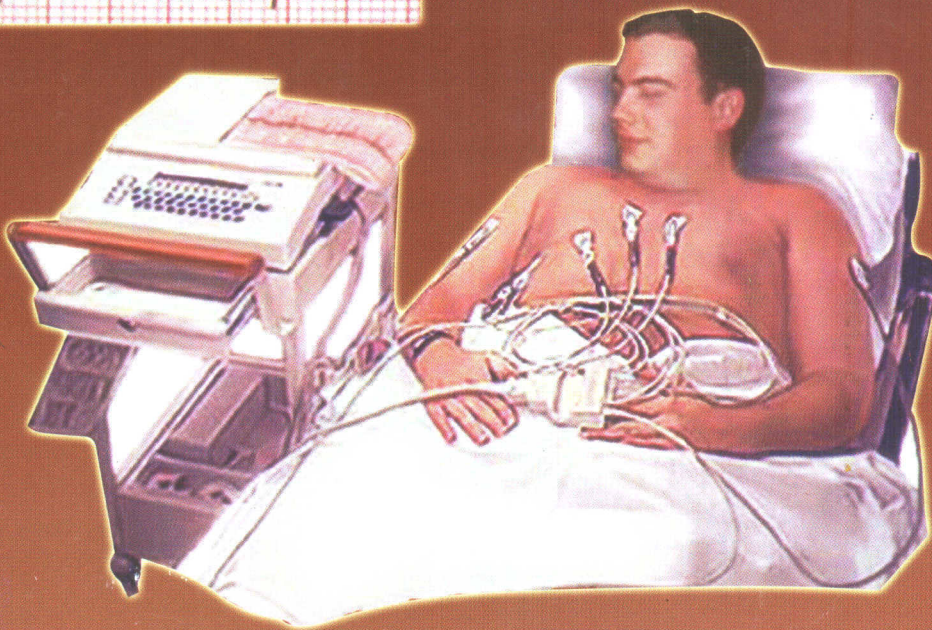
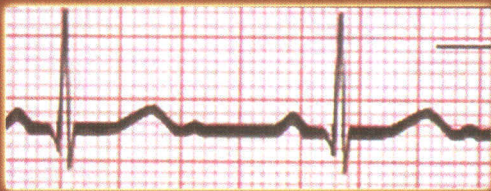


Lecture Notes of Internal Medicine

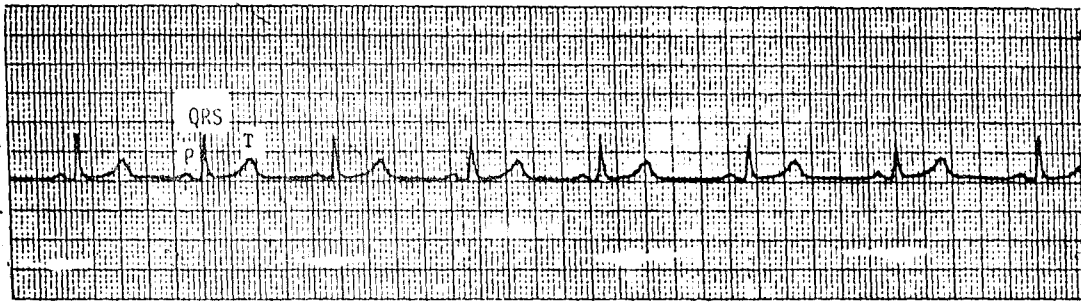
ECG



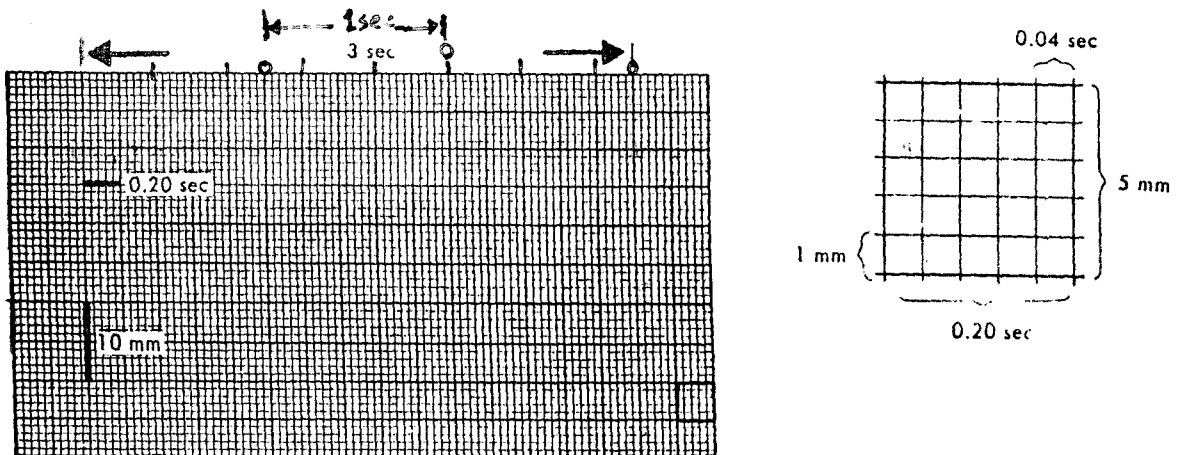
*Dr. Osama Mahmoud Mohamed
Lecture of Internal Medicine
Ain Shams University*

