JACC: CASE REPORTS VOL. 3, NO. 6, 2021

MINI-FOCUS ISSUE: IMAGING

BEGINNER

IMAGING VIGNETTE: CLINICAL VIGNETTE

Unilateral Lung Congestion During Exercise in a Patient With a Single Pulmonary Vein Stenosis

Toshimitsu Kato, MD, PhD,[a] Masaru Obokata, MD, PhD,[b] Tomonari Harada, MD, PhD,[b] Yoshiaki Kaneko, MD, PhD,[b] Masahiko Kurabayashi, MD, PhD[b]

ABSTRACT

A 55-year-old man underwent exercise stress echocardiography for evaluation of left inferior pulmonary vein stenosis. During exercise, ultrasound B-lines developed in the left lung only. Unilateral pulmonary congestion did not lead to forward or backward failure. The patient was followed up conservatively. (**Level of Difficulty: Beginner**.)
(J Am Coll Cardiol Case Rep 2021;3:935-7) © 2021 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/).

A 55-year-old man presented to our hospital because of abnormal findings on chest radiography during a medical checkup (**Figure 1A**, yellow arrow). He had an episode of bloody sputum. He had undergone extensive encircling pulmonary vein (PV) isolation for persistent atrial fibrillation 1 year previously at another hospital. Computed tomography showed ground-glass opacity and consolidation on the left lower lobe of the lung (**Figure 1B**, yellow arrows). Contrast-enhanced computed tomography showed a contrast defect in the left inferior PV (LIPV) (**Figure 1C**, yellow arrow). Transesophageal echocardiography revealed an elevated peak velocity in the LIPV (140 cm/s), while velocities in the other PVs were normal (50 to 70 cm/s), indicative of LIPV stenosis (Supplemental Figures 1a to 1d). Supine ergometry exercise stress echocardiography (ESE) was performed. At rest, left ventricular (LV) and right ventricular contractility were preserved (LV ejection fraction 62%, tricuspid annular plane systolic excursion 27 mm). Estimated LV filling pressure and pulmonary artery systolic pressure (PASP) were not elevated (E/e′ ratio 9.6, PASP 19 mm Hg). There were no B-lines (Supplemental Figure 2a). Oxygen saturation was 99% (ambient air). The patient achieved a peak work load of 140 W without desaturation (~96%). LV ejection fraction (69%) and tricuspid annular plane systolic excursion (~29.2 mm) successfully augmented during exercise. B-lines developed in the left lung from submaximal (40 W) to peak exercise, while no B-lines were observed in the right lung throughout exercise (Supplemental Figures 2b and 2c). The E/e′ ratio and estimated PASP remained normal with exercise (~10.7 and ~36 mm Hg, respectively). Early diastolic transmitral flow ve-

From the [a]Department of Clinical Laboratory, Gunma University Hospital, Maebashi, Japan; and the [b]Department of Cardiovascular Medicine, Gunma University Graduate School of Medicine, Maebashi, Japan.
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 Author Center.

Manuscript received February 15, 2021; accepted February 26, 2021.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2021.02.036

ABBREVIATIONS AND ACRONYMS

ESE = exercise stress echocardiography

LIPV = left inferior pulmonary vein

LV = left ventricular

PASP = pulmonary artery systolic pressure

PV = pulmonary vein

locity and cardiac output increased from 97 to 145 cm/s and from 6.0 to 11.9 l/min, respectively. The patient was followed up conservatively.

