

Resolution of right bundle branch block after a premature ventricular beat: What is the mechanism?



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Introduction

The presence of bundle branch block on the electrocardiogram (ECG) does not always imply anatomic disease or complete block in the conduction system. We present an interesting ECG with resolution of the baseline right bundle branch block (RBBB) following a premature ventricular beat and discuss the possible mechanisms.

Case report

A 57-year-old man with history of coronary artery disease, ischemic cardiomyopathy, diabetes, and chronic kidney disease was admitted for an acute heart failure exacerbation. He was noted to have an irregular heart rhythm on clinical examination and a 12-lead ECG was obtained. ECG is shown in [Figure 1](#).

What is the mechanism of the narrow complex beats?

What is the mechanism of the subsequent beats conducted with an RBBB?

Discussion

The ECG in [Figure 1](#) shows normal sinus rhythm with RBBB at a rate of 60 beats per minute with 2 ventricular premature contractions (VPC) each followed by a post-VPC pause. The QRS duration > 120 ms, rsR' morphology in V₁, R > S in V₆, and slurred terminal S wave > 40 ms in leads I and aVL meet criteria for a typical RBBB.¹ Upon closer review of the ECG, it shows a RBBB with 2 VPCs with left bundle morphology (likely originating from the right ventricle) ([Figure 2A](#)). Of significance, the morphology of the beat immediately following the VPC does not demonstrate an RBBB pattern but rather is narrow with complete resolution of the RBBB ([Figure 2B](#)). Importantly, this observation supports the concept that the underlying RBBB mechanism here

KEY TEACHING POINTS

- This particular electrocardiogram supports that not all bundle branch blocks are due to a diseased conduction system but they may also be caused by a concealed retrograde penetration from the contralateral bundle preventing anterograde conduction through a particular bundle, resulting in what is known as a functional block.
- When ventricular premature contractions (or other extrinsic impulses) occur, the functional bundle branch block can resolve given that the conduction is facilitated temporarily owing to the peeling back of the refractory period, and by also shortening the refractory period of tissues with cycle length-dependent refractoriness.
- Regardless of location of origin, a ventricular premature contraction (VPC) can cause peeling back of refractoriness or pause-dependent recovery. The VPC does not need to be ipsilateral to the bundle branch block.

is due to functional block. This can be further explained by the linking phenomenon, which means there is repetitive transeptal concealed retrograde penetration of the right bundle by impulses propagating along the left bundle, resulting in functional block in the right bundle branch.^{2,3}

The evidence for transeptal retrograde concealed penetration by impulses propagating along the contralateral bundle has been documented during electrophysiologic studies.^{3,4} During RBBB, the impulse propagates down the left bundle, activating the left ventricle, then traverses across the interventricular septum, activating the right ventricle, and penetrates in a retrograde fashion into the right bundle branch. The subsequent antegrade impulse finds the right bundle refractory, resulting in perpetuation of a functional

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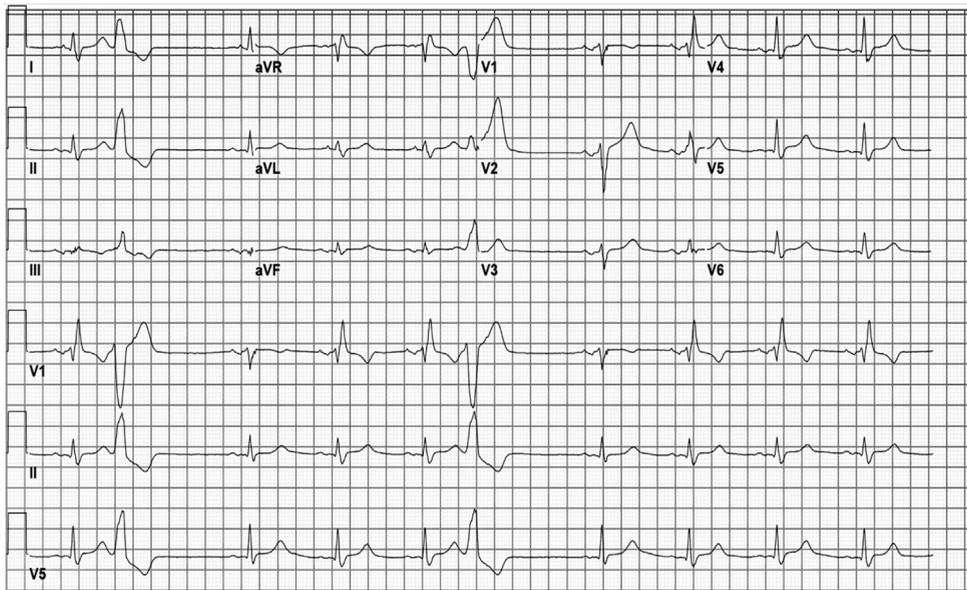


