ECG
(ELECTROGARDIOGRAPHY)

MAHBOUBEH PAZOKI

ASSOCIATE PROFESSOR OF IUMS

CARDIOLOGIST, FELLOWSHIP OF ECHOCARDIOGRAPHY

Cardiac chamber enlargement

ECG WAVE MAVEN

GOLDBERGERS-CLINICAL-ELECTROCARDIOGRAPHY-SIMPLIFIED-APPROACH

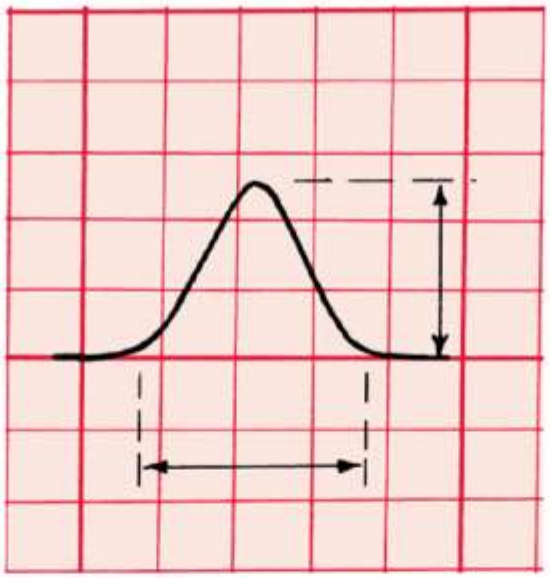

Figure 6-1. The normal P wave is usually less than 2.5 mm in height and less than 0.12 sec in width.

RIGHT ATRIAL ABNORMALITY:

➢Normally, at rest, the P wave in every lead is less than 2.5 mm (0.25 mV) in amplitude and less than 0.12 sec (three small boxes) in width

➢Overload of the RA may produce an abnormally tall P wave (2.5 mm or more).

➢because pure RAA generally does not increase the total duration of atrial depolarization, the width of the P wave is normal (less than 0.12 sec).

➢The abnormal P wave in RAA is sometimes referred to as P pulmonale because the atrial enlargement that it signifies often occurs with severe pulmonary disease .

➢The tall, narrow P waves characteristic of RAA can usually be seen best in leads II, III, aVF, and sometimes V1.

➢Tall peaked P waves are of limited sensitivity and specificity in the diagnosis of right atrial enlargement.

Right Atrial Abnormality (Overload)

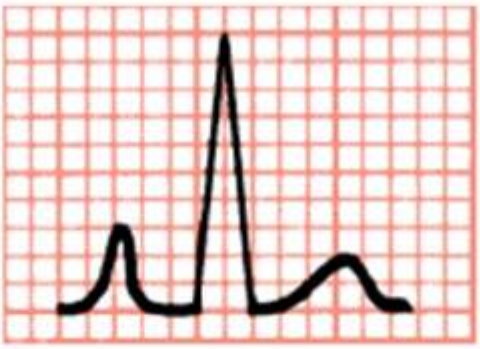

Figure 6-2. Tall narrow P waves may indicate right atrial abnormality or overload (formerly referred to as *P pulmonale* pattern).