First Edition

ECG

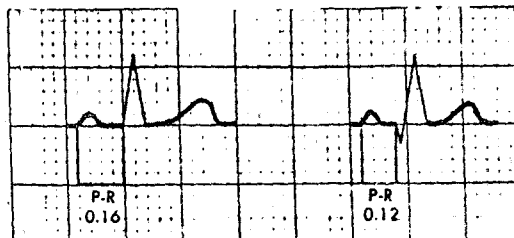
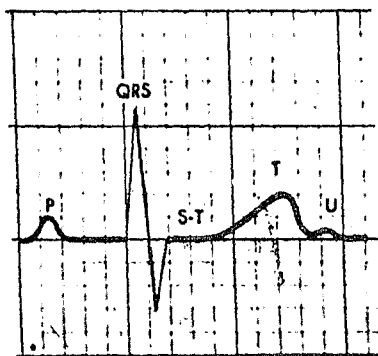


Cardiac cycle. Basic cardiac cycle (P-QRS-T) repeats itself again and again.



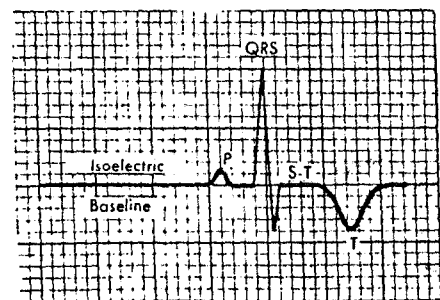
ECG paper. ECG paper is a graphic divided into millimeter squares. Time is measured on the horizontal axis. Each small millimeter box equals 0.04 sec, and each larger (5 mm) box equals 0.2 sec with a paper speed of 25 mm/sec. the amplitude of any wave is measured on the vertical axis in millimeters.

BASIC ECG COBPLEX

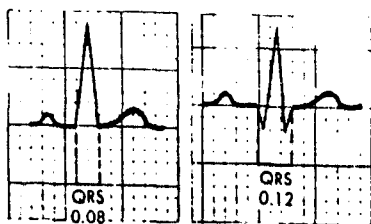


Measurement of the P-R interval.

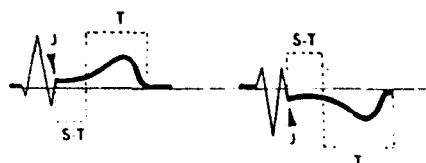
P wave represents atrial depolarization. P-R interval represents time from initial stimulation of atria to initial stimulation of ventricles. QRS represents ventricular depolarization. S-T segment, T wave, and U wave are produced by ventricular repolarization.



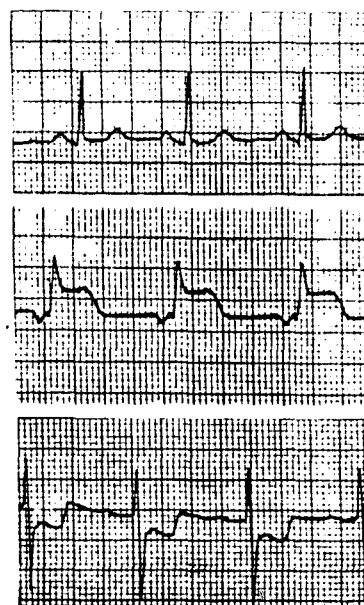
Positive and Negative Complexes. P Wave Here Is Positive (Upright), and T Wave Is Negative (Downwards). QRS Complex Is Biphasic (Partly Positive, Partly Negative) S-T Segment Is Isoelectric (Neither Positive nor Negative)



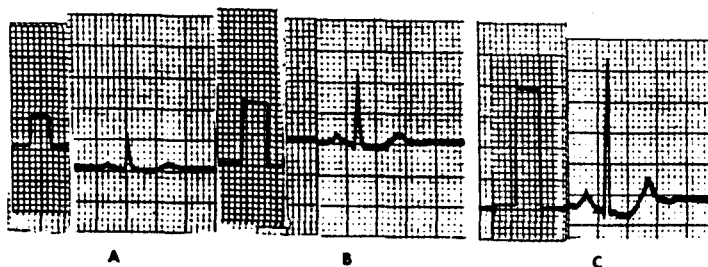
Measurement of QRS width.



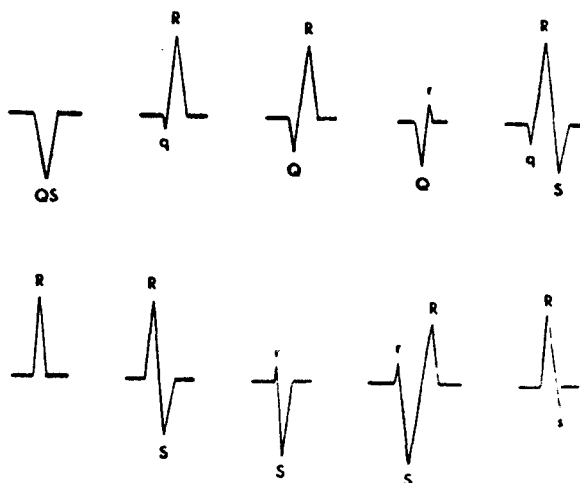
Characteristics of normal S-T segment & T wave. J junction, marks beginning of S-T segment.



