

Various triggers of phase 4 block



Jae-Sun Uhm, MD, PhD, Boyoung Joung, MD, PhD, Hui-Nam Pak, MD, PhD,
Moon-Hyoung Lee, MD, PhD

From the Department of Cardiology, Severance Hospital, Yonsei University College of Medicine, Seoul, Korea.

Introduction

Phase 4 block or pause-dependent block is a suggested mechanism of paroxysmal atrioventricular block (AVB) in patients with a diseased His-Purkinje system.¹ Premature atrial contraction (PAC) or premature ventricular contraction (PVC) is a typical trigger of phase 4 block. However, various beats or rhythms can cause phase 4 block.

Case reports

Case 1

A 72-year-old man visited the clinic for recurrent syncope. During syncope, Holter monitoring showed paroxysmal AVB. AVB was initiated with prolongation of the P-P interval (890 to 1200 ms) (arrow with solid line; [Figure 1A](#)). Atrioventricular (AV) conduction resumed with junctional escape beat (arrow with broken line). Thus, a permanent pacemaker was implanted.

Case 2

A 73-year-old man underwent coronary artery bypass surgery for myocardial infarction. On postoperative day (POD) 1, electrocardiography (ECG) showed that paroxysmal AVB appeared following PVC (arrow with solid line) and was terminated by fascicular escape beat (arrow in broken line; [Figure 1B](#)). The patient had no symptoms at that time because he was deeply sedated. We recommended pacemaker implantation. However, he refused it. On POD 12, he was discharged without permanent pacemaker implantation.

Case 3

A 69-year-old man visited the emergency room after experiencing syncope in the toilet in the middle of the night. He had undergone double valve replacement for severe mitral and

aortic stenosis 10 years prior. ECG showed atrial flutter and 4.7-second ventricular pause after PVC (arrow) was observed during sleep ([Figure 1C](#)). Because he did not have symptomatic ventricular pause, we decided not to implant a pacemaker.

Case 4

A 68-year-old man underwent aortic valve replacement for severe aortic stenosis. On POD 13, he complained of dizziness. ECG at that time showed that paroxysmal AVB appeared following PAC (arrow with solid line) and was terminated by PVC (arrow with broken line; [Figure 1D](#)). A temporary pacemaker was turned on. On POD 14, ECG monitoring showed that paroxysmal AVB followed supraventricular tachycardia (arrow with solid line), which was terminated by the ventricular pacing beat (arrow with broken line; [Figure 1E](#)). Since paroxysmal AVB recurred, a permanent pacemaker was implanted on POD 16.

Case 5

A 71-year-old man underwent aortic valve replacement and coronary artery bypass surgery for severe aortic stenosis and significant coronary artery disease (3-vessel disease). On POD 7, he complained of syncope. ECG at that time showed that paroxysmal AVB appeared following termination of atrial fibrillation (arrow with solid line) and was terminated by PVC (arrow with broken line; [Figure 1F](#)). A temporary pacemaker was inserted. As paroxysmal AVB after paroxysmal atrial fibrillation recurred, a permanent pacemaker was implanted on POD 13.

Discussion

The present cases had paroxysmal AVB triggered by slow-down of the sinus rhythm ([Figure 1A](#)), PVC ([Figure 1B](#) and [C](#)), PAC ([Figure 1D](#)), termination of supraventricular tachycardia ([Figure 1E](#)), and paroxysmal atrial fibrillation ([Figure 1F](#)), respectively. Phase 4 block has been suggested as a mechanism of paroxysmal AVB.¹ Typically prolongation of the P-P interval of the sinus rhythm or the long pause after PAC, PVC, or termination of tachycardia can cause

KEYWORDS Atrioventricular block; His-Purkinje system; Pause-dependent block; Phase 4 block; Premature contraction
(Heart Rhythm Case Reports 2018;4:197–199)

Address reprint requests and correspondence: Dr Moon-Hyoung Lee, Department of Cardiology, Severance Hospital, Yonsei University College of Medicine, 50-1 Yonsei-ro Seodaemun-gu, Seoul, 03722, Korea. E-mail address: mhlee@yuhs.ac.

