

MINI-FOCUS ISSUE: CONGENITAL HEART DISEASE

BEGINNER

IMAGING VIGNETTE: ECG CHALLENGE

Alternating QRS Morphologies and PR Intervals After Transcatheter Aortic Valve Replacement



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ABSTRACT

Alternating bundle branch block pattern on electrocardiogram (ECG) is a concerning finding with important prognostic implications. This ECG challenge explores the electrophysiological mechanism of a case of alternating bundle branch block with alternating PR intervals. (**Level of Difficulty: Beginner.**) (J Am Coll Cardiol Case Rep 2020;2:1742-4)
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An 83-year-old man, whose baseline electrocardiogram (ECG) had a right bundle-branch block (RBBB) and left posterior fascicular block (LPFB), and who underwent transcatheter aortic valve replacement (TAVR) with a balloon-expandable valve 4 weeks before, was admitted to the hospital for symptomatic anemia. A 12-lead rhythm strip was reconstructed from telemetry (**Figure 1A**).

What is the mechanism of alternating bundle branch block?

1. Intermittent phase 3 block in the bundle branches
2. Intermittent phase 4 block in the bundle branches
3. Variable conduction delay in both bundle branches
4. Premature ventricular contractions with isorhythmic atrioventricular (AV) dissociation

DISCUSSION

The best explanation for this patient's ECG is variable conduction delay in both bundle branches. Bundle-branch block (BBB) patterns on ECG are typically caused by relative conduction delay in the left bundle (LB) or the right bundle (RB) rather than complete conduction block. Furthermore, conduction delay does not need to be fixed and can occur intermittently.

Before TAVR, the patient's ECG showed sinus rhythm at a rate of 70 beats/min, with normal PR interval (170 ms), right-axis deviation (QRS axis 97°), RBBB (QRS duration 128 ms), and LPFB (**Supplemental Figure 1**). The RBBB and LPFB indicate that the left anterior fascicle (LAF) was the faster conducting fascicle. The patient likely had intermittent conduction in the RB, but at a slower conduction velocity than the LAF, producing a RBBB and LPFB pattern on the ECG. Following TAVR, the patient's ECG showed sinus bradycardia at a rate of

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the *JACC: Case Reports* [author instructions page](#).

Manuscript received March 11, 2020; revised manuscript received May 11, 2020, accepted May 27, 2020.

54 beats/min, normal axis (QRS axis 64°), first-degree AV delay (PR interval 238 ms), and RBBB (QRS duration 128 ms) (Supplemental Figure 2). He had developed PR prolongation, and the pre-existing LPFB was no longer evident, likely because of balanced delay in the LAF, induced by mechanical injury.