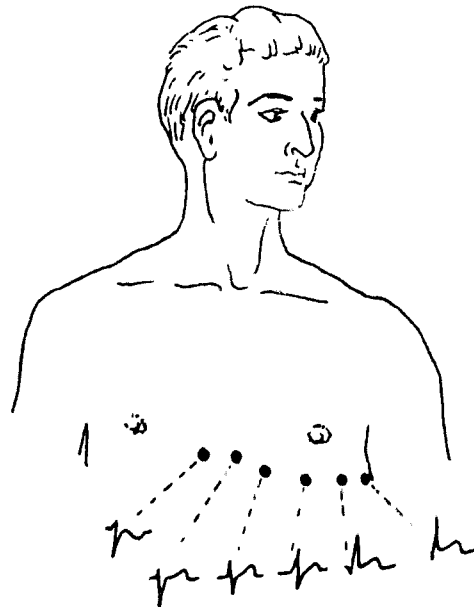
S-T segments. Top, normal S-T segment. middle, abnormal S-T elevation. Bottom, abnormal S-T depression.



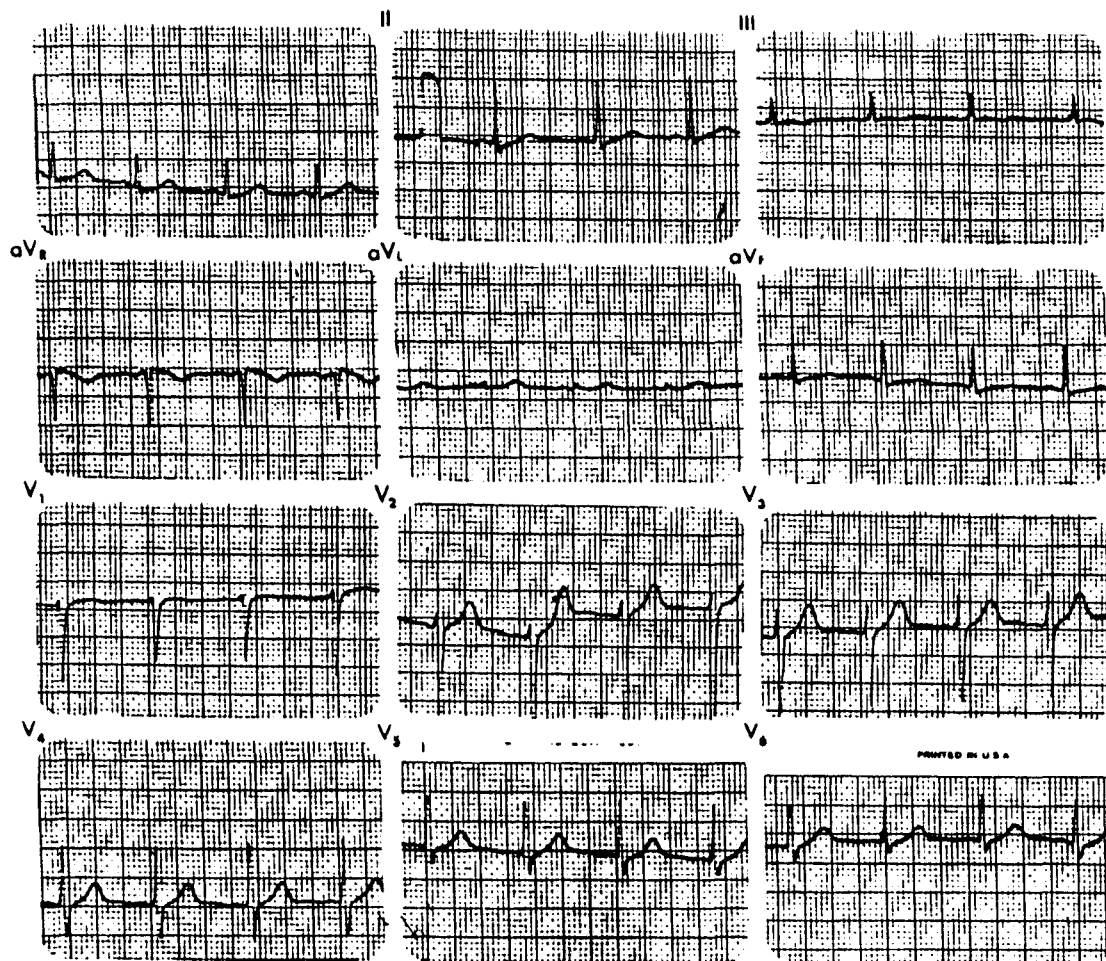
Standardization mark. Before taking an ECG, the machine must be calibrated so that the standardization mark, A, is 10 mm tall. Electrocardiographs can also be set at one-half standardization, B, or 2 times standardization, C.



QRS nomenclature.

