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CASE REPORT

INTERMEDIATE

CLINICAL CASE

Exercise-Induced Left Bundle Branch Block Resulting in Severe Mitral Regurgitation

Brenden S. Ingraham, MD, Panithaya Chareonthaitawee, MD, Yogesh N.V. Reddy, MBBS, MSc

ABSTRACT

Exercise hemodynamic catheterization is helpful to evaluate exertional symptoms when noninvasive investigations fail to provide an explanation in non-ischemic cardiomyopathy. In this case, a rate-related left bundle branch block resulted in severe dynamic mitral regurgitation and acute increase in pulmonary capillary wedge pressure. Cardiac resynchronization therapy resolved her symptoms. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2021;3:1287–1290)

HISTORY OF PRESENTATION

A 49-year-old woman presented with subacute, profound exertional dyspnea with minimal activity but asymptomatic at rest. She was afebrile with a blood pressure of 129/72 mm Hg and heart rate of 72 beats/min; oxygen saturation was 99% on room air. Her examination was unremarkable with normal heart sounds and regular rate and rhythm. Lungs were clear, and there was no elevation of jugular venous pressure.

MEDICAL HISTORY

She had a history significant for hypertension, Raynaud's phenomenon, and fibromyalgia. She is overweight (body mass index: 29.4 kg/m^2) and had no history of tobacco use.

LEARNING OBJECTIVES

- To evaluate for rare causes of exertional dyspnea with invasive exercise hemodynamic catheterization.
- To understand the mechanism of severe MR resulting from a rate-related LBBB.

DIFFERENTIAL DIAGNOSIS

A broad range of causes were considered, including cardiomyopathy secondary to long-standing hypertension or undiagnosed heart failure with preserved or reduced ejection fraction; valvular heart disease; pulmonary hypertension in the setting of possible heart, lung, or autoimmune disease; interstitial lung disease in the setting of possible autoimmune disease; chronotropic incompetence; fatigue and sensation of dyspnea in the setting of fibromyalgia and/or deconditioning.

INVESTIGATIONS

An exercise oxygen consumption (Vo_2) study showed limited peak Vo_2 with intermittent left bundle branch block (LBBB). Transthoracic echocardiogram (TTE) and cardiac magnetic resonance (CMR) imaging demonstrated non-ischemic cardiomyopathy with a

From the Department of Cardiovascular Medicine, Mayo Clinic, Rochester, Minnesota, USA.
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ABBREVIATIONS AND ACRONYMS

AO = aorta

BMI = body mass index

CRT = cardiac resynchronization therapy

LA = left atrium

LBBB = left bundle branch block

MR = mitral regurgitation

PA = pulmonary artery

PCWP = pulmonary capillary wedge

TTE = transthoracic echocardiogram

Vo_2 = oxygen consumption

reduced ejection fraction (EF) of 38% with mild left ventricular enlargement but normal left atrial size. There was no delayed myocardial enhancement, microscopic scarring, or myocardial edema. Mild mitral regurgitation (MR) was noted on resting TTE (Videos 1 and 2). Coronary angiogram was normal, with mildly elevated pulmonary capillary wedge pressure (PCWP) at rest (17 mm Hg; small v-waves). Exercise right heart catheterization (RHC) was performed due to severe unexplained exertional symptoms and demonstrated relatively normal PCWP during early exercise (20 mm Hg). She developed an acute rate-related left BBB (LBBB) with reproduction of her typical symptoms (**Figure 1**). She had rapid, instantaneous rise in left atrial pressure (mean PCWP: 47 mm Hg; giant v-waves, 69 mm Hg) and pulmonary artery pressure (48 mm Hg) with large reflected v-waves in late systole from the left atrium (**Figure 2**). Cardiac output with exercise was limited (70% predicted) with a peak Vo_2 of only 8.5 ml/kg/min, indicating severe impairment. Exercise echocardiography revealed acute severe MR with posterior leaflet tethering and dyssynchrony (Videos 3, 4, 5, and 6, **Figure 3**), and simultaneous lung ultrasound suggested dynamic pulmonary congestion during exercise.