KEY TEACHING POINTS

- Phase 4 block is a mechanism of paroxysmal atrioventricular block in patients with diseased His-Purkinje systems.
- Slowdown of sinus rhythm, premature contractions, and termination of tachycardia can be triggers of phase 4 block.
- A permanent pacemaker is necessary in patients with phase 4 block.

slow spontaneous depolarization of the diseased His-Purkinje system.²⁻⁴ It can cause unresponsiveness of the His-Purkinje system because the membrane potential reaches over the threshold. Under this condition, the next impulses from the atrium are blocked. AVB typically recovers when a PVC resets the membrane potentials to the resting state, and the next P wave occurs before the phase 4 resting potential again rises to the point where AVB would recur.⁴ Retrograde conduction tends to be preserved during paroxysmal AVB.¹ In **Figure 1D**, a retrograde P wave (arrowhead) appeared after the first PVC during paroxysmal AVB. However, the first PVC failed to recover AV conduction, whereas the second PVC without a retrograde P wave recovered AV

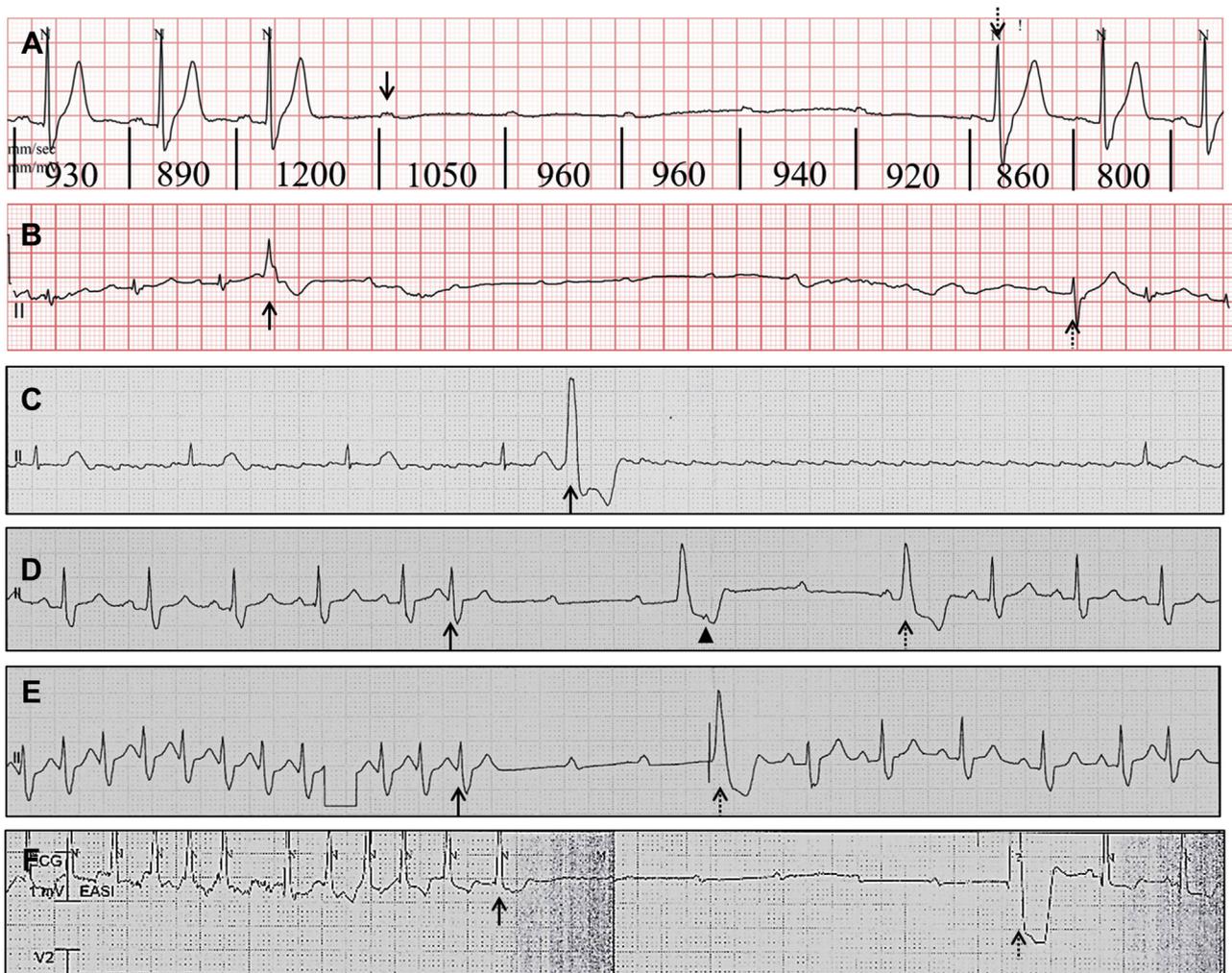


Figure 1 **A:** Case 1: Atrioventricular block (AVB) in a 72-year-old man initiated with prolongation of the P-P interval (890 to 1200 ms) (arrow with solid line). Atrioventricular conduction resumed with junctional escape beat (arrow with broken line). **B:** Case 2: AVB in a 73-year-old man following coronary artery bypass surgery for myocardial infarction. Electrocardiography (ECG) on postoperative day (POD) 1 showed that paroxysmal AVB appeared following premature ventricular contraction (PVC) (arrow with solid line) and was terminated by fascicular escape beat (arrow with broken line). **C:** Case 3: ECG of a 69-year-old man post double valve replacement for severe mitral and aortic stenosis 10 years prior. ECG shows atrial flutter and 4.7-second ventricular pause after PVC (arrow) observed during sleep. Because