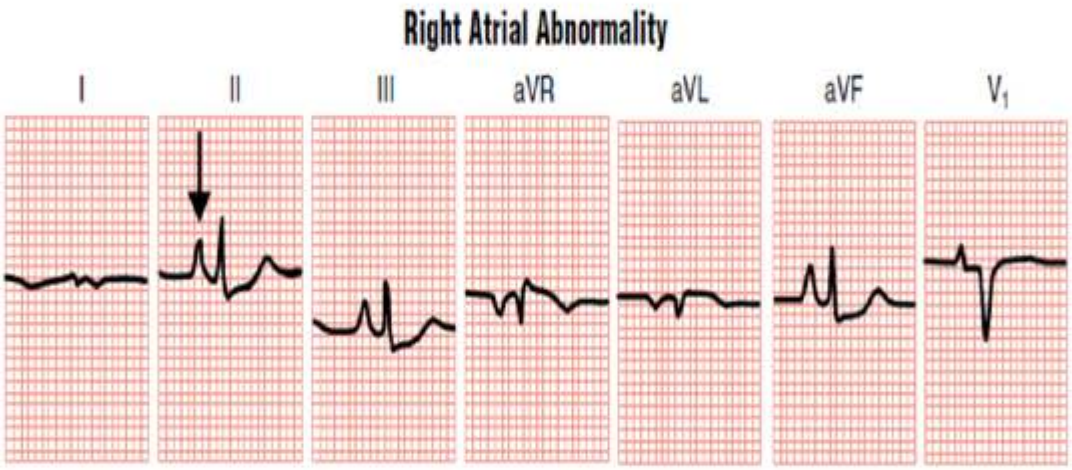

Figure 6-3. Tall P waves (*arrow*) are seen in leads II, III, aVF, and V_1 from the ECG of a patient with chronic lung disease. This finding is sometimes called the *P pulmonale* pattern.

➢Normally the left atrium depolarize after the right atrium. Thus, left atrial enlargement should prolong the total duration of atrial depolarization, indicated by an abnormally wide P wave.

➢Left atrial enlargement (LAE) characteristically produces a wide P wave with duration of 0.12 sec o more (at least three small boxes).

➢These humped P waves are usually best seen in one or more of the extremity leads.

➢The older term P mitrale is sometimes still used to describe wide P waves seen with LAA because these waves were first described in patients with rheumatic mitral valve disease.

➢In patients with LAA, lead V1 sometimes shows a distinctive biphasic P wave.

➢This wave has a small, initial positive deflection and a prominent, wide negative deflection.

➢The negative component is longer than 0.04 sec in duration or 1 mm or more in depth.

Left Atrial Abnormality

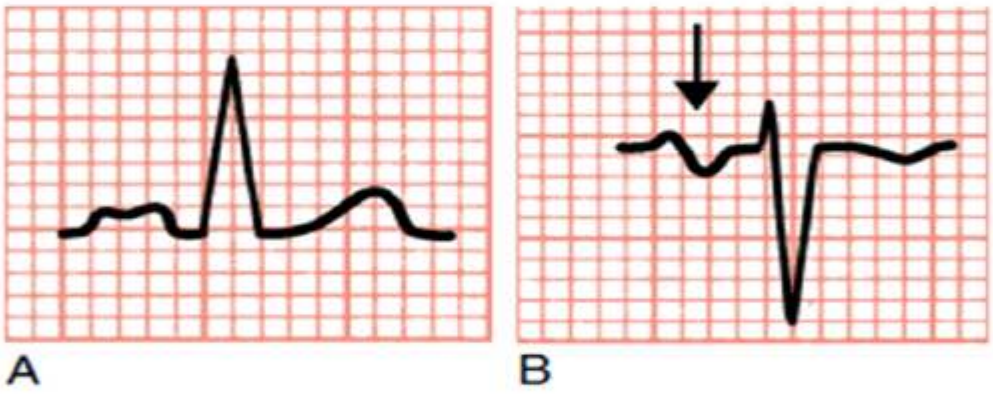

Figure 6-4. Left atrial abnormality/enlargement may produce the following: **A**, wide, sometimes notched P waves in one or more extremity leads (formerly referred to as *P mitrale* pattern), and **B**, wide biphasic P waves in lead V_1.

Figure 6-5. Broad, humped P waves from the ECG of a patient with left atrial enlargement (abnormality).