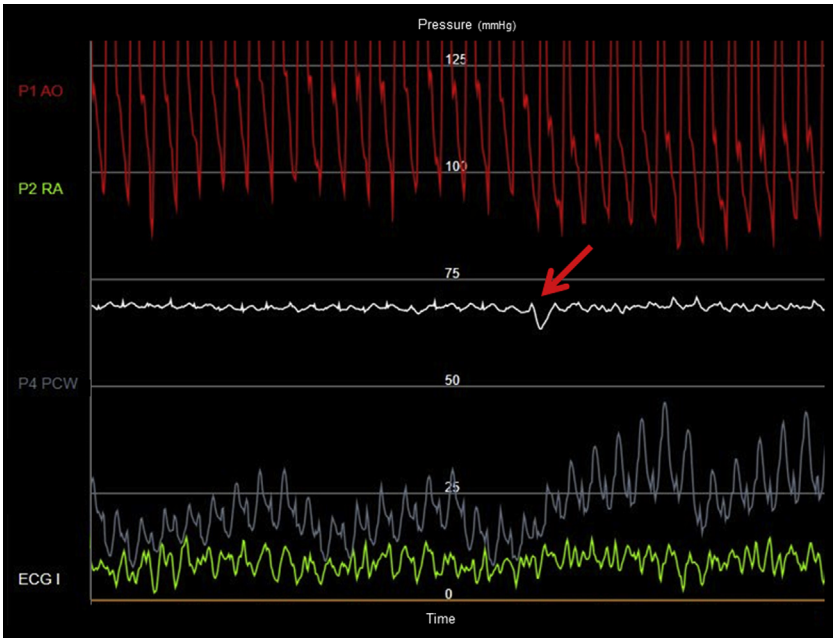
MANAGEMENT

The patient was initiated on guideline-directed medical therapy for heart failure with reduced EF and offered cardiac resynchronization therapy (CRT) to restore papillary muscle synchrony and correct the MR.

DISCUSSION

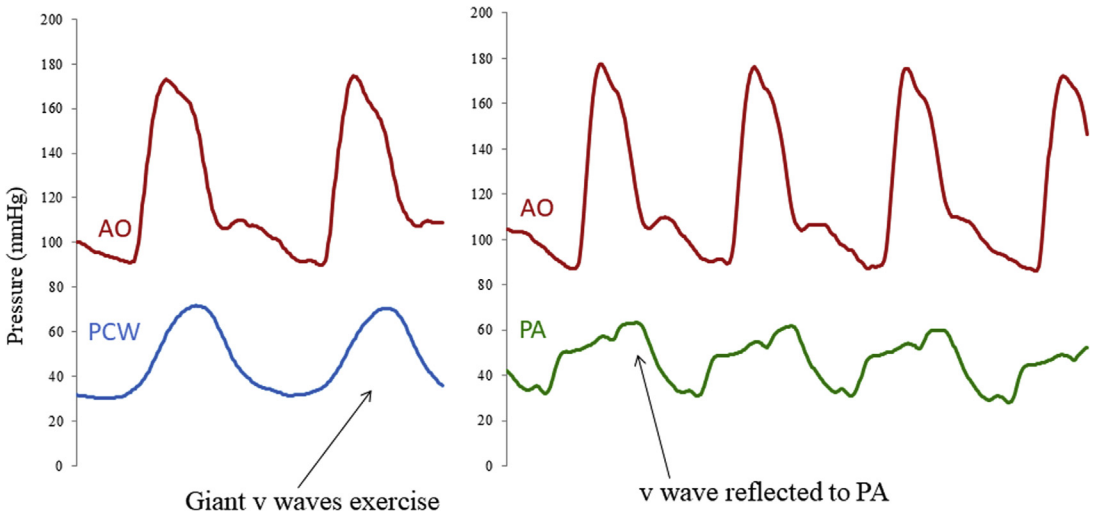
This case illustrates the value of exercise hemodynamics in evaluating exertional symptoms in patients with cardiomyopathy with symptoms out of proportion to objective abnormalities. LBBB may result in functional MR due to: 1) papillary muscle dyssynchrony; or 2) ventricular dilation and remodeling (1). In this case, there was no ventricular dilation, and the LBBB appeared only during exercise associated with immediate hemodynamic evidence of hemodynamically important MR (2). Therefore, the dynamic, severe MR was due to dyssynchrony of the papillary muscles, which can acutely improve with cardiac resynchronization (CRT) to restore papillary muscle synchrony and correct the MR (1,3,4). As opposed to the severe functional MR that occurs with chronic LBBB and ventricular/atrial dilation, patients with intermittent LBBB develop acute severe MR into a non-compliant atria that results in severe LA pressure

FIGURE 1 Electrocardiogram and Pressure Tracings During Exercise



Transition from narrow complex sinus tachycardia to left bundle branch block (LBBB) during exercise at 20 W. AO = aorta; PCW = pulmonary capillary wedge; RA = right atrium.