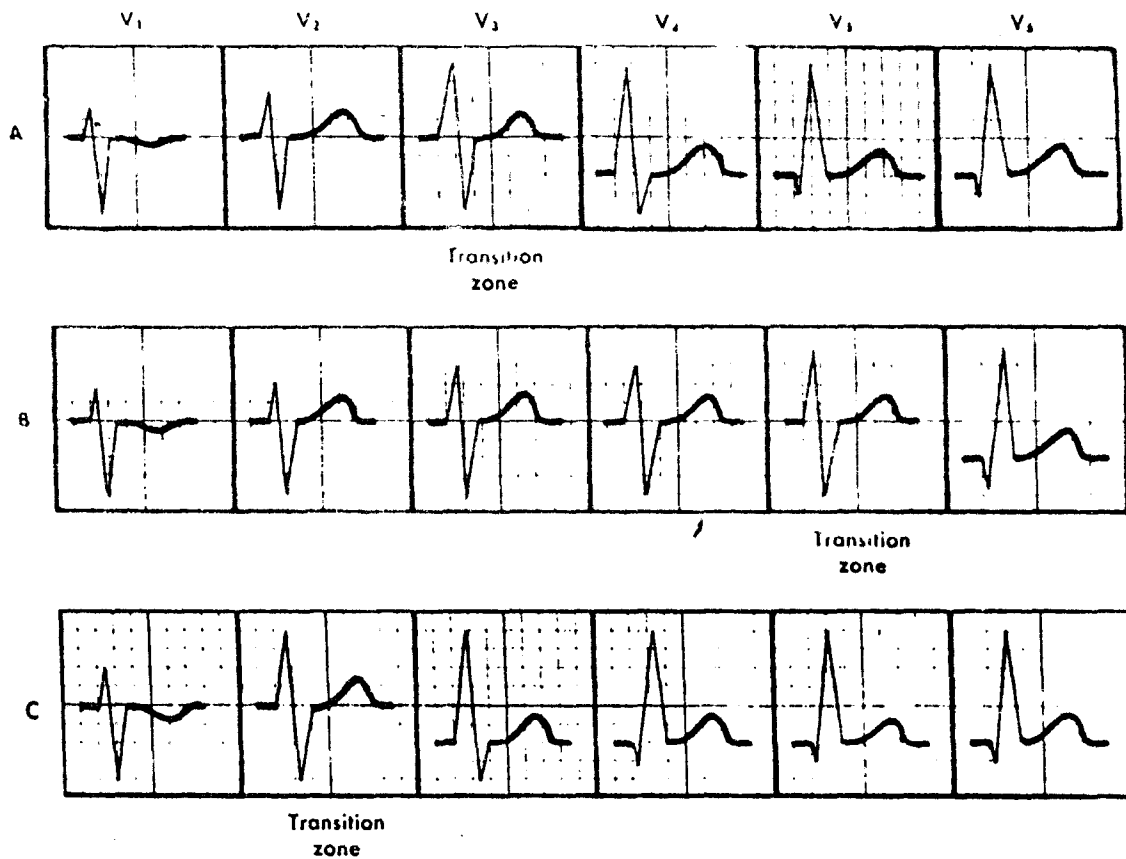


Multiple chest leads give a three- dimensional view of cardiac electrical activity.



Sample ECG mounted for interpretation showing 12 standard leads.

NORMAL CHEST LEAD PATTERNS



Normally, the R wave in chest leads becomes relatively taller from lead V₁ to left chest leads.

A, Normal R wave progression with transition zone in lead V₃

B, Somewhat delayed R wave progression with transition zone in lead V₅.

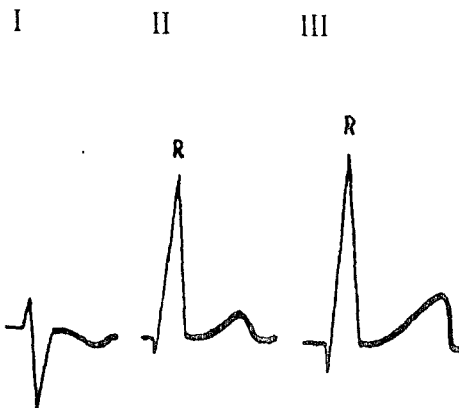
C, Early transition zone in lead V₁. These are all normal variants.



Pattern of QRS in limb leads

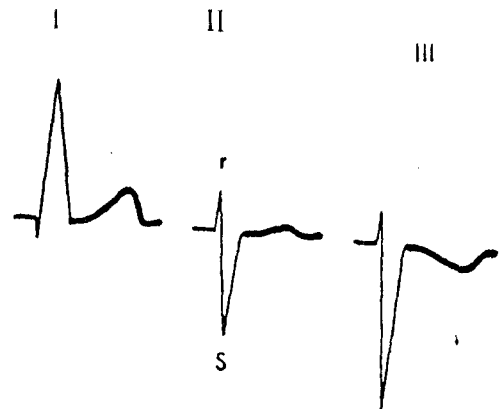
The normal pattern (the complex in both I, AVF) = normal axis

RIGHT AXIS DEVIATION



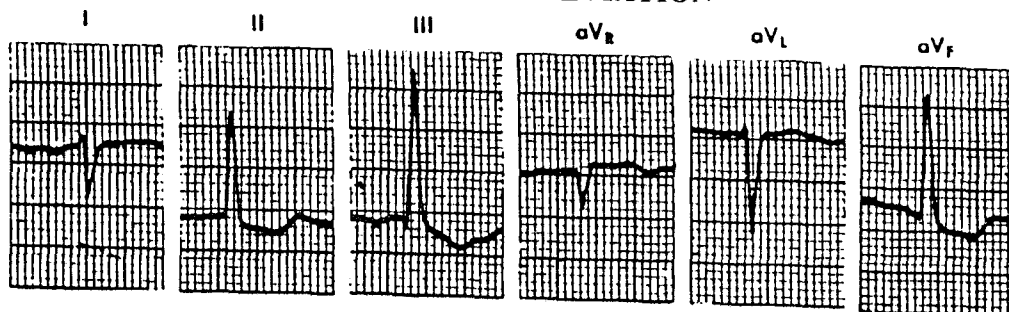
Right axis deviation (RAD)—mean QRS axis more positive than $+100^\circ$ —can be determined by simple inspection of leads I, II, and III. With RAD, lead III will show an R wave taller than the R wave in lead II.