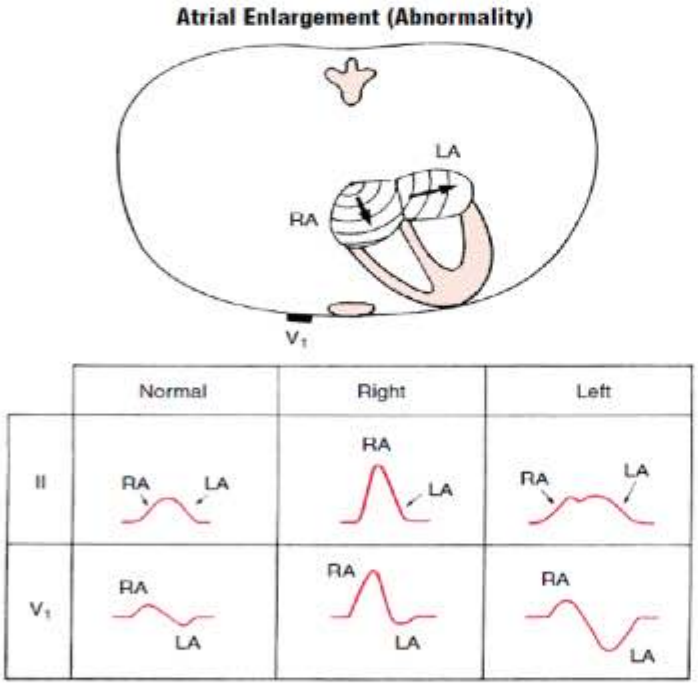

Figure 6-6. Overload of the right atrium (RA) may cause tall, peaked P waves in the extremity or chest leads. An abnormality of the left atrium (LA) may cause broad, often notched P waves in the extremity leads and a biphasic P wave in lead V_1 with a prominent negative component representing delayed depolarization of the left atrium. (Modified from Park MK, Guntheroth WG: How to Read Pediatric ECGs, 4th ed. St. Louis, Mosby/Elsevier, 2004.)

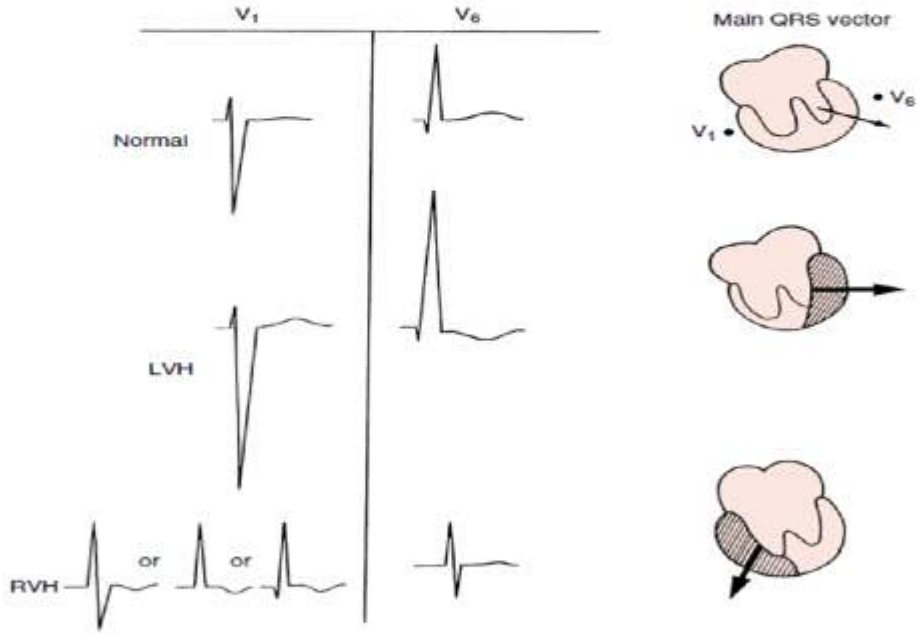

Figure 6-7. The QRS patterns with left ventricular hypertrophy (LVH) and right ventricular hypertrophy (RVH) can be anticipated based on the abnormal physiology. Notice that left ventricular hypertrophy exaggerates the normal pattern, causing deeper right precordial S waves and taller left precordial R waves. By contrast, right ventricular hypertrophy shifts the QRS vector to the right, causing increased right precordial R waves.

