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Diagnosing left ventricular hypertrophy

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Left ventricular hypertrophy (LVH) is the abnormal enlargement of the left ventricle in response to increased peripheral vascular resistance, most commonly resulting from long-standing hypertension. The ventricle is forced to work against the increased pressure, causing the muscle to hypertrophy in an effort to keep up with the demand.

Symptoms LVH by itself has no individual symptoms. However, LVH often results in a drop in ejection fraction, which leads to such symptoms as dyspnea on exertion, orthopnea, and chest pain.

Etiology While the most common etiology of LVH is long-standing hypertension, there are other, less common causes. These include hypertrophic cardiomyopathy, athletic training, and aortic stenosis.

ECG findings As discussed in a [previous installment](#) of this department on axis deviation, left axis deviation can suggest the presence of LVH. The reason for this is that all cells in the heart muscle depolarize, generating electrical activity. More cells (eg, hypertrophy) create more electricity. This can cause a shift in the axis toward the hypertrophied chamber—in this case, the left ventricle.

Other ECG findings can also indicate LVH. Increased voltages generated by hypertrophied heart muscle are best observed in the R and S waves (**Figure 1**) of various leads overlying the left ventricle, specifically V₁, aVL, V₅, and V₆. The *R wave* is the first upward deflection of the QRS complex and is measured from Q to R on the ECG. The *S wave* is the downward portion of the QRS complex after the R wave (R to S on the ECG).

Diagnosing LVH Many ECG criteria for LVH have been published over the years. All are quite specific (greater than 90%) but not very sensitive (6.9%).¹⁻³ This means that patients whose ECG demonstrates findings that fulfill the criteria for LVH are likely to have clinical LVH; however, patients lacking the ECG criteria may still have clinical LVH. Sensitivity does improve with the

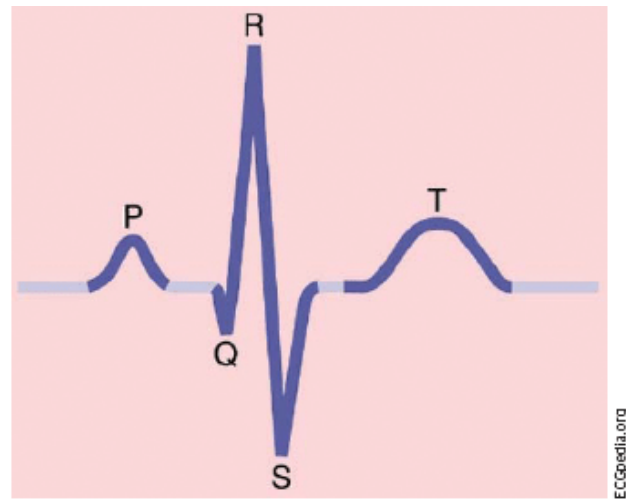


FIGURE 1. QRS complex as seen on a normal ECG

combination of multiple sets of criteria.³ We chose to combine the Sokolow and Lyon criteria¹ with the Cornell criteria.²

Sokolow and Lyon offer two criteria: First, the S wave measurement in lead V₁ added to the R wave measurement in lead V₅ or V₆ (whichever is larger) must equal more than 35 mm. Second, the R wave in aVL must be greater than or equal to 11 mm. Cornell diagnoses LVH if the sum of the S wave in V₃ and the R wave in aVL is greater than 28 mm in men or greater than 20 mm in women.

EKG challenge

A 70-year-old white man with a history of hypertension presented with complaints of fatigue and lower-extremity edema. At this visit, his BP was 148/92 mm Hg. He takes oral hydrochlorothiazide 20 mg each day and oral lisinopril 40 mg day.

