Left Ventricular Hypertrophy and Arrhythmogenesis

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KEYWORDS

• Left ventricular hypertrophy • Ventricular arrhythmias • Atrial fibrillation • Hypertension • Hypertensive heart disease • Arrhythmogenesis • Torsades de pointes

KEY POINTS

- Left ventricular hypertrophy (LVH) is a common yet underdiagnosed condition with a heterogeneous cause; the most common cause is long-term hypertension and valvular heart disease.
- LVH diagnosis is based on electrocardiogram (ECG) and other cardiac imaging modalities, such as echocardiogram, cardiac magnetic resonance (CMR) imaging, and cardiac computed tomography (CCT).
- Aggressive management of specific causes of LVH such as hypertension control and appropriate management of valvular heart disease may reverse LVH and its consequences.
- Atrial and ventricular arrhythmias are common in moderate to severe LVH, are often underdiagnosed, and require specific management based on the cause.
- Mechanisms of atrial and ventricular arrhythmias in LVH are diverse and depend on specific causes, mostly related to dispersion of refractoriness that promotes reentry arrhythmias.
- LVH is no longer considered a benign condition and indeed is a silent killer; however, it is a treatable and preventable condition.

INTRODUCTION

Definition of Left Ventricular Hypertrophy

LVH is due to an increase in cardiomyocyte size (cell hypertrophy), which results in increased left ventricular (LV) mass and cavity size. The normal LV mass for men is 135 g and LV mass index is 71 g/m^2. For women, the normal values are 99 g and 62 g/m^2, respectively. LVH is then usually defined as 2 standard deviations more than the normal.[1–6]

LVH is a common and often underdiagnosed condition and remains silent in the early stages, eventually leading to congestive heart failure (CHF).[7] In patients with a definite ECG pattern of LVH, there is a 59% overall mortality at 12 years. LVH as an independent risk factor increases the risk of coronary artery disease (CAD) by 3-fold. It also increases the risk of sudden cardiac death (SCD) 6- to 8-fold in men and 3-fold in women. It increases the risk of CHF by 10-fold at 16 years. The LIFE (Losartan Intervention For Endpoint reduction in hypertension) study examined the presence of LVH and ST-T wave changes. LVH also increases the risk of myocardial infarction (MI) and other cardiovascular morbidity and mortality in patients with hypertension.[8]

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ELECTROCARDIOGRAM CRITERIA OF LEFT VENTRICULAR HYPERTROPHY

The following are the 2 most used criteria[1–3]:

1. The Sokolow-Lyon voltage criteria: S wave in lead V1 + R wave in lead V5 or V6 greater than or equal to 3.50 mV or R wave in lead V5 or V6 greater than 2.60 mV
2. The Cornell voltage criteria: For women, R wave in lead aVL + S wave in lead V3 greater than 2.00 mV. For men, R wave in lead aVL + S wave in lead V3 greater than 2.80 mV[9]

THE ELECTROCARDIOGRAPHIC MANIFESTATION OF LEFT VENTRICULAR HYPERTROPHY

Although ECG is easily accessible and cheap, the diagnostic yield of LVH by ECG is only 2.4%, with a low sensitivity and specificity (25%–60%) compared with echocardiography (Echo).[10–12] Furthermore, the diagnostic yield of LVH by ECG is affected by race, gender, medications, and so on. The following are the ECG abnormalities observed in patients with established LVH:

1. Left atrial (LA) abnormalities such as negative p-wave suggest an increase of the left atrial size.
2. There is increased QRS voltage.
3. There is increased QRS duration.
4. Left-axis deviation in hypertensive patients suggests presence of LVH.
5. Left bundle branch block (in advanced stages) is seen.
6. Repolarization abnormalities (ie, ST-T wave changes) are observed.

A slow R wave progression (V1-V3), although nonspecific, may be seen in patients with LVH (one has to exclude underlying anteroseptal MI). **Fig. 1** is an example of significant LVH and ST-T wave abnormalities in a patient with aortic stenosis.

ECHOCARDIOGRAPHIC CRITERIA OF LEFT VENTRICULAR HYPERTROPHY

The diagnostic yield of LVH by Echo is 17.4%. The equation for LV mass is (g) = 1.05[(left ventricular end-diastolic diameter (LVEDD) + IVS (interventricular septal thickness) + PW (posterior wall thickness))^3 − LVEDD^3]. LV mass was divided by body surface area to obtain the LV mass index. According to data from the Framingham Heart Study, LVH was defined as LVMI (left ventricular mass index) greater than or equal to 150 g/m^2.[5,13–18]

Echo indices that are usually measured during an Echo examination are listed below:

- LV geometry
- Wall thickness
- Motion
- LV systolic function
- LV diastolic function

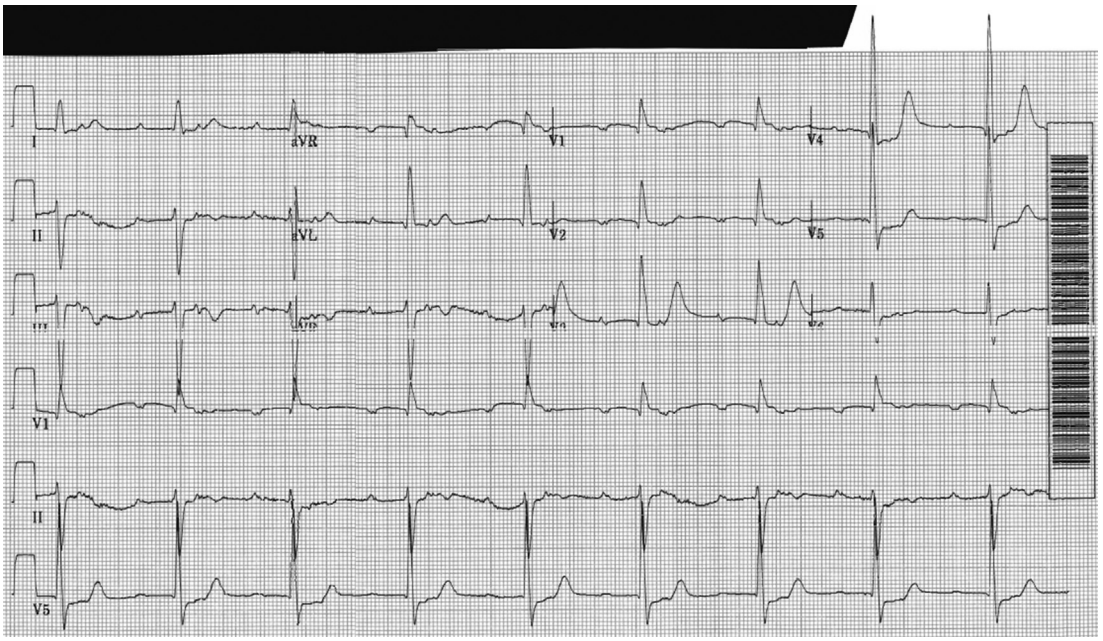

Fig. 1. Twelve-lead electrogram of an 85-year-old male with severe aortic stenosis, two-to-one A-V block with prolonged PR Interval of the conducted beats, incomplete right bundle branch block, left ventricular hypertrophy, and ST-T wave abnormalities.