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CASE REPORT

ADVANCED

CLINICAL CASE

Precapillary Pulmonary Arterial Hypertension Despite Contrary Anchoring Bias

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ABSTRACT

We present the case of a patient with risk factors and a noninvasive evaluation that suggested postcapillary pulmonary hypertension, but in fact had invasive hemodynamics consistent with precapillary pulmonary hypertension. A thorough hemodynamic evaluation of pulmonary hypertension must be performed, as treatment is linked to the underlying physiology. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2023;22:101977) © 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/).

HISTORY OF PRESENTATION

A 78-year-old female former smoker with history of heart failure with preserved ejection fraction, severe mitral stenosis (MS), and atrial flutter presented to the hospital with hypoxemia and progressive dyspnea on exertion. On arrival, she was afebrile with a heart rate of 87 beats/min, blood pressure of 136/58 mm Hg, and respiratory rate of 20 breaths/min with oxygen saturation 97% on 6 L/min O_2 per nasal cannula. Examination was notable for increased inspiratory effort and mild bibasilar crackles. An electrocardiogram showed atrial flutter with variable atrioventricular block (**Figure 1**).

LEARNING OBJECTIVES

- To understand the differential diagnosis and systematic approach to cases of pulmonary hypertension, to deter anchoring bias.
- To understand the limitations of invasive testing in the evaluation of cardiopulmonary hemodynamics.
- To understand the differences in hemodynamics and treatments for the various causes of pulmonary hypertension, particularly among WHO Groups I, II, and III.

High-sensitivity troponin was 33 pg/mL and B-type natriuretic peptide was 1,159 pg/mL (compared with 280 pg/mL 1 year prior). Chest radiograph did not show pulmonary edema. Transthoracic echocardiogram (TTE) was performed (**Figure 2**).

TTE demonstrated an estimated right ventricular systolic pressure of 60 mm Hg (Video 1), new right ventricular systolic dysfunction (Video 2), left atrial (LA) size of 56 mL/m^2 (**Figure 2E**), and a mitral valve (MV) mean gradient of 5 mm Hg at a heart rate of 51 beats per minute (Video 3) with hockey stick deformity of the MV, suggestive of rheumatic disease (Video 4).

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ABBREVIATIONS AND ACRONYMS

COPD = chronic obstructive pulmonary disease

LA = left atrial

LA_P = left atrial pressure

LVEDP = left ventricular end-diastolic pressure

MS = mitral stenosis

MV = mitral valve

PAH = pulmonary arterial hypertension

PCWP = pulmonary capillary wedge pressure

PH = pulmonary hypertension

TTE = transthoracic echocardiogram

WHO = World Health Organization

PAST MEDICAL HISTORY

The patient had a history of heart failure with preserved ejection fraction, severe MS due to rheumatic heart disease with echocardiogram from 3 months prior that showed MV area 1.22 cm^2, 0.84 cm^2 by planimetry, diastolic pressure half-time 175 ms, and LA size of 52.5 mL/m^2 (severely enlarged), as well as atrial flutter, and chronic obstructive pulmonary disease (COPD) with forced expiratory volume in 1 second of 87%.

DIFFERENTIAL DIAGNOSIS

The differential for newly elevated right-sided pressures included acutely decompensated heart failure with preserved ejection fraction, worsening MS, pulmonary embolism, World Health Organization (WHO) group I pulmonary arterial hypertension (PAH), and WHO group III pulmonary hypertension (PH) due to COPD.

