



Case Report Cardiovascular

Dynamic Enigma: Exercise Induced Left Bundle Branch Block

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ABSTRACT

EI-LBBB represents a rare phenomenon observed during electrocardiographic evaluation in response to exercise. We present an asymptomatic patient referred for cardiac fitness before tympanoplasty surgery. During the treadmill exercise test, the patient developed a left bundle branch block, which reverted spontaneously in the recovery phase. A coronary angiogram revealed double vessel disease involving the left anterior descending and left circumflex arteries. The occurrence of EI-LBBB during stress tests like the treadmill test (TMT) can be a direct marker of underlying ischemia and underlying coronary artery disease as seen in our case.

Keywords: Bundle branch block, Exercise-induced Left bundle branch block, Rate dependent Left bundle branch block, Transient bundle branch block, Treadmill test

INTRODUCTION

EI-LBBB refers to a conduction abnormality in which a transient or newly developed left bundle branch block manifests during exercise (e.g., exercise stress test-Treadmill test [TMT]) and resolves when the individual rests or the heart rate (HR) returns to baseline. It is a rare phenomenon, occurring in approximately 0.5–1.1% of patients undergoing TMT.^[1] This condition occurs approximately six times more frequently in women.^[2] The proposed mechanisms for transient bundle branch block (BBB) are as follows:^[3]

1. Phase 3 block occurs when the initial aberrant complex results from an impulse encroaching on the refractory period (Phase 3 of the action potential). Tachycardia-associated LBBB is considered to occur because of an abnormality in Phase 3 conduction (repolarization), leading to delayed or blocked impulses at elevated heart rates when they fall within the refractory period of the action potential.
2. Phase 4 or bradycardia-dependent block is due to loss of resting membrane potential owing to disease and/or phase 4 depolarization. At slower heart rates, spontaneous diastolic (Phase 4) depolarization of the left bundle branch renders it refractory to the next incoming impulse.^[4,5]
3. Rate dependent conduction block: At higher HRs, the electrical impulse travels faster reducing the refractory period. If one bundle branch cannot conduct impulse fast enough, a temporary block occurs at a certain HR (rate dependent block) and resolves when the HR slows
4. An acceleration-dependent block resulting from pathology within the His-Purkinje system
5. Retrograde concealment: It refers to the process by which, at faster heart rates, retrograde

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penetration of a bundle branch leaves it refractory, inhibiting the forward conduction of subsequent impulses through the normal pathways.

6. Ischemia-related conduction block: Ischemia due to coronary artery disease (CAD) can impair conduction systems ability to transmit electrical impulses and is often seen during episodes of stress or exertion
7. During episodes of increased vagal tone or autonomic imbalance (e.g., fainting and bradycardia), a transient bundle branch block (BBB) can occur
8. Infection or inflammation such as myocarditis may cause transient BBB due to inflammation affecting the conducting system.

EI-LBBB serves as an independent predictor of significant cardiovascular morbidity and mortality.^[4] Coronary artery disease (CAD) is present in 70% of patients with EI-LBBB, whereas exercise-induced right bundle branch block (EI-RBBB) has been associated with CAD in all reported cases.^[4] LBBB can lead to mechanical dyssynchrony, deterioration of left ventricular function, and heart failure. Transient exercise-induced left bundle branch block (EI-LBBB) can result in reversible left ventricular dyssynchrony. The existing understanding of this phenomenon primarily stems from case reports and case series, and its management remains a subject of ongoing discussion. Here, we present a case of EI-LBBB attributed to coronary artery disease (CAD).

