tends to be faster and more reliable.[3,5] In general, atrioventricular block at the supra-His level is associated with slower progression, a faster and more reliable atrioventricular junctional escape mechanism, and greater responsiveness to autonomic manipulation. In contrast, atrioventricular block within or below the His bundle may progress rapidly and unexpectedly, is associated with a slower and more unpredictable ventricular escape mechanism, will not respond to atropine but will sometimes improve with catecholamines.[6]

Mobitz II block can occur anywhere in the AV conduction system, and the width of the QRS complex and the configuration of conducted beats and/or escape beats are of only limited value in localizing the site of block. A narrow QRS complex is most compatible with

Table 1. Sites of Atrioventricular Block

	First Degree	Second Degree		Third Degree
		Type I	Type II	
Atrium	Common	Virtually never	Virtually never	**Virtually never**
AV node	Common	Common	Virtually never	Common
Intra-His	Common	Uncommon	Common	Common
Infra-His	Common	Uncommon	Common	Common

Modified from: Josephson ME. Atrioventricular conduction. In: Josephson's Clinical Cardiac Electrophysiology. 5th ed: Lippincott Williams & Wilkins; 2015:96-115

an supra-His or intra-His problem, and a wide QRS complex is most compatible with an infra-His problem; however, a wide QRS complex may occur with A-V nodal or intra-His disease in the presence of coexistent bundle branch block. Approximately 70 % of type II blocks (i.e. consecutive, non-conducted P waves without changes in the PR interval) are associated with bundle branch block, whereas 30 % are associated with a narrow QRS complex, and are therefore within the His bundle. Although 2:1 or higher degrees of block (e.g. 3:1 and 4:1) have traditionally been classified as type II block, the site of those blocks cannot be reliably determined by the surface ECG. A 2:1 block in the context of bundle branch block does not necessarily indicate infranodal block, since in 15–20 % of patients the block is in the AV node.[5]

There are numerous disease states that may affect the atrioventricular conduction system resulting in atrioventricular block. These include both congenital and acquired forms. The latter are much more common and include infectious, inflammatory, degenerative, ischemic, and iatrogenic causes.[6] AV block caused by vagal influences is usually transient and generally does not require cardiac pacing.[4-6] In unusual circumstances (at night, with accompanying sinus slowing) a vagal cause may be considered especially when the QRS in narrow.5 Vagally mediated AV block observed with ambulatory electrocardiographic monitoring may be an incidental finding that occurred while the patient was sleeping or in other cases be associated with syncope. It might be related to neural reflexes, which result in simultaneous bradycardia and hypotension. There is typically sinus rate slowing in conjunction with the onset of AV block and the block can be Mobitz II or complete. AV block attributable to high vagal tone, such as during sleep, is almost always asymptomatic. The level of the block is at the AV node, and there is normal AV nodal function when tested at EPS.[4,5]

Paroxysmal AV block is a rare phenomenon most commonly caused by phase 4 block in the infra-Hisian conduction system. Phase 4 or diastolic depolarization is a property of pacemaker cells of the heart. Normal Purkinje cells do not possess this property; however, diseased Purkinje cells will acquire the property of phase 4 depolarization.[7] The presence of phase 4 block can be suspected by observing prolonged ventricular asystole and the absence of type I block in long tracings. Absence of sinus slowing is usually a criterion for type II block because a vagal surge can cause simultaneous sinus slowing and AV nodal block, which can superficially resemble type II block.[8] Significant PR prolongation before and after block and prolonged P-P intervals during ventricular asystole are indicative of vagal block that is a benign condition, rather than paroxysmal AV block, i.e. pause-dependent phase 4 AV block which is potentially dangerous for syncope.[9] A definitive diagnosis of phase 4 AV block require His bundle recordings. Thus pacing may not be required in asymptomatic patients with this pattern.[5]

In aircrew, the most common type of second-degree heart block is Mobitz type I (Wenckebach). In most cases this is an incidental finding in asymptomatic individuals, and further examination is usually not required.1 As with first degree heart block, further investigation is only required in those with symptoms, diurnal occurrence of Mobitz type I or in those aged over 40 years at first presentation. Most aircrew with Mobitz type I may be returned to unrestricted duties.[2,11]

Table 2. Indication for Electrophysiology Study of Atrioventricular Block

1.	Suspicion of concealed AV junctional extrasystoles
2.	Asymptomatic type I second degree AV block with bundle branch block
3.	Asymptomatic second degree AV block with bundle branch block
4.	Questionable diagnosis of type II block with a narrow QRS complex
5.	Suspicion of bradycardia-dependent (phase 4) infranodal block
6.	Transient second degree AV block with bundle branch block in patients with inferior myocardial infarction where the site of block is suspected to be in the His-Purkinje system rather than the AV node
7.	Third degree AV block with a fast ventricular rate
8.	Progressive conduction disease due to neuromuscular disorders or suspected SCN5A mutations

Modified from Katritsis DG, Josephson ME. Electrophysiological Testing for the Investigation of Bradycardias. Arrhythmia & Electrophysiology Review 2017;6:24-8.