FIGURE 2 Pressure Tracings During Exercise

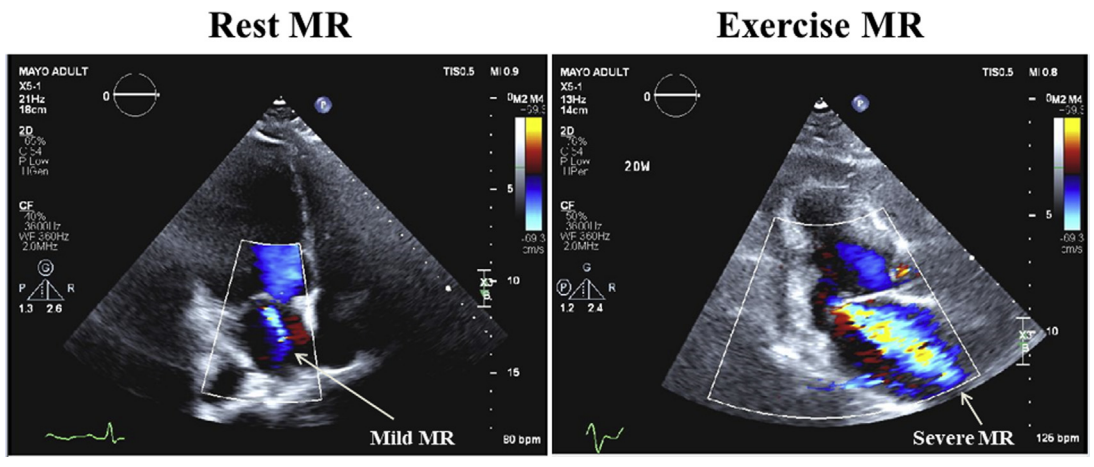


PCW acutely and rapidly rose from 17 to 47 mm Hg with v-waves to 69 mm Hg during exercise with the development of LBBB. PA pressure increased proportionately to a mean pressure of 48 mm Hg with large retrograde v-waves in late systole from the left atrium. Cardiac output increased to 6.5 l/min, which is 70% predicted based on the measured change in oxygen consumption. PA = pulmonary artery; other abbreviations as in Figure 1.

elevation during exercise. Medical therapy for idiopathic non-ischemic cardiomyopathy was initiated, and CRT can be used in non-responders to medical therapy to prevent dynamic MR.

Prior case reports have used stress echocardiography alone to diagnose exercise LBBB related dynamic severe MR. Carvalho et al. (5) described the case of a 69-year-old woman with LBBB-related acute severe MR detected on stress echocardiography and associated with repeated heart failure hospitalizations that improved with CRT. Similarly, Issa (6) reported the case of a 62-year-old woman with exercise LBBB at rates >65 to 70 beat/min associated with severe MR by TTE. Following biventricular pacing, the patient was less symptomatic with improved functional capacity. Our case demonstrates the additional diagnostic value of simultaneous exercise RHC to demonstrate acute simultaneous increase in PCWP

FIGURE 3 Transthoracic Echocardiogram Before and After Exercise



Mild MR at baseline converted to severe, symptomatic mitral regurgitation (MR) with posterior leaflet tethering and dyssynchrony with the development of a left bundle branch block (LBBB) at 20 W of exercise.

JACC: CASE REPORTS, VOL. 3, NO. 10, 2021
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with large v-waves from the LBBB-induced MR during exercise. To further establish causality between the dynamic LBBB and MR, the patient was directed to exercise twice in the same setting with reproduction of the exercise LBBB and acute dynamic increase in PCWP with simultaneous severe MR by echo.

This case illustrates the importance of choosing a diagnostic test that reproduces the patient's symptoms and allows simultaneous physiologic assessment. Evaluating exertional symptoms with a resting test is often done clinically but may miss clinically relevant abnormalities. Exercise RHC can be done simultaneously with echocardiography to provide a comprehensive assessment of cardiac function and its relationship to patient symptoms.

We did not seek institutional review board approval for this project, as we are retrospectively reporting a case of a single, anonymous patient. The patient provided consent for publication of her case.

FOLLOW-UP

The patient was seen by electrophysiology and offered CRT for correction of the MR along with guideline medical therapy for the cardiomyopathy. Her exertional dyspnea completely resolved with biventricular pacing. She reported a dramatic improvement in her quality of life and functional status at her 6 week follow up visit.

CONCLUSIONS

Exertional dyspnea secondary to severe MR resulting from a rate-related LBBB is a rarely seen cause of shortness of breath. Careful evaluation with invasive exercise hemodynamics with simultaneous echocardiography can help elucidate the cause of unexplained exertional symptoms. CRT can improve symptoms in this setting.

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The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr. Yogesh N.V. Reddy, Department of Cardiovascular Diseases, Mayo Clinic, 200 1st Street SW, Rochester, Minnesota 55905, USA. E-mail: Reddy.Yogesh@Mayo.edu. Twitter: @yreddyhf.

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KEY WORDS cardiac resynchronization therapy, exercise, hemodynamics, mitral valve, right-sided catheterization

APPENDIX For supplemental videos, please see the online version of this article.