LEFT AXIS DEVIATION



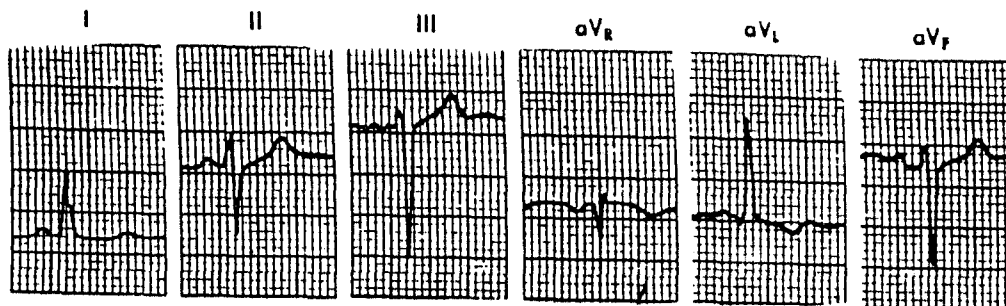
Left axis deviation (LAD), mean QRS axis more negative than -30° , can also be determined by simple inspection of leads I, II, and III. With LAD, lead II will show an rS complex, with the S wave of greater amplitude than the r wave.

RIGHT AXIS DEVIATION

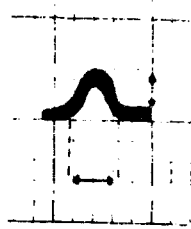


Example of right axis deviation. Note R waves in leads II and III, with the R wave in lead III greater than that in lead II.

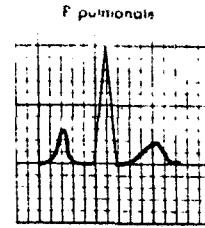
LEFT AXIS DEVIATION



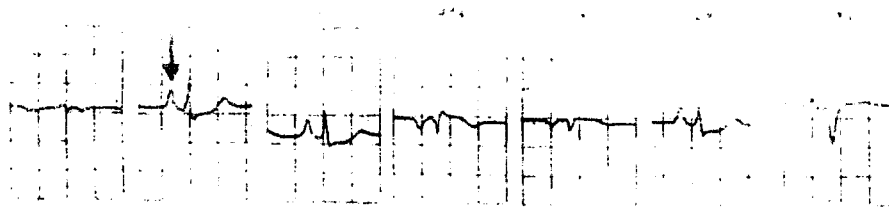
Example of left axis deviation. Note rs complex in lead II.



P wave measurements. Normal P wave is less than 2.5 mm tall and less than 0.12 sec wide.



Tall narrow P wave indicate right atrial enlargement (P pulmonale pattern).

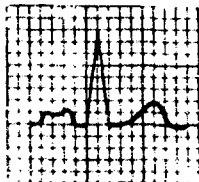


Note tall P waves, best seen here in leads II, III, aVF, and V1, in patient with right atrial enlargement (P pulmonale).

LEFT ATRIAL ENLARGEMENT (ABNORMALITY)

P Mitrale

Biphasic P wave in lead V1

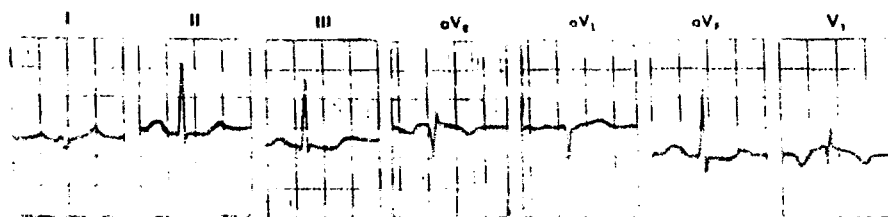


A

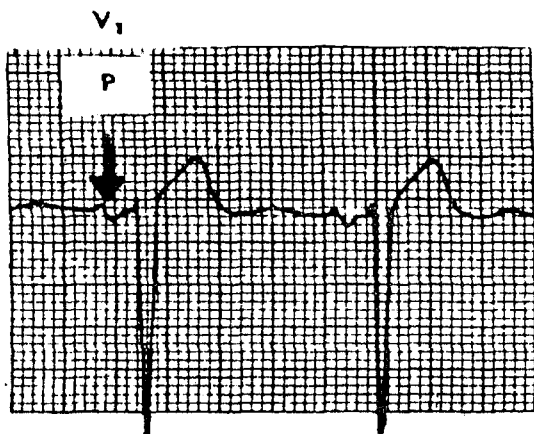


B

Left atrial enlargement may produce, A, wide, humped P waves in one or more extremity leads (P mitrale pattern) and / or, B, wide, biphasic P waves in lead V1.