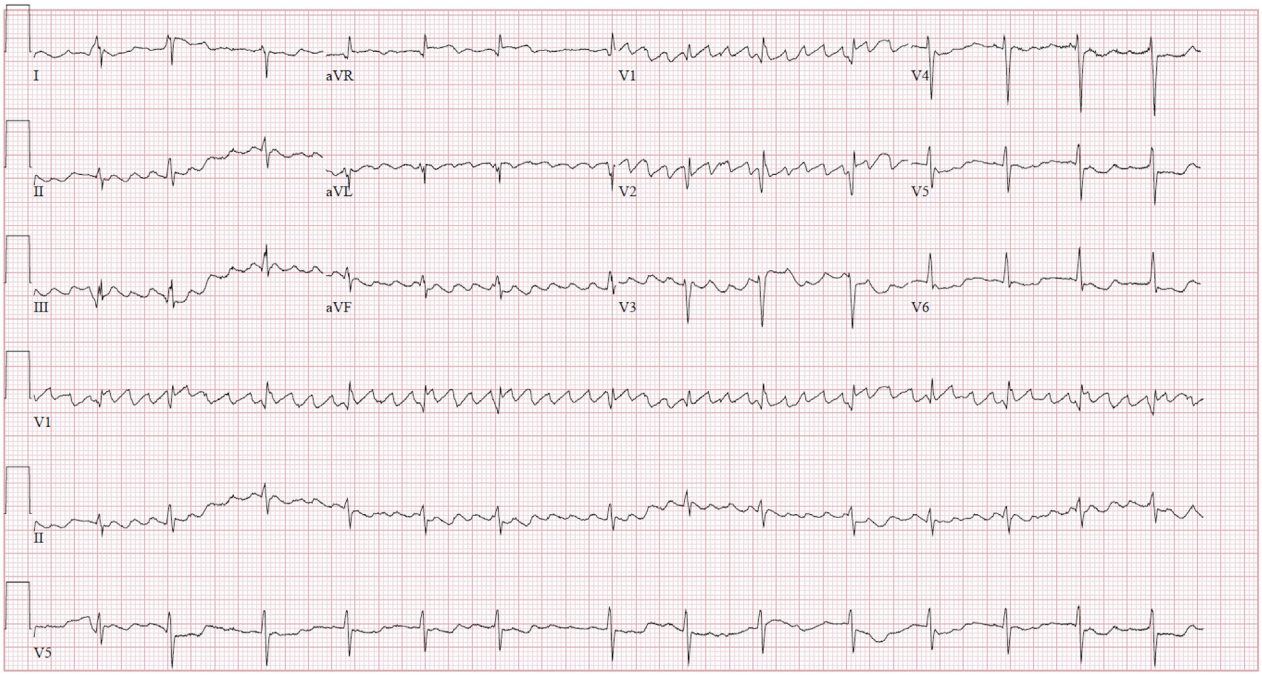
INVESTIGATIONS

Serologies were negative for HIV or autoimmune disease. Chest computed tomography with pulmonary angiography did not show pulmonary embolism or interstitial lung disease, and ventilation-perfusion scan did not demonstrate perfusion defects.

Right and left heart catheterization was performed, which demonstrated a right atrial pressure of 10 mm Hg, mean pulmonary artery pressure of 60 mm Hg, and pulmonary capillary wedge pressure (PCWP) of 20 mm Hg. A PCWP oxygen saturation was not performed. Thermodilution cardiac output was severely depressed at 1.93 L/min. Pulmonary vascular resistance was 20.7 WU, consistent with severe combined pre- and postcapillary PH. Left heart catheterization revealed left ventricular end-diastolic pressure (LVEDP) of 9 mm Hg (**Figure 3**).