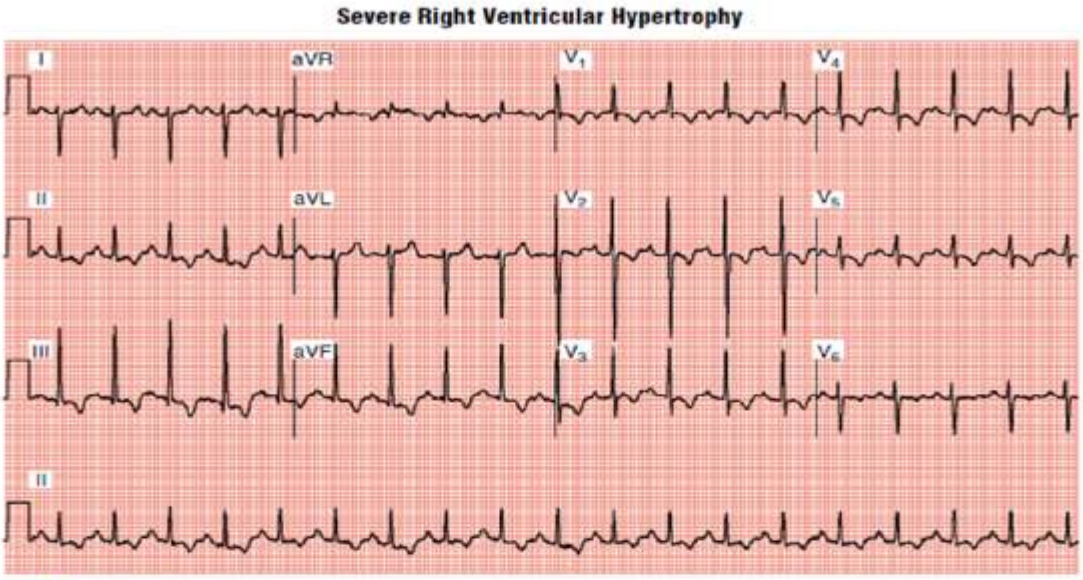

Figure 6-8. A tall R wave (as part of an Rs complex) with an inverted T wave caused by right ventricular overload is seen in leads V_1 to V_3 (also in II, III, and aVF) from a patient with right ventricular hypertrophy (RVH) that was multifactorial. Marked right axis deviation is also present because the R wave in lead III is much taller than the R wave in lead II. In fact, the RVH is so severe that the R wave progression pattern is actually reversed (rS in V_6). The negative but prominent P wave in V_1 is probably due to right atrial overload, with slightly peaked P waves in leads II, III, and aVF.

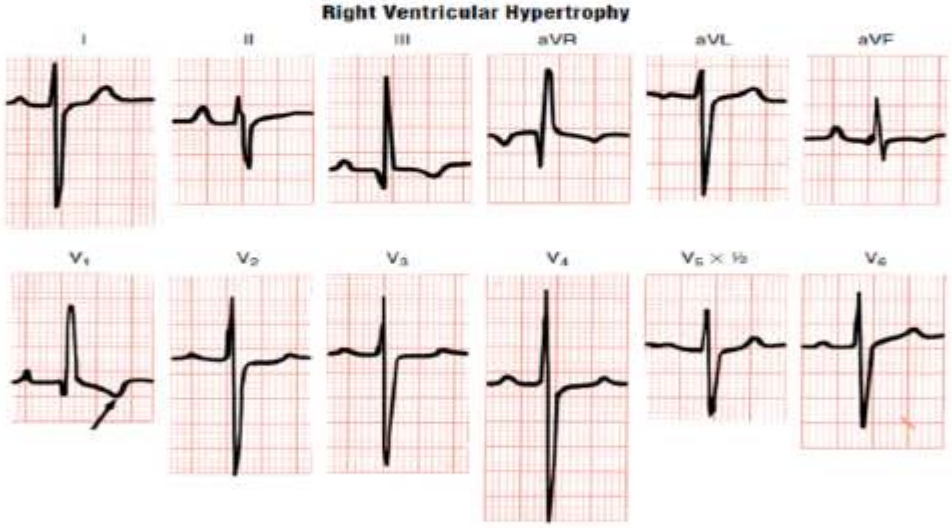

Figure 6-9. With right ventricular hypertrophy, lead V_1 sometimes shows a tall R wave as part of the qR complex. Because of right atrial enlargement, peaked P waves are seen in leads II, III, and V_1. The T wave inversion in lead V_1 and the ST segment depressions in leads V_2 and V_3 are due to right ventricular overload. The PR interval is also prolonged (0.24 sec).