Figure 1 Twelve-lead electrocardiogram showing a normal sinus rhythm with right bundle branch block at a rate of 60 beats per minute. Additionally, there are 2 ventricular premature contractions (VPC) that are followed by a post-VPC pause and subsequent narrow complex beat with complete resolution of the right bundle branch block.

right bundle branch block. These retrograde impulses are classified as concealed owing to the fact that they are not appreciated on surface ECG under normal circumstances.⁵

In this case, the post-VPC beat conducts without an RBBB for 1 beat (Figure 2B) and subsequent beats conduct with an RBBB. This likely occurs for 2 reasons. The first reason is that the VPC can conceal into the RBBB and LBBB and can peel back refractoriness for the ensuing sinus rhythm beat, resulting in a narrow beat.² In our tracing, VPC results in retrograde conduction up to the atria and manifests as a retrograde P wave, as seen at the onset of the T wave

within the VPC beat in Figure 1. Second, the refractoriness of the bundle branches is cycle length dependent. Shortening the cycle length shortens the refractory period of the bundle branches and lengthening the cycle length prolongs the refractory period of the bundle branch. The VPC, by shortening the cycle length, shortens the refractory period of the right bundle branch and thereby allows both the right and left bundle to conduct the subsequent spontaneous impulse, resulting in a narrow QRS morphology (short-long cycle). The narrow beat will be associated with longer refractory periods of the bundle branches as it is preceded

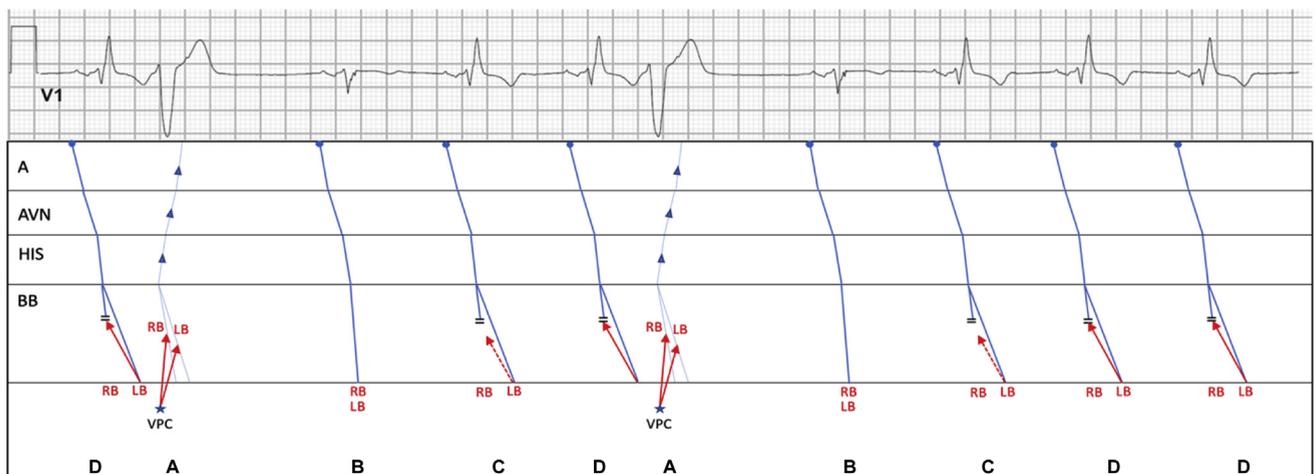


Figure 2 Ladder diagram representing the underlying mechanism. **A:** Ventricular premature contraction (VPC) with left bundle morphology that penetrates the conduction system in a retrograde manner, as evidenced by retrograde P wave on surface electrocardiogram at the upslope of the T wave. **B:** Narrow complex beat with resolution of the right bundle branch block (RBBB) immediately following the VPC. **C:** Representation of Ashman phenomenon as the sinus impulse finds the right bundle refractory, resulting in RBBB aberrancy. **D:** Lastly, the RBBB is perpetuated in the subsequent beats by concealed retrograde penetration of impulses into the right bundle branch until a VPC ensues (A). A = Atria; AVN = atrioventricular node; BB = bundle branch; HIS = His bundle; LB = left bundle; RB = right bundle; VPC = ventricular premature contraction.

by a longer cycle. The subsequent sinus impulse finds the right bundle refractory, resulting in RBBB aberrancy (long-short cycle, also known as Ashman phenomenon) (Figure 2C), and the RBBB is perpetuated in subsequent beats by concealed retrograde penetration of impulses into the right bundle branch until a VPC ensues (Figure 2A and D).^{2,5} In conclusion, this tracing shows cycle length dependency of the bundle branches whereby short-long cycles result in resolution of bundle branch block and long-short cycles result in bundle branch block aberrancy. Additionally, the ipsilateral nature of the VPC in this case is not critical for this phenomenon. Any VPC, regardless of location of origin, could have caused peel-back of refractoriness and or pause-dependent recovery.

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