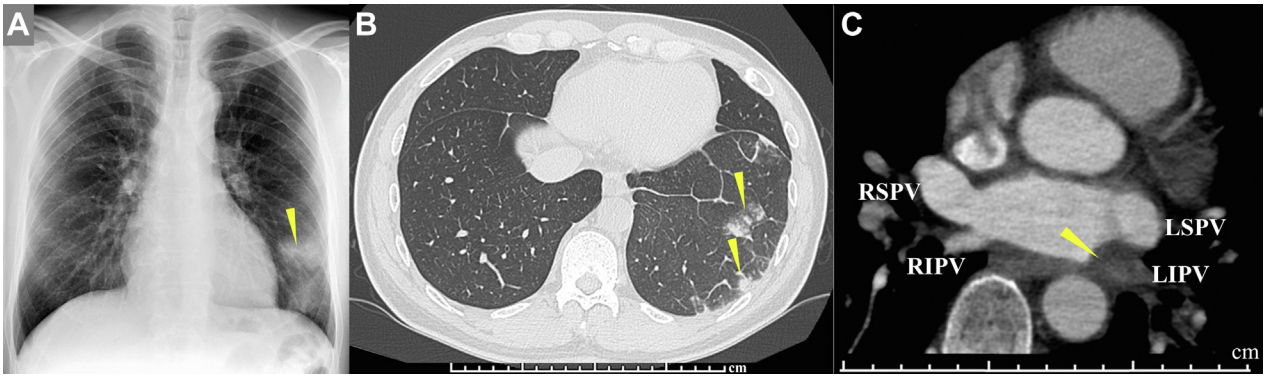
PV stenosis is a rare condition that requires careful diagnostic evaluation. Traditionally, PV stenosis is associated with congenital heart disease. In the modern era, the primary cause is related to catheter ablation procedures for atrial fibrillation, although the incidence is low (<1%) (1). Although surgical treatment or percutaneous transluminal angioplasty is often necessary for PV stenosis, the optimal treatment strategy has not been established. PV stenosis can be symptomatic (e.g., dyspnea, cough, bloody sputum) when pulmonary wedge pressure elevates and/or pulmonary perfusion decreases. ESE provides valuable information on pulmonary hemodynamic status. Emerging evidence has shown that increases in pulmonary congestion during exercise can be demonstrated on lung ultrasound in patients with heart failure. It is worth noting that in our patient, ultrasound B-lines developed only in the left lung during exercise (Videos 1 and 2). The normal E/e′ ratio observed during exercise suggests that unilateral pulmonary congestion was caused by increased local pulmonary venous pressure associated with the LIPV stenosis rather than LV diastolic dysfunction (2). The normal PASP also indicates that local pulmonary venous hypertension and congestion did not lead to post-capillary pulmonary hypertension. The augmentation in early diastolic transmitral flow velocity and cardiac output suggests that LV pre-load was probably maintained to increase forward flow (3). The present case demonstrates the usefulness of ESE to unmask the hemodynamic effects of a single PV stenosis during exercise and to make clinical decisions.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr. Obokata has received research grants from the Fukuda Foundation for Medical Technology, the Mochida Memorial Foundation for Medical and Pharmaceutical Research, Nippon Shinyaku, Takeda Science Foundation, and the Japanese Circulation Society. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr. Toshimitsu Kato, Department of Clinical Laboratory, Gunma University Hospital, 3-39-15 Showa-machi, Maebashi, Gunma 371-8511, Japan. E-mail: t-kato@gunma-u.ac.jp.

FIGURE 1 Chest Radiography and Computed Tomography



(A) Chest radiography shows ground-glass opacity in the left lower lung field **(yellow arrow)**. **(B)** Computed tomography shows ground-glass opacity and consolidation in the left lower lobe of the lung **(yellow arrows)**. **(C)** Contrast-enhanced computed tomography shows contrast defect in the left inferior pulmonary vein (LIPV) **(yellow arrow)**. LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

REFERENCES

1. Cappato R, Calkins H, Chen SA, et al. Updated worldwide survey on the methods, efficacy, and safety of catheter ablation for human atrial fibrillation. Circ Arrhythm Electrophysiol 2010;3:32–8.

2. Reddy YNV, Obokata M, Wiley B, et al. The haemodynamic basis of lung congestion during exercise in heart failure with preserved ejection fraction. Eur Heart J 2019;40:3721–30.

3. Obokata M, Reddy YNV, Borlaug BA. The role of echocardiography in heart failure with preserved ejection fraction: what do we want from imaging? Heart Fail Clin 2019;15:241–56.

KEY WORDS single pulmonary vein stenosis, supine ergometry exercise stress echocardiography, unilateral B-lines

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