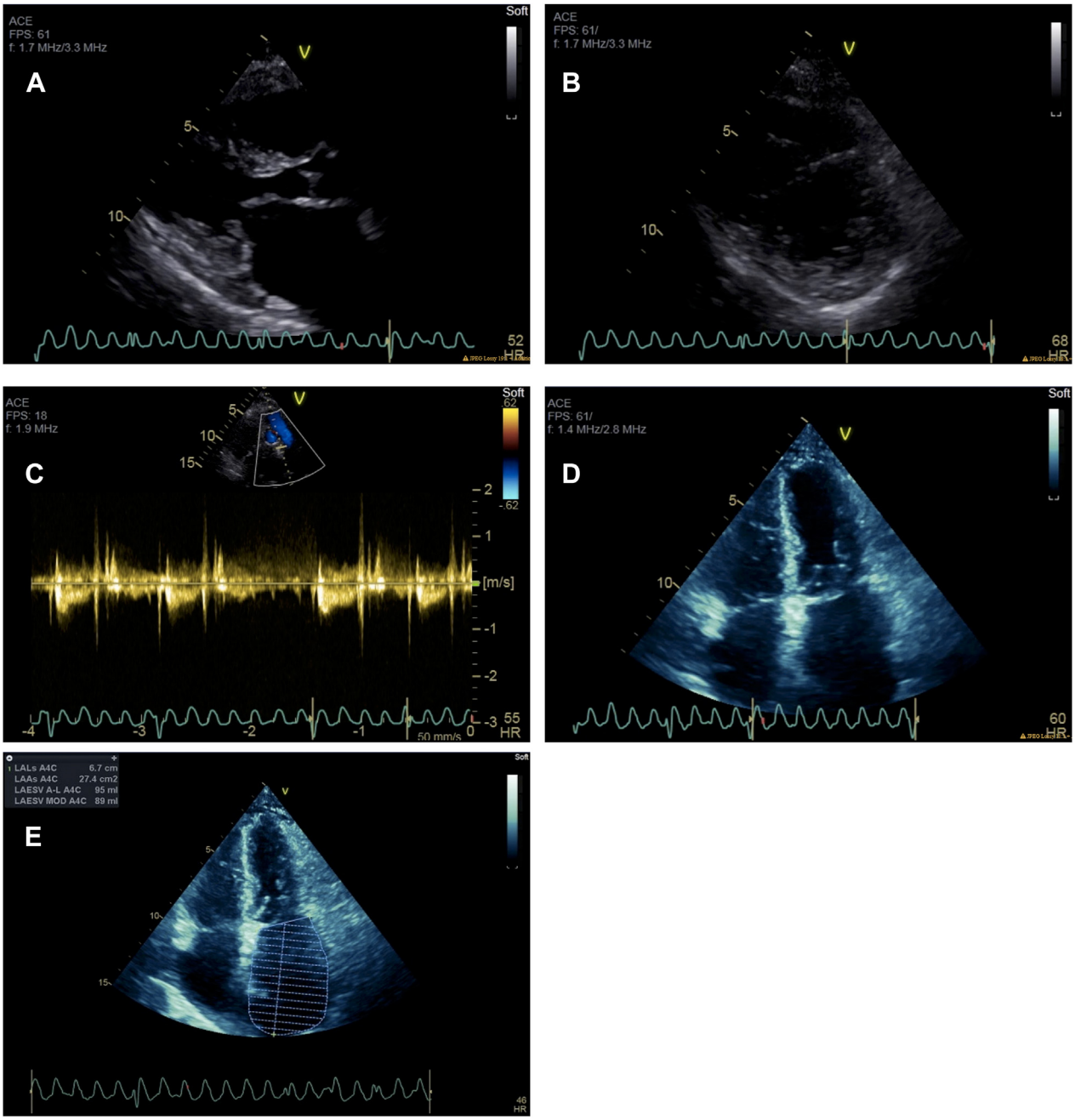
The elevated gradient between PCWP and LVEDP was thought consistent with severe MS, particularly given the LA enlargement on TTE (**Figure 2E**). However, the echocardiographic MV gradient of

