The Clinical Picture
It’s all in the P wave

A
d-year-old man with rheumatic mitral valve
stenosis, which had been diagnosed 3 years pre-
viously, presented to the outpatient department with
worsening exertional dyspnea, fatigue, and cough.
At rest, he appeared comfortable; his pulse rate was
94 bpm and his blood pressure was 117/82 mm Hg.
Cardiac auscultation revealed a loud first heart sound,
a mid-diastolic murmur with presystolic accentuation
at the cardiac apex, and a pansystolic murmur at the
left lower sternal border that increased in intensity
with inspiration. A prominent left parasternal heave
was present.

His 12-lead electrocardiogram is shown in FIGURE 1.

Transsthoracic echocardiography confirmed severe
mitral stenosis with an estimated mitral valve area of
0.7 cm² without significant mitral regurgitation. In ad-
dition, right ventricular dilatation with moderately
severe systolic dysfunction and 4+ (severe) tricuspid
regurgitation were present. On the basis of the peak
tricuspid regurgitant velocity, the right ventricular sys-
tolic pressure was calculated to be 80 mm Hg, con-
sistent with severe pulmonary hypertension. The left
ventricular end-diastolic volume was reduced and the
ejection fraction was normal.

On right heart catheterization, the pulmonary ar-
tery pressure was 92/51 mm Hg.

Q: Electrocardiographic findings that support a diag-
osis of pulmonary hypertension include which of the following?
A: The correct answer is all of the above. Regardless of
the cause, patients with long-standing pulmonary hy-
pertension possess varying degrees of right ventricular
hypertrophy that may be accompanied by right ven-
tricular enlargement and systolic dysfunction. A QRS
complex axis of 110° or more, an R/S (QRS complex)
ratio greater than 1 in lead V₁, and the sum of the am-
plitudes of the R wave in lead V₁ and the S wave in
lead V₆ greater than 1.0 mV all support right ventricu-
lar hypertrophy.¹

As noted in this electrocardiogram, T-wave inver-
sion in leads V₁ and V₂ supports a right ventricular
repolarization abnormality secondary to the hypertro-

Q: Important electrocardiographic findings in this pa-
tient that support secondary pulmonary hypertension
due to mitral stenosis include which of the follow-
ing?
A: The correct answer is prolonged P waves of at least
0.25 mV in lead II and terminal negative P waves in
lead V₁ greater than 40 ms.

Abnormal surface electrocardiographic findings re-
flecting atrial enlargement or slowed atrial conduc-
tion are difficult to differentiate and are best characterized
as “atrial abnormalities.” On surface electrocardiogra-
phy, an atrial abnormality is represented by a P wave
morphology that is best studied in leads II and V₁. In
lead II, a tall peaked P wave of at least 0.25 mV supports
right atrial abnormality, and a prolonged P wave (≥ 120
ms) supports left atrial abnormality. In lead V₁, right

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Atrial abnormality is suggested by a positive P wave in V₁ greater than 0.15 mV, and a terminally negative P wave greater than 40 ms in duration and greater than 0.1 mV deep supports left atrial abnormality.³

It is well recognized that the pathophysiology of pulmonary hypertension involves both the right ventricle and the right atrium.⁴ Therefore, irrespective of the cause of pulmonary hypertension, electrocardiography may additionally reveal right atrial abnormality.⁵

When the findings suggest pulmonary hypertension (ie, right ventricular hypertrophy with or without right atrial abnormality), it is also important to evaluate for concurrent left atrial abnormality. If present, concomitant left atrial abnormality is a valuable, more specific clue that may help characterize secondary pulmonary hypertension from left-sided heart disease, as illustrated in this example with long-standing severe mitral stenosis.⁶

**FIGURE 1.** This 12-lead electrocardiogram demonstrates bi-atrial abnormality and right ventricular hypertrophy compatible with severe pulmonary hypertension in the setting of mitral stenosis. Specific findings:

**Normal sinus rhythm with heart rate 94 bpm**

**Bi-atrial enlargement (red arrow)**
- Tall, peaked, and broad-based P wave in lead II (0.3 mV, 120 ms)
- Positive P in lead V₁ (0.2 mV)
- Negative terminal component of P in lead V₁ (0.4 mV, 60 ms)

**Right ventricular hypertrophy**
- R/S (QRS complex) ratio >1 in lead V₁ (green arrow) with T-wave inversion in leads V₁ and V₂
- Right axis QRS complex deviation (+110°)
- Delayed R wave progression in leads V₁–V₆
- R in lead V₁ plus S in lead V₆ = 1.9 mV
- Right ventricular conduction delay
P WAVE

REFERENCES


ADDRESS: Curtis Rimmerman, MD, MBA, FACC, Gus P. Karos Chair in Clinical Cardiovascular Medicine, Department of Cardiovascular Medicine, J2-4, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, OH 44195; e-mail address rimmerc@ccf.org.