he did not have symptomatic ventricular pause, we decided not to implant a pacemaker. **D:** Case 4: POD 14 ECG of a 68-year-old man who underwent aortic valve replacement for severe aortic stenosis. ECG showed that paroxysmal AVB appeared following premature atrial contraction (arrow with solid line) and was terminated by PVC (arrow with broken line). **E:** Case 4: After a temporary pacemaker was turned on, ECG monitoring showed that paroxysmal AVB followed supraventricular tachycardia (arrow with solid line), which was terminated by the ventricular pacing beat (arrow with broken line). **F:** Case 5: POD 7 ECG of a 71-year-old man who underwent aortic valve replacement and coronary artery bypass surgery. ECG showed that paroxysmal AVB appeared following termination of atrial fibrillation (arrow with solid line) and was terminated by PVC (arrow with broken line).

conduction. This may have been because the retrograde P wave functioned like PAC, and phase 4 block was maintained after pause of the retrograde P wave of the first PVC. In patients with phase 4 block, a permanent pacemaker is needed in cases of irreversible disease of the His-Purkinje system. A permanent pacemaker was not implanted in the patient in [Figure 1C](#). It might be because increased vagal tone could partially contribute to paroxysmal AVB.

References

1. Rosenbaum MB, Elizari MV, Levi RJ, Nau GJ. Paroxysmal atrioventricular block related to hypopolarization and spontaneous diastolic depolarization. *Chest* 1973; 63:678–688.
2. El-Sherif N, Jalife J. Paroxysmal atrioventricular block: are phase 3 and phase 4 block mechanisms or misnomer? *Heart Rhythm* 2009;6:1514–1521.
3. Lee S, Wellens HJ, Jeseption ME. Paroxysmal atrioventricular block. *Heart Rhythm* 2009;6:1229–1234.
4. Barold SS, Stroobandt RX. Paroxysmal atrioventricular block precipitated by an atrial premature beats. What is the mechanism? *Cardiol J* 2012;19:645–656.