FIGURE 1 Electrocardiogram Showing Atrial Flutter



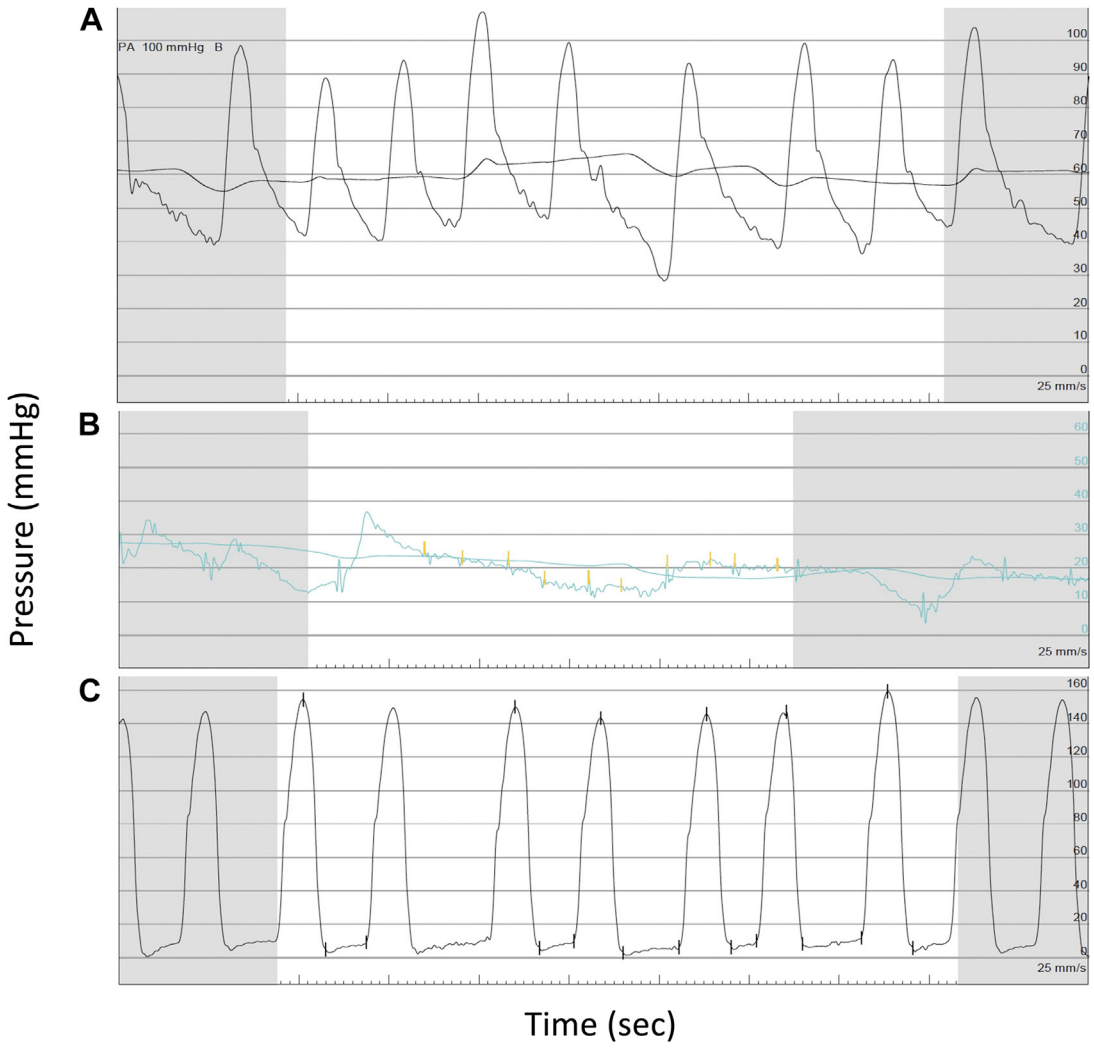
Atrial flutter is in a typical, anticlockwise pattern.

FIGURE 2 **Representative Transthoracic Echocardiogram Images**



(A) Parasternal long-axis view demonstrating mitral stenosis with hockey stick deformity, estimated left ventricular ejection fraction is 64%. **(B)** Parasternal short-axis view demonstrating interventricular septal flattening during systole. **(C)** Doppler of right ventricular outflow tract showing mid-systolic notching. **(D)** Apical 4-chamber view. **(E)** Left atrium volume measurement.

FIGURE 3 Right and Left Heart Catheterization With Chamber Pressures and Corresponding Waveforms



(A) Pulmonary artery pressure waveform with mean pressure overlaid. **(B)** Pulmonary capillary wedge pressure (PCWP) waveform with mean overlaid with mean PCWP of 20 mm Hg. **(C)** Left ventricular pressure waveform shows left ventricular end-diastolic pressure of 9 mm Hg.

5 mm Hg (Video 3) seemed insufficient to explain the discrepancy. Therefore, transseptal puncture was performed to directly measure left atrial pressure (LA_P) (**Figure 4**). This showed an LA_P of 10 mm Hg, and thus, a pulmonary vascular resistance of 26 WU. The diagnosis of idiopathic precapillary PAH was made.

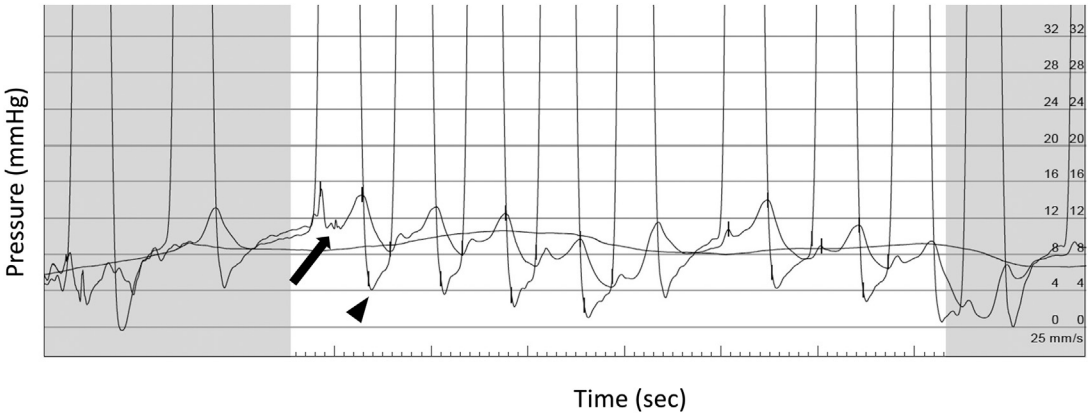
MANAGEMENT

The patient was initiated on sildenafil, continued on home oxygen therapy, and followed as an outpatient.

