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CASE REPORT

INTERMEDIATE

CLINICAL CASE

Possible Involvement of Coronary Microvascular Dysfunction in Painful Left Bundle Branch Block

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ABSTRACT

Cases of painful left bundle branch block syndrome have been reported; however, the pathophysiology of chest pain remains unclear. Here, we report a patient with left bundle branch block and chest pain. We evaluated coronary microvascular dysfunction using guide wire-based thermodilution. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2023;23:102008) © 2023 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Painful left bundle branch block (LBBB) syndrome, characterized by chest pain in patients with LBBB without ischemic cardiomyopathy, has been recently reported.[1] The involvement of dyssynchrony and interoceptive hypersensitivity in the pathogenesis of chest pain has also been reported[2] but remains largely unknown. The European Society of Cardiology proposed the concept of ischemic nonocclusive coronary artery disease (INOCA),[3] and the American Heart Association guidelines include information on the management of INOCA.[4] In addition to coronary angina pectoris, coronary microvascular disease (CMD) is also gaining attention as an important cause of chest pain.[3] The CorMicA (Coronary Microvascular Angina) Trial defined INOCA as a condition with symptoms and signs of angina but without obstructive coronary artery disease and reported that a strategy of combined invasive testing and stratified treatment leads to reduced severity of angina and improved quality of life.[5]

LEARNING OBJECTIVES

- To evaluate CMD in patients with chest pain and a history of LBBB to clarify the pathophysiology of chest pain in LBBB.
- To attempt drug therapy to avoid invasive treatments if LBBB and CMD coexist.

Although the evaluation of CMD has been challenging, using the new guide wire-based sensor technology (coroFlow, Abbott), measuring coronary flow reserve (CFR), index of microvascular resistance (IMR), and resistive reserve ratio has become easier.

In a previous report, technetium myocardial scintigraphy was performed in patients with LBBB and a perfusion defect centered in the septum was found.[6] This is thought to be due to a mechanism in which the delayed motion of the left ventricular wall due to LBBB causes intracardiac pressure to move toward the septum, thereby inhibiting coronary blood flow.[6] On the other hand, this finding is not necessarily related to the ischemic etiology. Therefore, invasive

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ABBREVIATIONS AND ACRONYMS

CFR = coronary flow reserve

CMD = coronary microvascular disease

ECG = electrocardiogram

FFR = fractional flow reserve

IMR = index of microvascular resistance

INOCA = ischemic nonocclusive coronary artery disease

LAD = left anterior descending artery

LBBB = left bundle branch block

pacing via a physiological conduction system has been used to treat painful LBBB.[1,7] By using guide wire-based thermodilution to ascertain the potential coexistence of CMD as one of its causes, it may be possible to treat such patients using drugs without invasive devices.

HISTORY OF PRESENTATION

The patient was an 80-year-old man who presented to his previous physician 1 month earlier with chest pain at rest and on exertion. The chest pain was mainly a feeling of strangulation and pressure and lasted from several minutes to tens of minutes and was not aggravated by deep breathing or reproducible by palpation. He was referred for ischemic evaluation because the electrocardiogram (ECG) revealed LBBB (Figure 1).

MEDICAL HISTORY

The patient had been taking hypertension medication for several years, had no history of dyslipidemia or diabetes mellitus, and had quit smoking approximately 10 years earlier. No ECG abnormalities or symptoms of chest pain were noted during the previous examinations. No other cardiac disease was observed.