CASE REPORT

A 50-year-old female with the right-sided otitis media, on cefixime oral antibiotic, planned for tympanoplasty was referred for surgical fitness. She had no cardiorespiratory complaints and had been newly diagnosed with hypothyroidism (Thyroid stimulating hormone [TSH]: 104.4 mIU/L, T3: 2.35 pg/mL,

Free T4: 0.42 ng/dL). The electrocardiogram (ECG) had a normal sinus rhythm, with HR of 80 bpm (beats/min), poor R wave progression, inverted T waves were observed in leads I, aVL, II, aVF, and V3-6 [Figure 1]. Echocardiography done was normal with no regional wall motion abnormalities, no diastolic dysfunction, and a normal left ventricular ejection fraction (LVEF) of 60%. An exercise stress test, TMT was conducted using the Bruce protocol, during which LBBB developed in stage 2 at a HR of 145 bpm, 85% of Target HR (THR) at 6:00 min of exercise [Figure 2]. Exercise was terminated in view of chest pain at 6:53 min. The LBBB reverted to sinus rhythm at a HR of 85 bpm after 3 min into the recovery phase, but ST depression and inverted T waves were observed in inferior leads [Figure 3], validating the need for coronary angiogram. During the TMT, the patient attained a normal HR response, blood pressure response, good exercise capacity (8 metabolic equivalent [METS]), and was diagnosed to have EI-LBBB. A coronary angiogram was advised to rule out ischemic heart disease and it revealed double-vessel disease, involving left anterior descending (LAD) showing proximal-to-mid long lesion maximum 90% [Figure 4a] and left circumflex arteries (LCXs) non-dominant vessel with ostial 20–30% lesion, proximal to distal long segment 90% lesion [Figure 4b], and right coronary artery was dominant and normal. The patient was advised for percutaneous transluminal coronary angioplasty (PTCA) stenting of the LAD and LCX. During the course of admission, endocrinologist opinion was taken for Hypothyroidism and was started on 100 mcg of Thyroxine tablet. The patient was taken up for elective PTCA stenting and successful PTCA stenting was done to LAD and LCX [Figure 5a and b]. At 1-month follow-up, her repeat TSH was 0.66 mIU/L and thyroxine tablet dose tapered accordingly. She remains symptomatically and hemodynamically stable on subsequent follow-up.

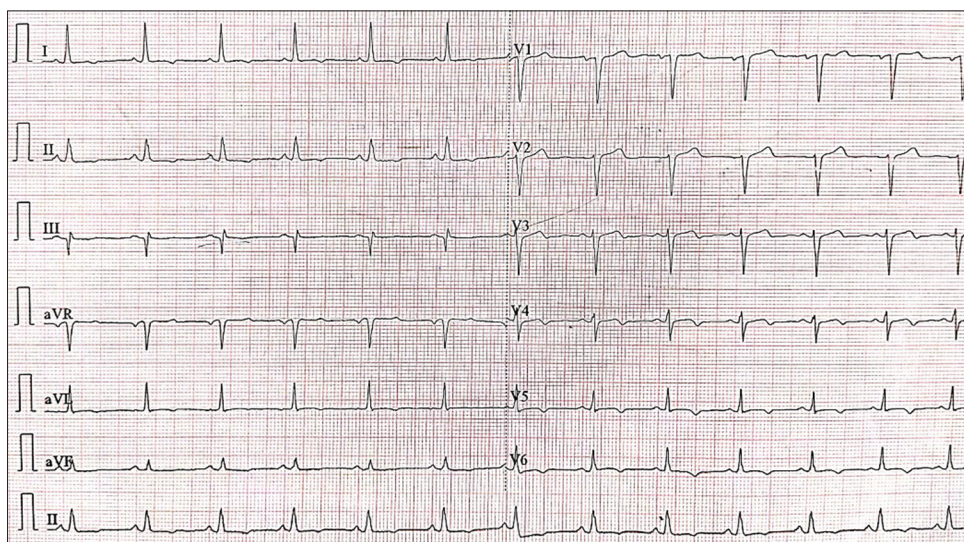


Figure 1: Baseline electrocardiogram. Normal sinus rhythm, heart rate of 75 bpm, poor R wave progression, and inverted T waves were observed in leads I, aVL, II, aVF, and V3-6.