Key Point

The following triad (in adults) strongly points to marked RVH due to a pressure load (pulmonary hypertension or pulmonic stenosis):

1. Tall right precordial R waves
2. Right axis deviation (RAD)
3. Right precordial T wave inversions in adults

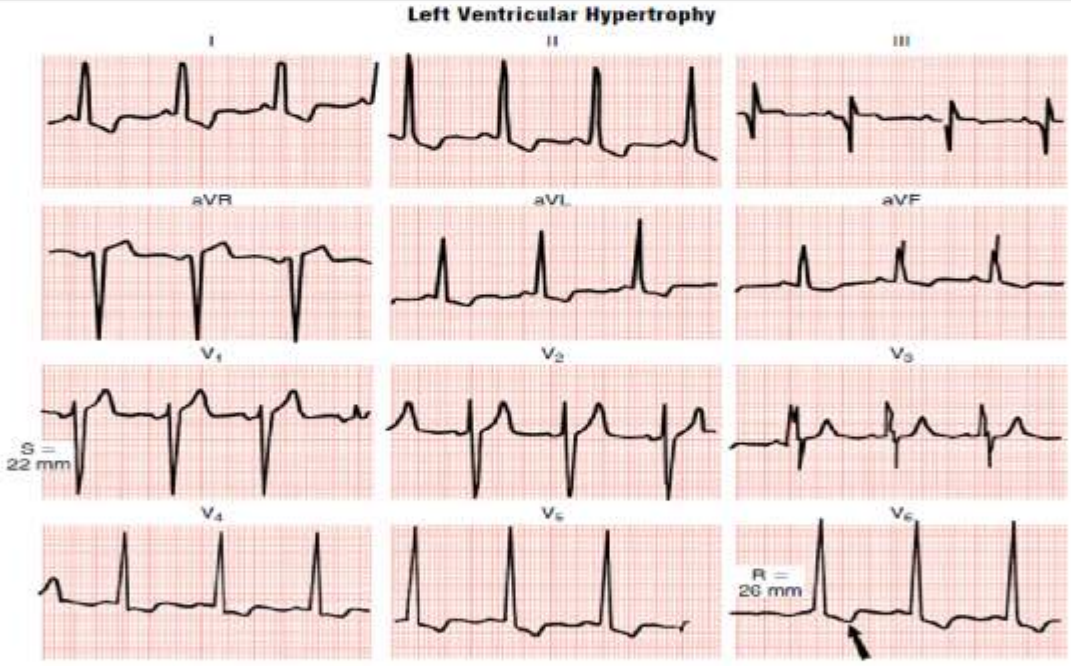

Figure 6-10. Pattern of left ventricular hypertrophy in a patient with severe hypertension. Tall voltages are seen in the chest leads and lead aVL (R = 17 mm). A repolarization (ST-T) abnormality, formerly referred to as a "strain" pattern, is also present in these leads. In addition, enlargement of the left atrium is indicated by a biphasic P wave in lead V_1.