DIFFERENTIAL DIAGNOSIS

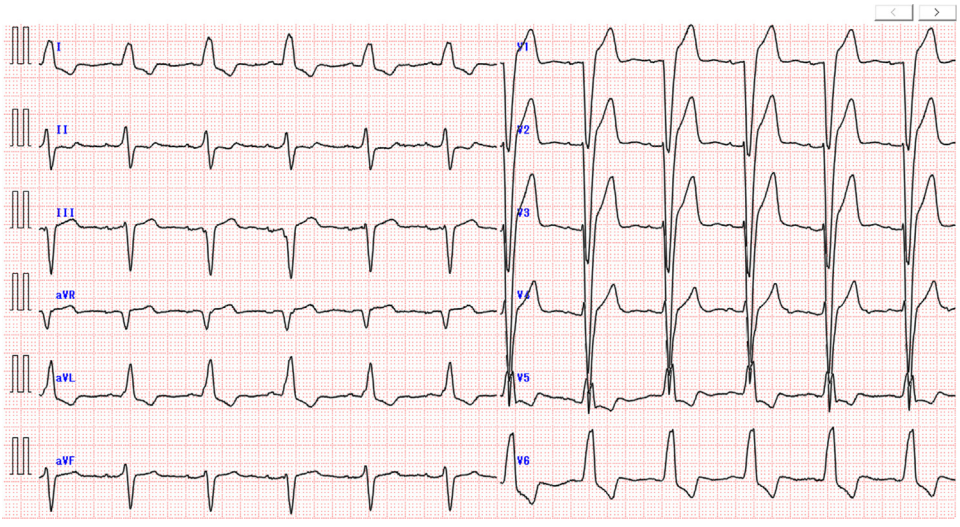
Ischemic heart disease was suspected because of the LBBB. Thus, coronary computed tomography angiography was performed; however, no significant stenosis was noted in the coronary arteries (Figures 2A and 2B).

INVESTIGATIONS

Echocardiography revealed a left ventricular ejection fraction of 51%, with no obvious ventricular wall thickening (interventricular septal thickness: 12.4 mm; left ventricular posterior wall: 11.4 mm) or valvular disease.

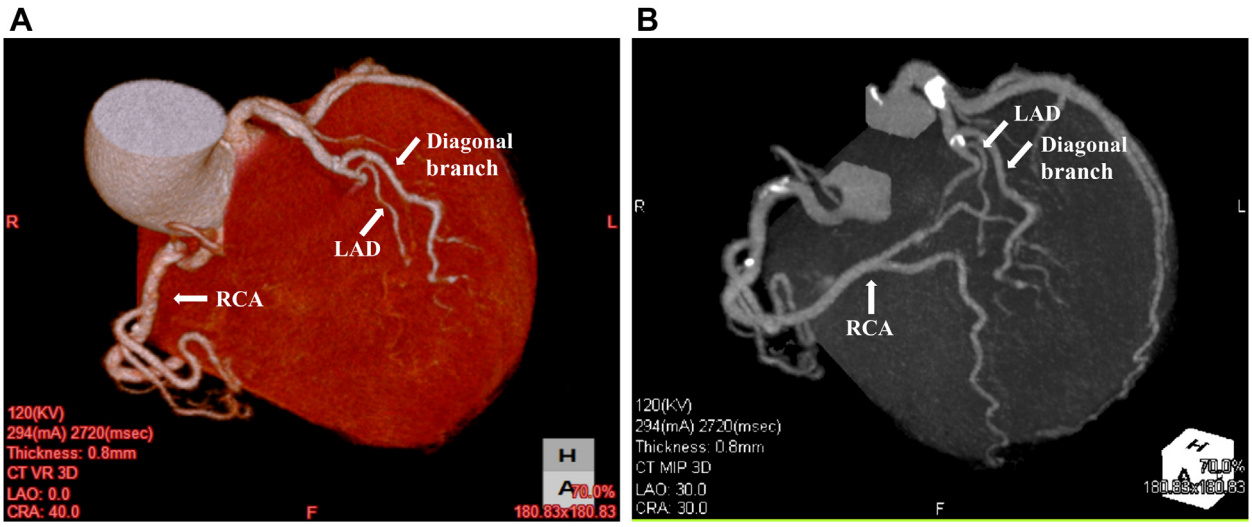
However, strain analysis revealed left ventricular dyssynchrony, increased global longitudinal strain in the lateral-to-anterior region, and decreased global longitudinal strain in the contralateral septal-to-inferior region (Figure 3A). Stress positron emission tomography is important for noninvasive evaluation of endothelial dysfunction; however, it is unavailable at our facility. Hence, we performed pharmacologic stress myocardial perfusion single-photon emission computed tomography. Adenosine was used for pharmacologic stress. The results revealed decreased accumulation in the septal-to-inferior region (Figure 3B). Phase analysis supported the presence of left ventricular dyssynchrony (Phase SD: 32.57; bandwidth: 101.00) (Figure 3C).