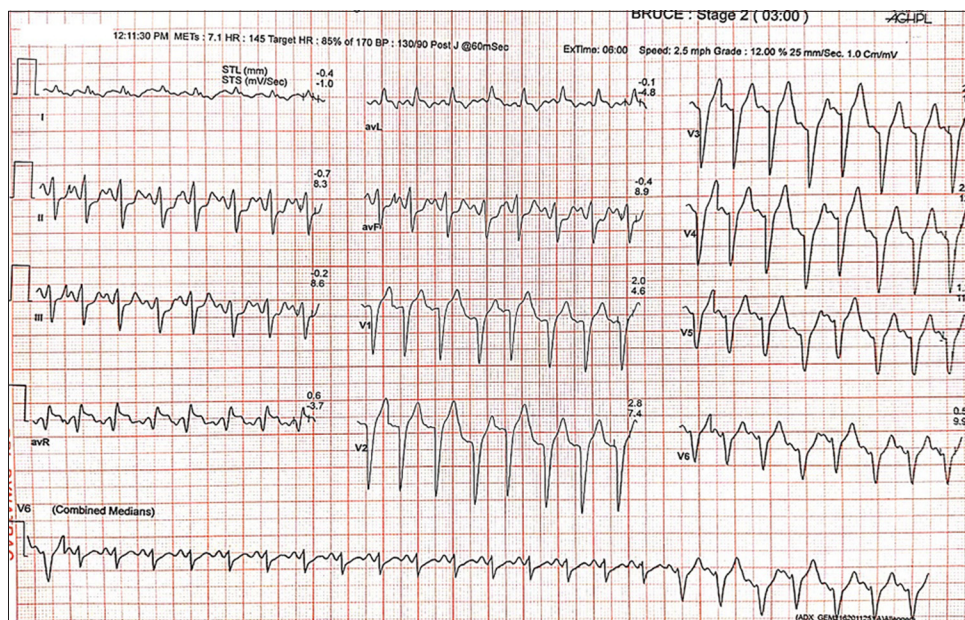


Figure 2: Stage 2 of Bruce protocol. A transition from sinus rhythm to left bundle branch block pattern observed at heart rate of 145 bpm.

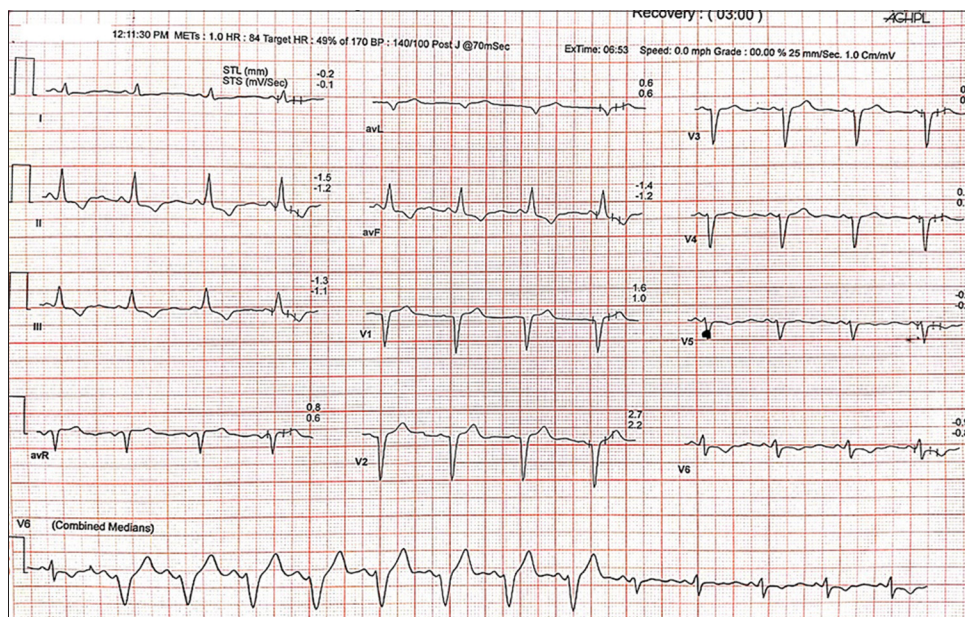


Figure 3: Recovery phase of exercise stress test. Transition from the left bundle branch block to sinus rhythm can be observed at a heart rate of 85 bpm at 3 min into recovery phase. ST depression with inverted T waves are noted in inferior leads.