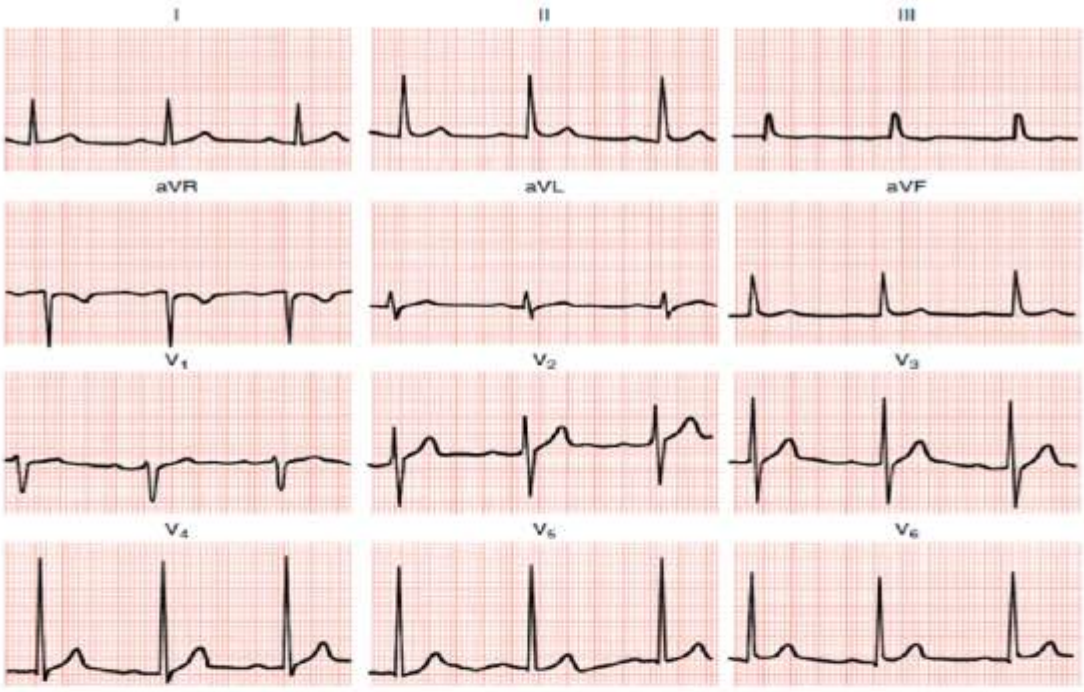

Figure 6-11. Tall voltages in the chest leads ($S_{V1} + R_{V5} - 36$ mm) from a 20-year-old man represent a common normal ECG variant, particularly in athletic or thin young adults. The ST-T complexes are normal, without evidence of repolarization (ST-T) abnormalities or left atrial abnormality.

Figure 6-12. Repolarization abnormalities associated with left ventricular hypertrophy were formerly referred to as the "strain" pattern, an imprecise but still sometimes used term. Notice the characteristic slight ST segment depression with T wave inversion in the leads that show tall R waves. These repolarization changes can be referred to as "LVH-related ST-T changes" or "ST-T changes due to LV overload."

ECG diagnosis of LVH:

➢1. If the sum of the depth of the S wave in lead V1 (SV1) and the height of the R wave in either lead V5 or V6 (RV5 or RV6) exceeds 35 mm (3.5 mV), LVH should be considered especially in middle-aged or older adults.

➢However, high voltage in the chest leads is a common normal finding, particularly in athletic or thin young adults; Consequently, high voltage in the chest leads (SV1 + RV5 or RV6 > 35 mm) is not a specific LVH indicator .

➢2. Another proposed set of LVH criteria (the Cornell voltage criteria) is based by summing components of the QRS voltages in leads V3 and aVL: for men, SV3 + RaVL > 28 mm; for women, SV3 + RaVL > 20 mm.

➢3. Sometimes LVH produces tall R waves in lead aVL. An R wave of 11 to 13 mm (1.1 to 1.3 mV) or more in lead aVL is another sign of LVH. Sometimes a tall R wave in lead aVL is the only ECG sign of LVH, and the voltage in the chest leads is normal. In other cases the chest voltages are abnormally high, with a norma R wave seen in lead aVL.

➢4.In some cases these T wave inversions are very deep. This LV overload related repolarization abnormality (formerly called LV "strain") is usually best seen in leads with tall R waves.

➢5.Actual left axis deviation (i.e., an axis −30° or more negative) may also be seen.

➢In addition, the QRS complex may become wider.

➢Not uncommonly, patients with LVH eventually develop an incomplete or complete left bundle branch block (LBBB) pattern.

➢6. Finally, signs of LAA are often seen in patients with ECG evidence of LVH.