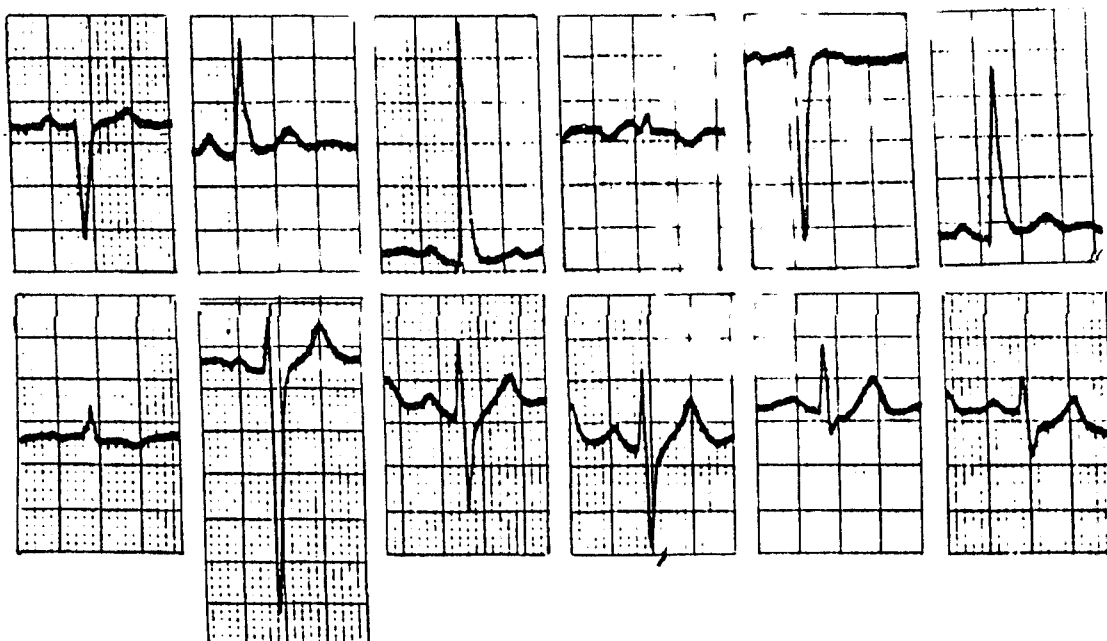


Example of broad, humped P waves in patient with left atrial enlargement (P mitrale pattern)

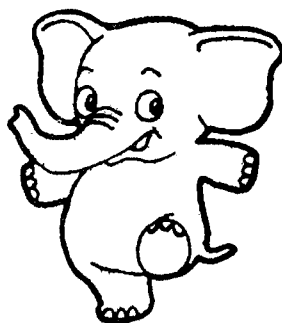


Example of wide, biphasic (initially positive, then negative) P wave in case of left atrial enlargement.

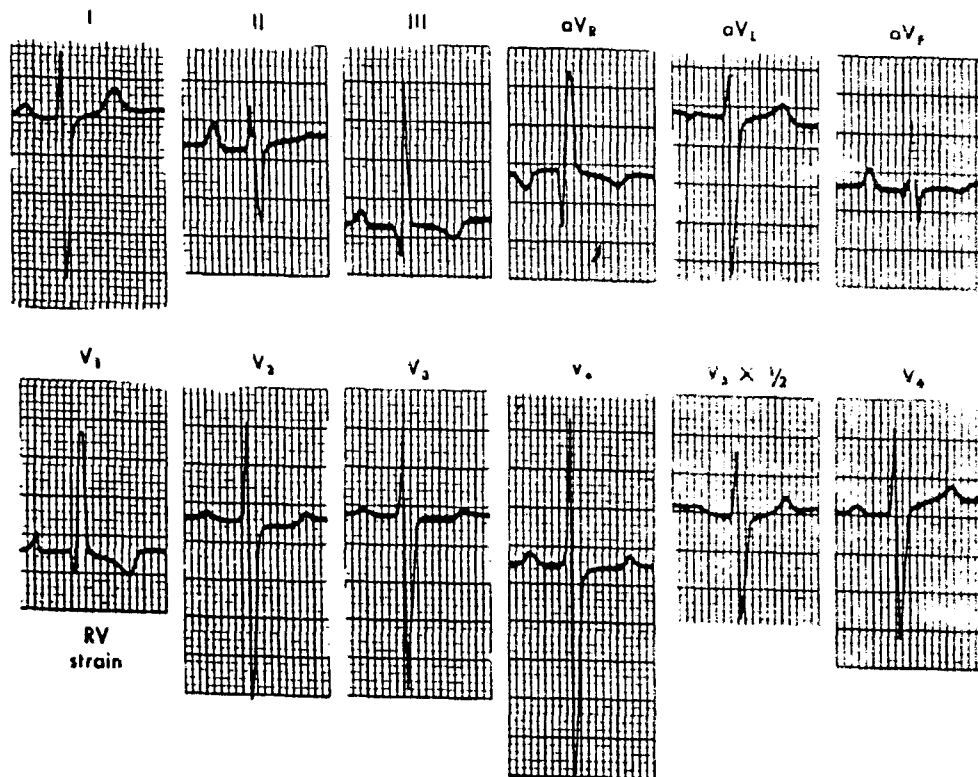
RIGHT VENTRICULAR HYPERTROPHY



Note tall R wave in lead V1 (with inverted T wave caused by right ventricular strain). Also note right axis deviation (R wave in lead III taller than R wave in lead II). Patient had tetralogy of Fallot.