DISCUSSION

EI-LBBB was initially described in 1946 in a young man with a history of smoking, presenting with exertional palpitations and dizziness.^[5] EI-LBBB is an uncommon electrocardiographic finding, observed in approximately 0.4% to 0.5% of exercise tests^[1] and independently predicts significant cardiovascular morbidity in 19% of cases and mortality in 29%.^[1]

Hypothyroidism can lead to various electrocardiographic changes including bradycardia (7–15%), BBBs such as RBBB (5.2%), LBBB (5.1%), low voltage QRS complexes, and arrhythmias due to QT prolongation. The relationship between hypothyroidism and EI-LBBB is not well-established in medical literature.^[6]

Although EI-RBBB is less frequently observed than EI-LBBB, it demonstrates a 100% association with CAD, commonly

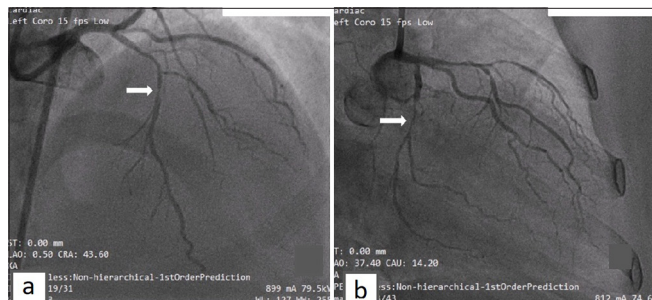


Figure 4: Coronary angiogram. (a) Left anterior descending shows proximal to mid long lesion maximum 90%. (b) Left circumflex arteries shows ostial 20–30% disease and proximal 90% lesion (white arrows indicating the narrowest part of stenosis).

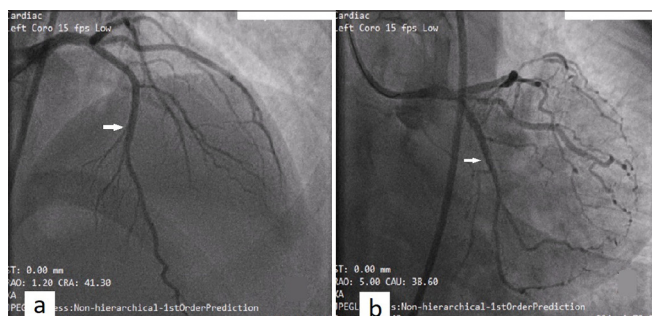


Figure 5: Post PTCA stenting with drug-eluting stents (DES). (a) Proximal to mid left anterior descending stented with 2.25 × 28 mm DES, post dilated with 2.75 × 10 mm non-compliant Balloon. (b) Proximal left circumflex arteries stented with 2.25 × 10 mm DES (white arrows indicating site of stent placement).

involving obstructive lesions in the left anterior descending artery.^[7,8]

The clinical prognosis of individuals with EI-LBBB is determined by the degree of coronary artery disease involvement, patient age and presence of heart failure. Patients with EI-LBBB are usually considered benign when EI-LBBB occurs at a HR of ≥120–125 bpm. These subset of patients were found to have normal epicardial coronaries and a better prognosis.^[9–11] EI-LBBB occurring at heart rates of <120–125 bpm is associated with occlusive coronary artery disease (CAD) in approximately 70% of cases.^[7]

However, in our case, the patient developed EI-LBBB at a heart rate of 145 bpm at 6-minutes, with the onset of chest pain occurring at 6 minutes and 53 seconds, prompting termination of the TMT. On further evaluation with coronary angiogram, the patient had underlying multi-vessel CAD.

In a patient with EI-LBBB, especially when they develop symptoms or ECG changes on recovery phase during exercise testing, it is always better to do further cardiac evaluation such as coronary angiogram to rule out underlying CAD.

CONCLUSION

Patients with EI-LBBB are typically considered as having a benign condition; However, its occurrence is associated

with an increased risk of all-cause mortality. The appearance of EI-LBBB during treadmill test (TMT) may indicate underlying ischemia, warranting test termination, especially if accompanied by chest pain or other concerning symptoms. Thus, patients developing EI-LBBB on exercise stress tests should be evaluated for any underlying CAD.

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