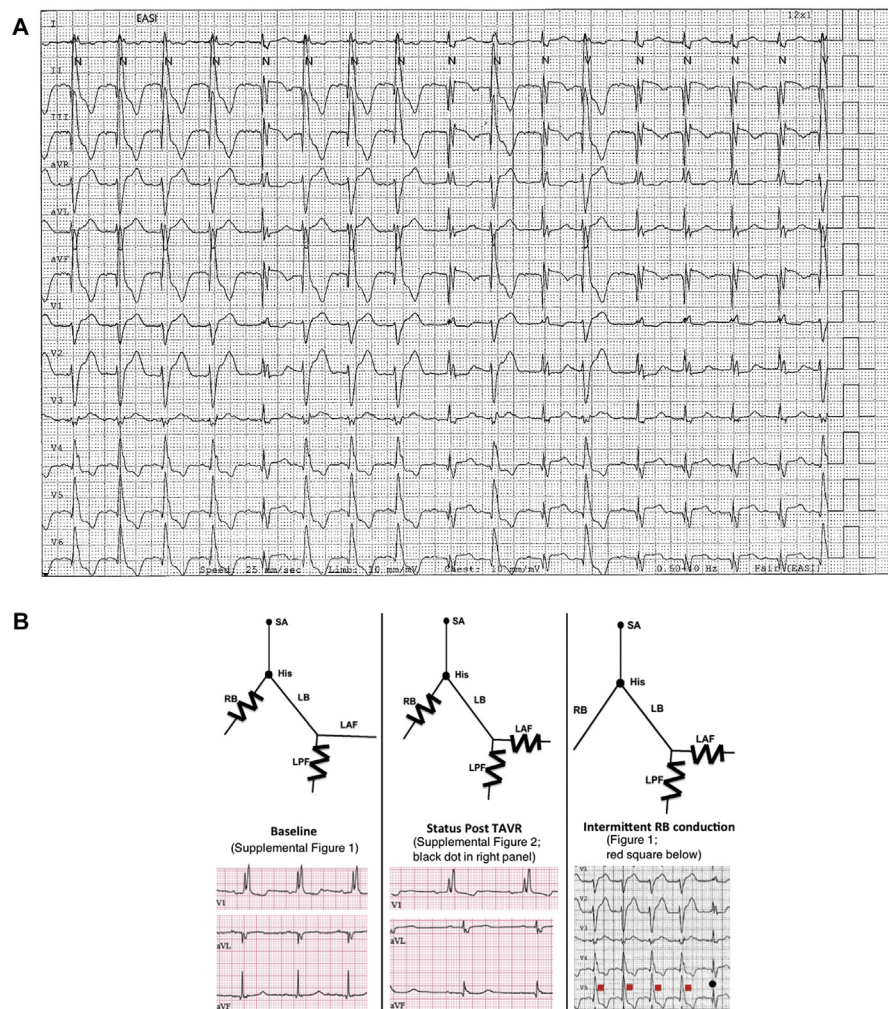
On the reconstructed rhythm strip (Figure 1A), with sinus tachycardia (rate: 102 beats/min), the patient had primarily RBBB (QRS duration: 130 ms) with a normal PR interval (180 ms). When the RB is able to intermittently conduct, it now conducts faster than the LAF, resulting in a shorter PR interval than baseline (140 ms) and left bundle-branch block (LBBB) QRS duration 150 ms. Figure 1B provides a schematic diagram of the patient's conduction system and our proposed mechanism for his ECG. The fixed sinus rate without variability and absence of atrial ectopy argues against phase 3 block and phase 4 block, respectively. The relatively fixed PR interval associated with the LBBB-morphology QRS complexes argues against a ventricular origin.

Thus, the patient was diagnosed with alternating BBB due to variable conduction delay in both bundle branches. In 1964, Lepschkin described alternating bundle

**ABBREVIATIONS
 AND ACRONYMS**

- AV** = atrioventricular
- BBB** = bundle-branch block
- ECG** = electrocardiogram
- LAF** = left anterior fascicle
- LB** = left bundle
- LBBB** = left bundle-branch block
- LPFB** = left posterior fascicular block
- RB** = right bundle
- RBBB** = right bundle-branch block
- TAVR** = transcatheter aortic valve replacement

FIGURE 1 Electrocardiogram



(A) Reconstructed 12-lead rhythm strip electrocardiogram. **(B)** Schematic diagram.

branch block and its tendency to progress to advanced heart block (1). In 2010, Massumi published a series of 16 patients with alternating BBBs and PR intervals, who all subsequently developed high-grade AV block requiring pacemaker placement (2). Most recently, in 2017, van Gils *et al.* found that, among patients with pre-existing RBBB who underwent TAVR, 8% developed alternating BBB within 24 h (3). Given the development of alternating BBB post TAVR, and the significant risk of progression to high-grade heart block, the patient ultimately underwent uncomplicated placement of a permanent pacemaker.

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REFERENCES

1. Lepeschkin E. The electrocardiographic diagnosis of bilateral bundle branch block in relation to heart block. *Prog Cardiovasc Dis* 1964;6:445-71.
2. Massumi R. Alternating bundle branch block together with alternation of PR intervals: advanced Mobitz II atrioventricular block. *Rev Cardiovasc Med* 2010;11:44-52.
3. van Gils L, Tchetché D, Lhermusier T, *et al.* Transcatheter heart valve selection and permanent pacemaker implantation in patients with pre-existent right bundle branch block. *J Am Heart Assoc* 2017;6:005028.

KEY WORDS aortic valve, electrocardiogram, valve replacement

APPENDIX For supplemental figures, please see the online version of this paper.