RIGHT VENTRICULAR HYPERTROPHY

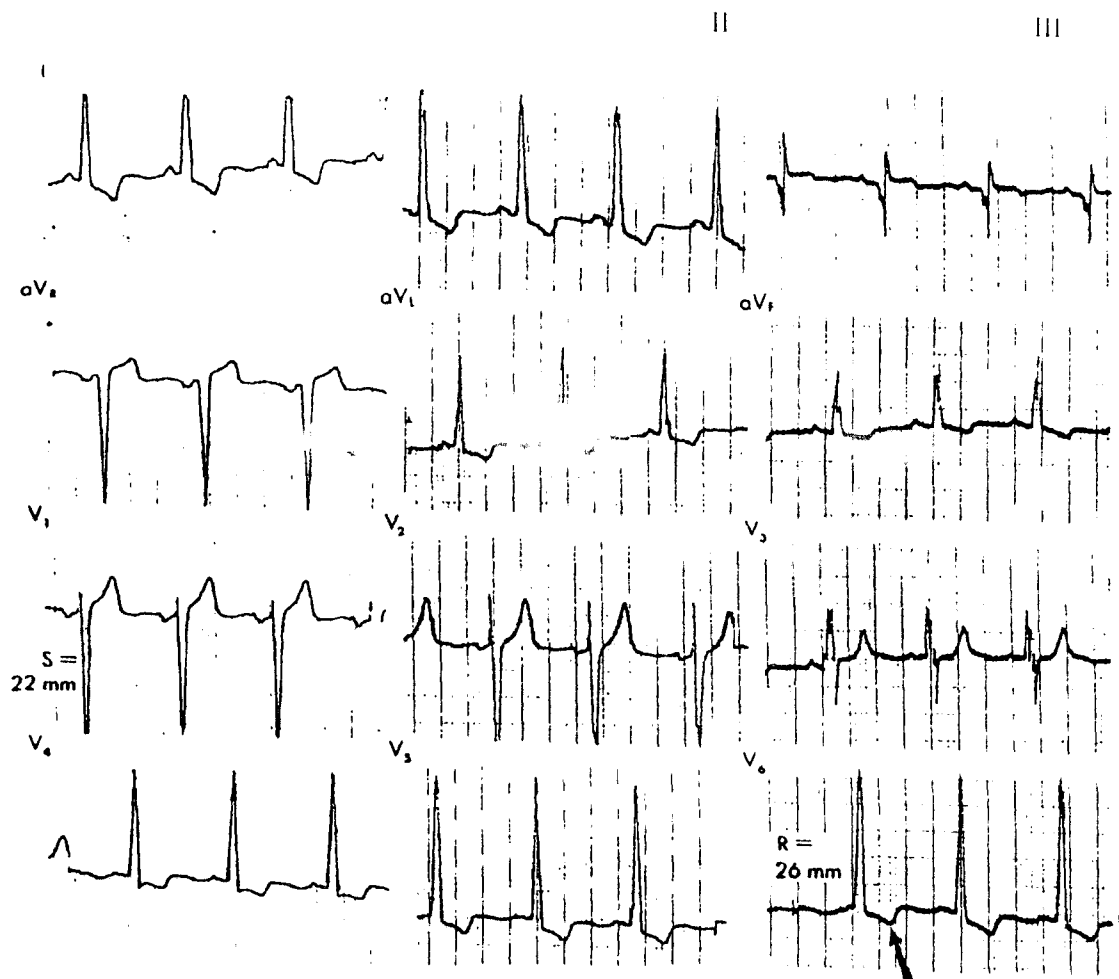


Sometimes with RVH lead V1 shows tall R wave as part of qR complex.

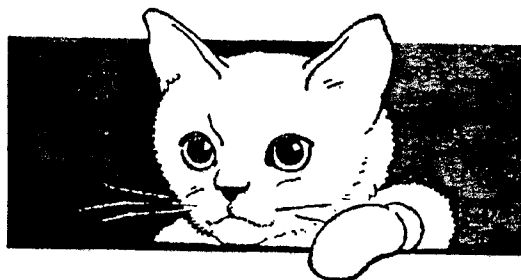
Note peaked P waves (leads II, III, and V1) because of right atrial enlargement. Also note prolonged P-R interval (0.24 sec), indicating first-degree AV block.