Table 2. Indications for Cardiac Pacing in Chronic Heart Block

Degree	Intra-His or Infra-His	AV-node
First degree (prolonged conduction)	Yes, with symptomsa	**Nob**
Second degree (intermittent conduction)	Yes	Yes, with symptomsa
Third degree (no conduction)	Yes	Yes, with symptomsa

[a]Symptoms must be of cardiac origin
[b]Unless P-R is so long that the P wave occurs during the QRS and produces symptomatic Canon A waves or a "pacemaker syndrome.

In contrast, Mobitz type II is rarely seen in aircrew; it is more commonly related to infra-Hisian block, located below the AV node, and carries a risk of progression to third degree (complete) AV block.[5,6]

An intracardiac study is essential for accurate localization when the site of block cannot be really determined. Indication for electrophysiology study is mentioned in Table 2. From the surface ECG, PR interval was the only description of AV conduction system, while in the electrogram (EGM) EP study, more variables can be observed, such as PA interval (time between earliest recorded atrial activity in any channel and the rapid deflection of atrial EGM on the His bundle catheter), AH interval (time measured between atrial electrogram recorded by the His bundle catheter and beginning of the His electrogram itself), His bundle electrogram (HBE) duration (total conduction time through His bundle), and HV interval (time between His bundle electrogram and the earliest recorded ventricular activation).[10] Measurement of the AH, HBE and HV interval may be helpful to determine the site of block.[2]

The asymptomatic Mobitz II AV block presented from our patient was suspected as a vagally mediated AV block, due to its occurrence at early dawn (3.53 AM) while he was relaxed. The prolonged P-P intervals during ventricular asystole are indicative of vagal block that is a benign condition, rather than paroxysmal AV block. He was then referred for electrophysiology study to locate the site of block.

Artificial permanent pacing via the epicardial or transvenous route is so far the only practical therapy for A-V conduction disorders. Patients considered for pacemaker therapy of a bradyarrhythmia can be generally placed in one of four groups: (a) those with sustained or documented bradyarrhythmia sufficient to precipitate hemodynamic deterioration and symptoms, (b) those with symptoms and suspected, but not documented paroxysmal bradyarrhythmia, (c) those with bradycardia-induced tachycardias, and (d) those who are asymptomatic but whose electrophysiologic findings place them at high risk for paroxysmal and potentially dangerous Mobitz II block and bradycardia.[4] If asymptomatic, medical treatment or pacemaker implantation is not warranted for AV block attributable to high vagal tone or vagally mediated atrioventricular block. If the patient is having frequent syncopal episodes, treatment may be warranted if bradycardia appears to be the dominant factor in these episodes. Although PPM implantation is a relatively low-risk cardiac procedure, procedural complications and death directly related to implant can occur, and implanted leads have long-term management implications.[6]

ACCF/AHA/HRS 2018 guideline on the evaluation and management of patients with bradycardia and cardiac conduction delay, in asymptomatic patients with first-degree atrioventricular block or second-degree Mobitz type I (Wenckebach) or 2:1 atrioventricular block which is believed to be at the level of the atrioventricular node, with symptoms that do not temporally correspond to the AV block, permanent pacing should not be performed (Class III-C).[6] In ESC 2013 guideline of pacing mentioned that pacing is indicated in patients with intermittent/paroxysmal intrinsic third- or second-degree AV block. Well-defined clinical and electrophysiological features allow intrinsic AV block to be differentiated from the other known form of block, namely, vagal (extrinsic) and idiopathic AV block. Documentation of infra-Hisian block by EPS or the documentation of initiation of the block by atrial or ventricular premature beats, or increased heart rate (tachy-dependent AV block) or decreased heart rate (brady-dependent AV block), support a diagnosis of intrinsic AV block.[12]

In this case, the Mobitz type II AV block was not found from EP study. Meanwhile, during stimulation with atrial pacing and ATP induction, prolongation of AH interval without changes in HV interval and second-degree type I AV block was noted, concluding the presence of supra-Hisian AV node dysfunction. Because the appearance of Mobitz II AV block with narrow QRS and prolonged P-P interval was highly suggestive due to vagally mediated, thus, permanent pacemaker implantation was not necessary. Normal stress test, thallium scanning and 6-month Holter evaluation support this asymptomatic condition.

From the cardiologist perspective, patient is considered fit enough to continue his job as an airline pilot after comprehensive examination. Regular follow up with stress test and Holter monitoring are strictly recommended. AV blocking agents should also be avoided. However, final decision should be made by the associated airline company according to local federal aviation administration policy.

Conclusion

We reported a case of a senior aircraft pilot with asymptomatic high degree AV block with narrow QRS complex and prolonged P-P interval during ventricular asystole episode detected from 24-h inflight Holter monitoring, which increase the likelihood of a vagotonic atrioventricular block. Electrophysiology study was conducted and revealed a supra-Hisian AV node dysfunction, therefore pacemaker implantation was not performed. In AV conduction disturbances, there are certain occasions in which an EPS is necessary for the appropriate diagnosis, identification of the anatomic site of block that allows both the avoidance of unnecessary permanent pacing and the appropriate implementation of prophylactic pacing. Vagotonic atrioventricular block can result in paroxysmal atrioventricular block, and if asymptomatic, does not require pacing therapy.

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