DISCUSSION

The diagnostic challenge faced by this patient's multidisciplinary team was that the pretest probability for precapillary pulmonary hypertension in a 78-year-old woman with massively enlarged LA and MS was low, increasing the risk of anchoring on left-sided heart disease as the culprit. However, the team noted that the mean pulmonary artery pressure (**Figure 3**) was elevated out of proportion to the MV gradient estimated by TTE (**Figure 2**), which would be inconsistent with primarily postcapillary disease.

FIGURE 4 **Right Heart Catheterization With Transseptal Puncture for Direct Measurement of LA_P**



Left atrial pressure (LA_P) waveform **(arrow)** with left ventricular pressure waveform overlaid **(arrowhead)**. Mean LA_P overlaid as well.

Therefore, transseptal puncture was performed, which showed a normal LA_P, showing her PH was due to precapillary pulmonary vascular resistance. The LA enlargement could be explained by atrial tachyarrhythmia rather than MS. This case highlights the importance of a thorough diagnostic evaluation and the potential pitfalls of anchoring bias in the workup of PH.

Treatment of PH should not be started until accurate diagnosis of precapillary vs postcapillary disease is made, particularly because pulmonary vasodilator treatment could lead to harm in left-sided heart failure or valvular disease.[1] Treatment of PH caused by left-sided heart failure or lung disease (WHO groups II and III, respectively) focuses on the underlying condition.[2] If the LA_P had not been measured, and the etiology of her PH was presumed to be MS, her management would have been vastly different.

To accurately diagnose PH, patients should undergo TTE, ventilation-perfusion scanning, and right heart catheterization.[2] Measurement of PCWP is crucial for determining whether PH is pre- or postcapillary. However, PCWP, a surrogate for LA_P, can be difficult to obtain in PAH because of the phenomenon of dilatation of proximal pulmonary arteries with significant occlusion and reabsorption of distal arterioles (pruning), making it difficult to obtain a wedge pressure.[3] Furthermore, the pressure in a wedged (occluded) pulmonary artery estimates that of the LA because there is a continuum among LA, pulmonary veins, venules, capillaries, and arterioles in a disease-free state. However, the continuum is disrupted in diseases such as COPD, via destruction of alveolar capillaries, and pulmonary veno-occlusive disease, via destruction of pulmonary venules.[4] The current gold standard for left-sided filling pressures is LVEDP, but it also can be inaccurate in the setting of MS or atrial arrhythmias.[5] One case series showed that both LVEDP and PCWP misdiagnosed the hemodynamics of PH in 33% of cases when compared with direct measurement of LA_P, suggesting that transseptal puncture may be underutilized.[6] Current consensus statement recommends measuring the PCWP oxygen saturation if PCWP is elevated to ensure occlusion of the artery,[2] and current guidelines do not recommend routine measurement of LA_P in the evaluation of PH.[7] However, in complex cases such as concomitant MV disease, prosthetic MV, or unreliable PCWP waveform, transseptal puncture may be considered.

FOLLOW-UP

The patient was seen in clinic for follow-up and had improved functional class on sildenafil. The patient was seen by a valvular disease expert but was deemed not to be a candidate for interventions for MS because there was suboptimal valve anatomy for percutaneous mitral balloon commissurotomy given

an elevated Wilkins score, and she was a high-risk surgical candidate.[8] In addition, transseptal puncture had shown the gradient between the LA and left ventricle was approximately 1 mm Hg, suggesting that the degree of stenosis had been overestimated echocardiographically.

CONCLUSIONS

Direct measurement of LA_P is underutilized in the workup of PH and may be considered if there is diagnostic uncertainty. A thorough diagnostic evaluation may sometimes reveal hoofbeats belong to a zebra; providing necessary evidence to mitigate potential anchoring biases.

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KEY WORDS postcapillary, precapillary, pulmonary arterial hypertension, transseptal puncture

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