FIGURE 1 Electrocardiography



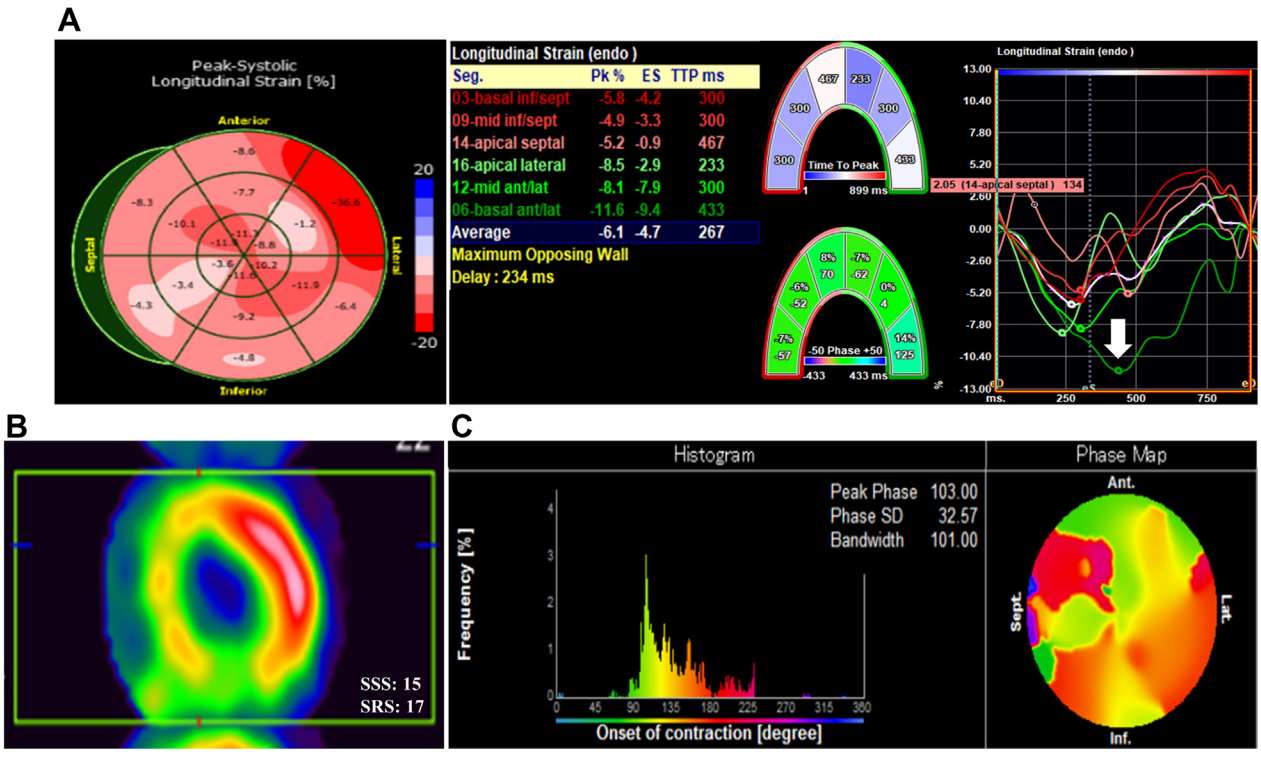
Electrocardiography showing LBBB (heart rate: 68 beats/min; QRSd: 168 ms; S/T ratio: 2.60). LBBB = left bundle branch block.

FIGURE 2 Coronary Computed Tomography Angiography



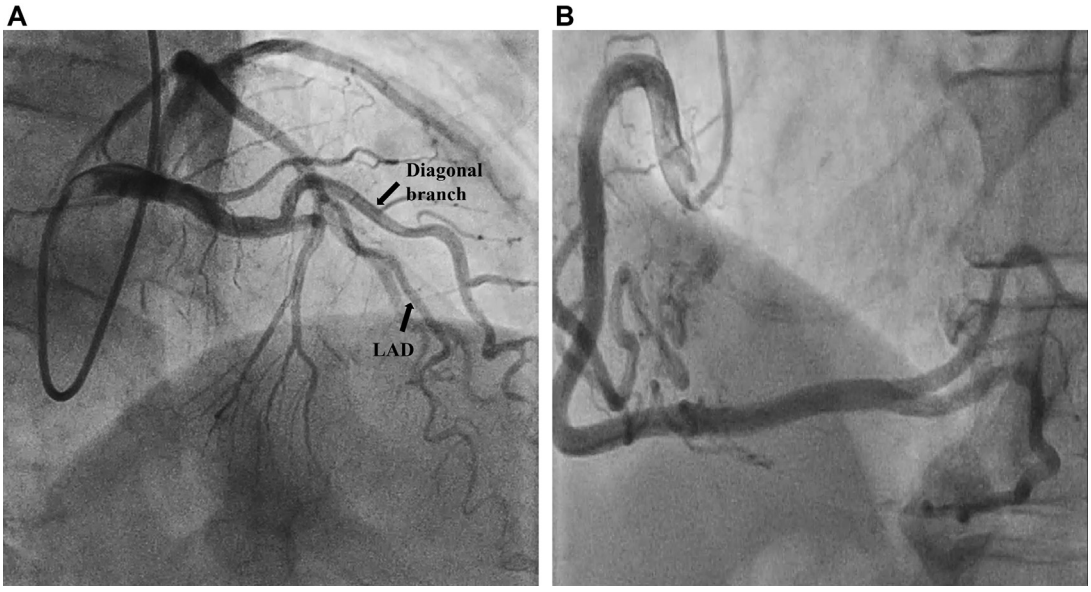
(A) Volume rendering showing hypoplasia and tortuosity of the LAD distal to the septal branch. **(B)** Maximal intensity projection showing calcification in #5 and #6, with the diagonal branch predominantly developed compared with the LAD. LAD = left anterior descending artery.