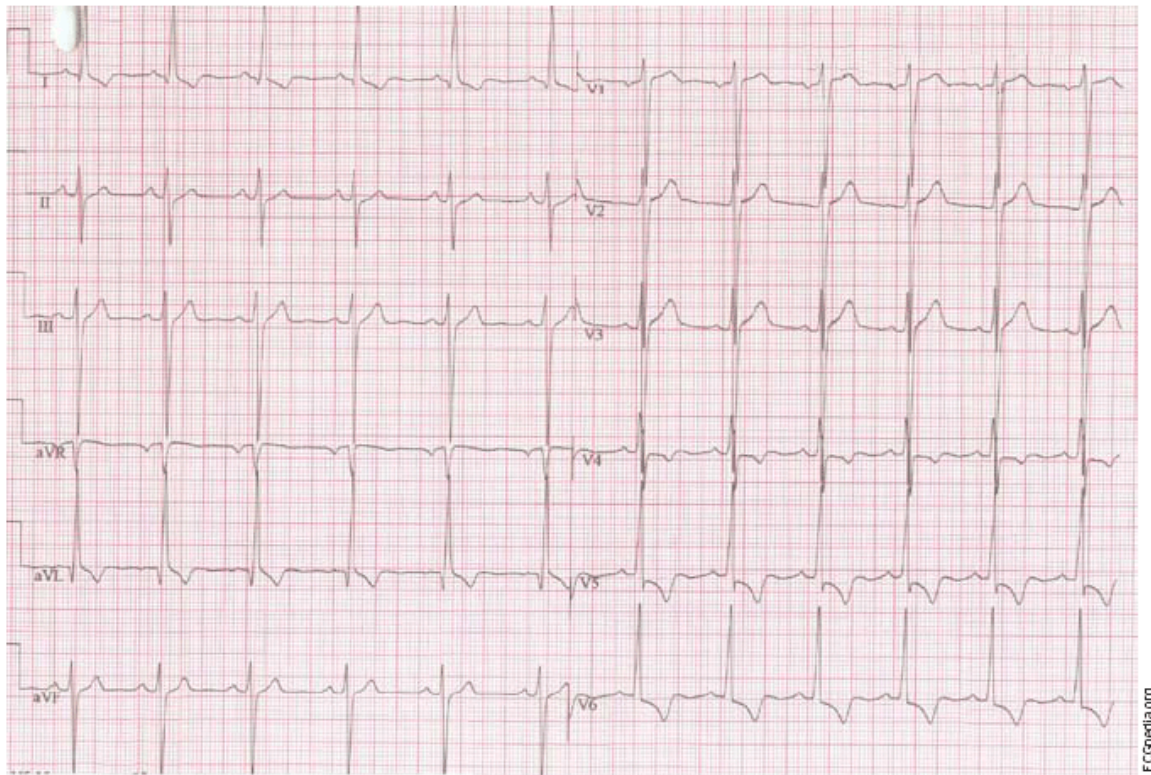


FIGURE 2. ECG of a patient with a history of hypertension and complaints of fatigue and leg swelling

Using the stepwise approach to analyze the patient's ECG (**Figure 2**), consider the following:

1. Is the ECG **regular**? Yes. The QRS complexes march out.
2. What is the **heart rate**? Find a QRS complex on or near a dark line.

Method A: Counting the large boxes, we see that there are slightly more than four large boxes before the next QRS complex. Four boxes would put the heart rate at 75 beats per minute, or we could estimate the rate to be slightly less than that at 70 beats per minute.

Method B: There are about seven QRS complexes in 6 seconds (30 large boxes), which estimates the heart rate at 7×10 or 70 beats per minute.

Method C: Dividing 300 by 4 (the number of large boxes between QRS complexes) gives us a heart rate of 75 beats per minute.

3. There is a **P wave** for each QRS complex, and all the P waves look the same.
4. The **PR interval** is about five small boxes, which is 0.2 seconds. This is borderline for a first-degree atrioventricular block (the subject of a future segment of this department).
5. The **QRS complex** spans fewer than two small boxes, which is normal.
6. In leads V₅ and V₆, the **ST segment** is depressed, which could suggest the presence of ischemia or injury to the lateral wall (to be discussed in a future segment).
7. The **T waves** in leads V₄-V₆ are inverted. This is a nonspecific finding that could suggest underlying ischemia and should be investigated if not done previously.
8. There are **no U waves**.

In order to assess this ECG for LVH criteria, we need to look at leads V₁, aVL, V₅, and V₆. Evaluating the Sokolow and Lyon criteria, we see that the S wave in lead V₁ is approximately 30 mm and the R wave in lead V₅ is approximately 21 mm; the sum of those two values is 51 mm, which is greater than 35 mm and meets one of the criteria for LVH. In addition, the R wave in lead aVL is approximately 26 mm, which is more than 11 mm and meets the second Sokolow and Lyon criterion. Finally, the S wave in V₃ is approximately 33 mm and the R wave in aVL is approximately 26 mm for a total of 59 mm, fulfilling the Cornell criterion of greater than 28 mm in a man. Because this ECG meets all three of the criteria for a diagnosis of LVH, there is a high likelihood that this patient has clinical LVH.

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