CASE REPORT

The Mischievous Bundle: A Case of Varying Degrees of Right Bundle Branch Block on Alternate Beats during Exercise Stress Testing

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A 78-year-old male was referred for exercise stress testing. He developed incomplete right bundle branch block during first stage of exercise and later on developed incomplete and complete right bundle branch block on alternate beats (2:1). During first minute of recovery he developed complete right bundle branch block on all beats (1:1). At 3 minutes of recovery, baseline electrocardiographic pattern was resumed. Variable degree of right bundle branch block on alternate beats is a rare phenomenon. The plausible mechanisms responsible for this phenomenon are being discussed.

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right bundle branch block; exercise stress testing; alternate beats; variable block

CASE SUMMARY

A 78-year-old male was subjected to exercise stress testing for atypical chest discomfort. Patient had a history of chronic bronchitis and essential hypertension for last 15 years. Baseline echocardiogram revealed normal chamber dimensions and ventricular functions. Patient had trivial tricuspid regurgitation with calculated right ventricular systolic pressure of 36 mmHg. Patient's baseline electrocardiogram revealed normal sinus rhythm with a rate of 74 beats per minute with QRS duration of 80 msec with no significant ST/T/Q wave changes (Fig. 1). Patient exercised on treadmill for 4 minutes and 34 seconds on Bruce protocol. He could perform 6.4 METs of exercise and attained a heart rate of 153 beats per minute (107% of age-predicted maximum heart rate). Exercise was terminated due to shortness of breath and fatigue experienced by patient. He had wheezing at peak exercise. Patient did not experience any anginal pain or discomfort. There was no significant ST depression during the test.

Notably, after exercising for approximately two and a half minutes, at a heart rate of 125 beats per minute, the QRS complex in lead V₁ changed from rS to qR pattern with QRS duration of approximately 100 msec suggesting right bundle branch conduction delay (Fig. 2). In fourth minute of exercise, at a heart rate of 139 beats per minute, alternate beats started manifesting incomplete and complete bundle branch block (Fig. 3). In first minute of recovery (heart rate of 140 beats per minute) the pattern changed to complete right bundle branch block in all the beats (Fig. 4). The block disappeared completely at 3 minutes of recovery and baseline QRS configuration reappeared (Fig. 5).

DISCUSSION

The appearance of right bundle branch block during exercise stress test is an uncommon phenomenon.¹ Occurrence of variable degree of right bundle branch block on alternate beats is even rarer. Only four such electrocardiograms

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Figure 1. Baseline electrocardiogram with rS pattern in V₁.

Figure 2. Electrocardiogram at 3 minutes of exercise depicting incomplete right bundle branch block.

Figure 3. Electrocardiogram at 3:12 minutes of exercise showing incomplete and complete right bundle branch block on alternate beats.

Figure 4. Electrocardiogram at 1 minute of recovery with complete right bundle branch block in all beats.

Figure 5. Electrocardiogram at 3 minutes of recovery with disappearance of bundle branch block.

showing this interesting phenomenon were available in published literature till 2009.² No report pertaining to its occurrence during an exercise stress test could be located in literature. In present patient, appearance of right bundle branch block with exercise and its disappearance during recovery can be related to two plausible mechanisms. It can be due to rate-dependent bundle branch block²⁻⁴ and the other contributing factor may be right ventricular overload secondary to hypoxia caused by bronchospasm.^{5,6}

The initial right bundle branch conduction delay (Fig. 2) can be explained by a tachycardia-dependent phase 3 block or this may occur due to increase right ventricular pressure associated with bronchospasm on subendothelial right bundle branch.

Presence of variable block on alternate beats (2:1) (Fig. 3) can be explained by bidirectional block in right bundle branch. The effective refractory period of bundle branch at this juncture was longer than the sum total of cycle length and transeptal conduction time but was shorter than double of cycle length. As a result once a beat conducted normally (with lesser delay), the next beat encountered an antegrade block as well as block to retrograde activation via transeptal

conduction. This gives enough time to right bundle branch to recover for next beat.^{2,3} Supernormal conduction on alternate beats could have been another explanation for this rare occurrence.^{2,7}

The presence of complete bundle branch block on all beats (1:1) during recovery (Fig. 4) with lesser heart rates was probably due to "retrograde concealment."^{3,4} An increase in cycle length enabled sum total of cycle length and transeptal conduction time to exceed effective refractory period of right bundle branch, though the cycle length remains lesser than the effective refractory period. In this arrangement, with each beat, antegrade activation of right bundle branch was blocked but retrograde activation takes place via transeptal conduction which makes right bundle branch refractory to antegrade activation in next cycle.²⁻⁴ A bradycardia-dependent bundle branch block could have been another explanation for this phenomenon but is unlikely at a cycle length of 428 msec. Moreover, bradycardia-dependent bundle branch block almost always manifests itself as left bundle branch block rather than right bundle branch block.⁴

As the cycle length further increased and became greater than effective refractory period of right bundle branch, the QRS duration normalized.

However, with increasing levels of exercise and heart rate, as the bronchospasm of the patient increased, the consequent hypoxia and increase in right ventricular strain might have contributed to right bundle branch conduction delay. Ischemia as a probable mechanism for these changes is unlikely in absence of significant ST change and typical chest pain. Because electrophysiological study was not performed in this case, the mechanisms proposed are only speculative. Occurrence of variable degree of right bundle branch block during dobutamine stress echocardiography has been reported in a patient with baseline complete right bundle branch block, where authors have proposed that variable degree of conduction delay in left bundle branch is responsible for this phenomenon.² In presented patient that mechanism does not seem to be operating, as the PR intervals for the beats with incomplete and complete right bundle branch block are similar.

In conclusion, the mechanisms responsible for this rare interesting electrophysiological phe-

nomenon remained speculative and open to discussion.

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