FIGURE 3 Strain Analysis and Single-Photon Emission Computed Tomography



(A) Strain analysis showing contractile retardation in the anterior to lateral regions (**white arrow**; opposing wall delay time: 234 ms). **(B)** Single-photon emission computed tomography showing decreased accumulation in the septal and posterior regions. **(C)** Phase analysis showing dyssynchrony. SSS = summed stress score; SRS = summed rest score.

FIGURE 4 Coronary Angiogram



(A) The left main coronary artery and left circumflex artery are intact, but there is a 25% stenosis in the diagonal branch of the LAD. The LAD distal (#7, #8) had shrunk but had good flow. **(B)** The right coronary artery had a well-developed #4PD, but no luminal stenosis. Abbreviation as in Figure 2.

MANAGEMENT

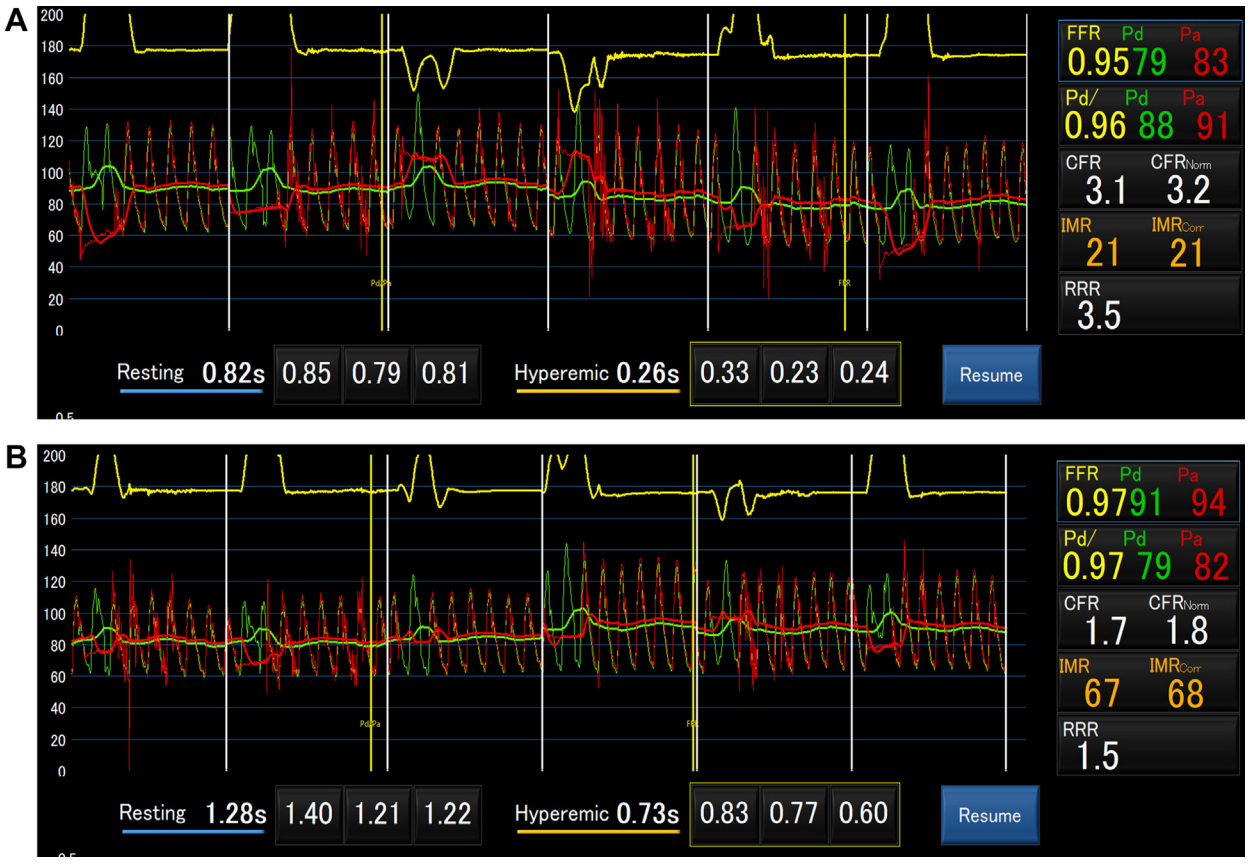
Coronary artery catheterization was performed, considering the possibility of coronary angina pectoris. No significant stenosis was found in the epicardial vessels (Figures 4A and 4B); hence, an acetylcholine stress test was performed (acetylcholine doses: 50 and 100 μg for left anterior descending artery (LAD), 20 and 50 μg for right coronary artery [RCA]). However, after the loading test, there was no evidence of recurrent chest symptoms, ECG changes, or >90% coronary spasms on fluoroscopy. Therefore, microvascular damage and fractional flow reserve (FFR) were evaluated using guide wire-based thermodilution. The guide wire-based thermodilution was performed after administering nitroglycerin after the acetylcholine test. A waiting time of 10 min was allowed to minimize the influence of nitroglycerin on the thermodilution measurement results to the maximum extent possible. In this case, the LAD and RCA were evaluated, and the LAD had a CFR of 3.1 and an IMR of 21 (Figure 5A), whereas the RCA had a low CFR and high IMR (CFR: 1.7; resistive reserve ratio: 1.5; IMR: 67) (Figure 5B). Additionally, a mild decrease in the FFR gradient was observed in the LAD (FFR: 0.95).

DISCUSSION

Although this case would not fit the definition of painful LBBB syndrome, a new evaluation of microvascular involvement may provide insights into the association of this condition.

The delayed contraction of the area centered on the lateral wall in LBBB can cause stress on the contralateral side of the wall, which presents a challenge. However, correcting LBBB with cardiac resynchronization therapy can reduce this stress.[6] In this case, retarded contraction was observed from the lateral to the anterior wall, and strain analysis and single-photon emission computed tomography revealed contralateral area changes.

FIGURE 5 Evaluation of Microcirculatory Disturbances Using Guide Wire-Based Thermodilution



(A) Results for the LAD and **(B)** right coronary arteries. Abbreviation as in Figure 2.

Hypothetically, the pathophysiology of chest pain, in this case, may be threefold: 1) physical compression of the microvessels due to dyssynchrony; 2) chronic stress on the microvessels causing organic stenosis; or 3) incidental coexistence of LBBB and CMD. To differentiate between these conditions, key considerations include evaluating the LAD and RCA and the transient nature of the original painful LBBB syndrome. First, the second point is negative because chest pain is also observed in transient LBBB. The same may be applied to the third point. If a patient had CMD apart from LBBB, it would be consistent with the presence of chest pain, regardless of ECG waveform changes. Therefore, the first point remains as the possible pathophysiology. The effect of dyssynchrony is expressed as a microcirculatory disturbance in the RCA, which is an indirect explanation. However, this case report has a limitation in that it is difficult to explain all painful LBBB syndromes based on a single factor. Therefore, large-scale evaluation is warranted.

FOLLOW-UP

After evaluating the coronary microcirculation, the patient was started on beta-blockers (carvedilol 10 mg/d). His chest pain symptoms resolved, with no complications.

CONCLUSIONS

This case report is the first to demonstrate the potential coexistence of coronary microcirculation as an association of painful LBBB syndrome. If CMD is implicated in the chest pain associated with painful LBBB, prioritizing medical therapy over invasive therapy may help reduce patient burden.

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KEY WORDS **chest pain, coronary flow reserve, coronary microvascular dysfunction, index of microvascular resistance, left bundle branch block**