LEFT VENTRICULAR HYPERTROPHY



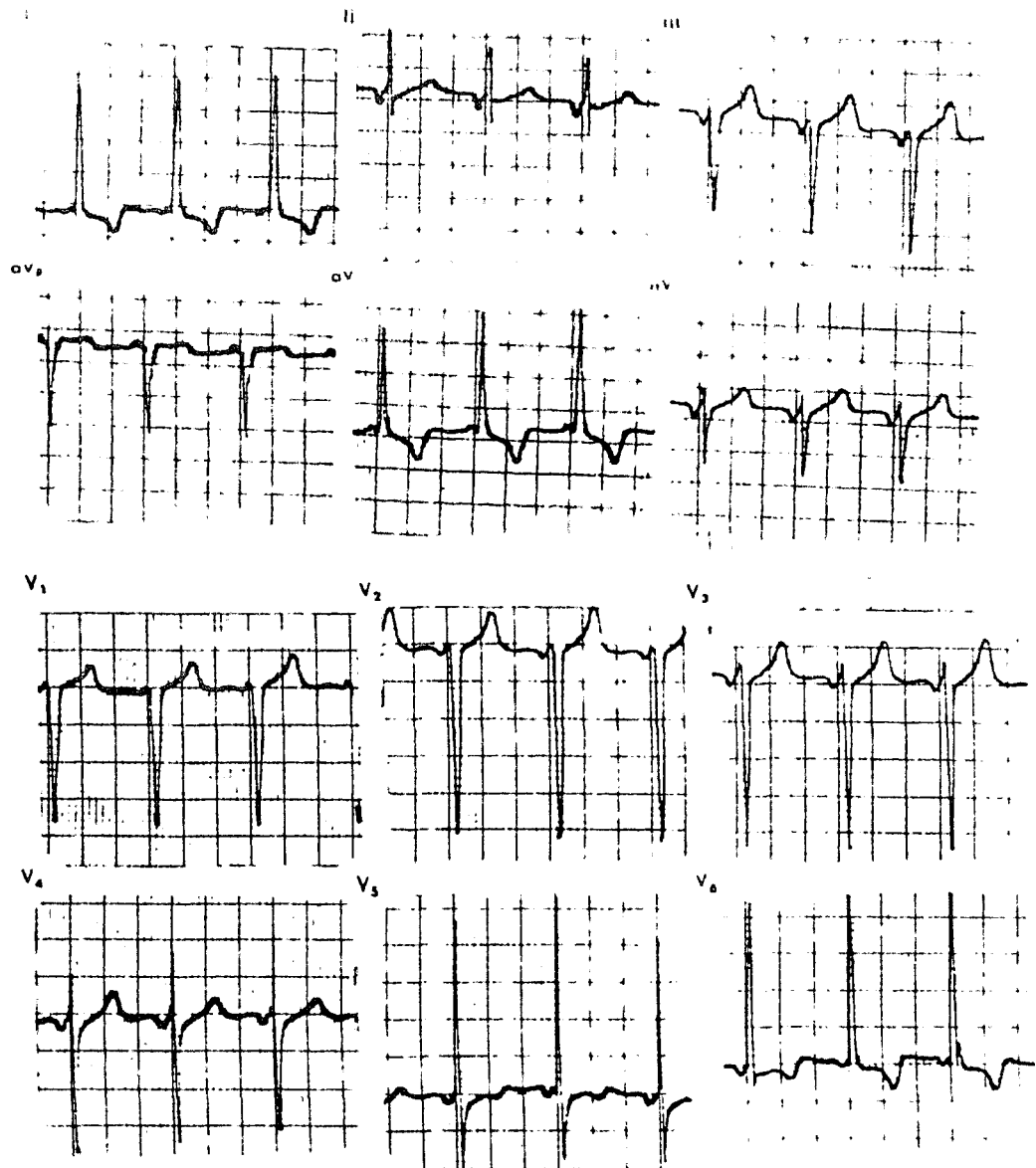
Patient with severe hypertension with left ventricular hypertrophy with strain pattern. Note tall voltage in chest leads, with strain pattern in leads I, aVL, and V4, to V6. Also note tall voltage in lead aVL, (R = 16 mm). In addition, note pattern of left atrial enlargement, with biphasic P wave in lead V1 and broad, notched P wave in lead II (P mitrale).



♠ Questions.

1. Answer these questions about the following EGG

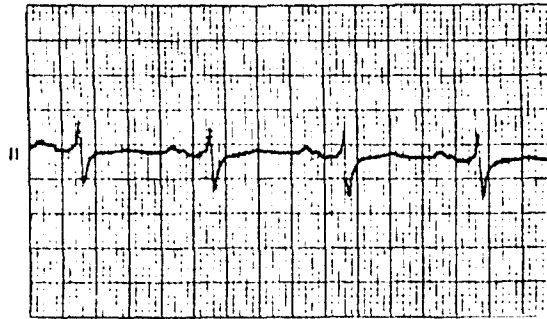
- a) What is the approximate heart rate?
- b) Is sinus rhythm present?
- c) Where is the transition zone in the chest leads?
- d) Cite three signs of LVH.



2. In the following ECC:

a. What is the heart rate?

b. Name two abnormal findings.



♠ Answers:

1. a) About 100 beats/min.

b) No. Notice retrograde P waves, positive in lead aVR and negative in lead II, owing to AV junctional rhythm.

c) Around lead V4.

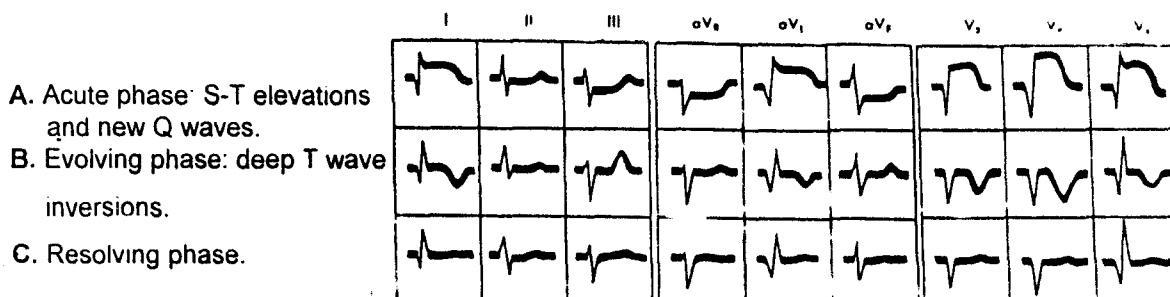
d) Tall voltage in chest leads ($SV_1 + RV_6 > 35$ mm); tall voltage in lead aVL. (R wave > 13 mm); left ventricular strain pattern in leads I, aVL, V5, and V6.

2. a) About 75 beats/min.

b) The P-R interval is prolonged (about 0.22 sec) because of first-degree AV block. Also, the P wave in lead II is abnormally wide and notched (notice the two humps) as a result of left atrial enlargement.

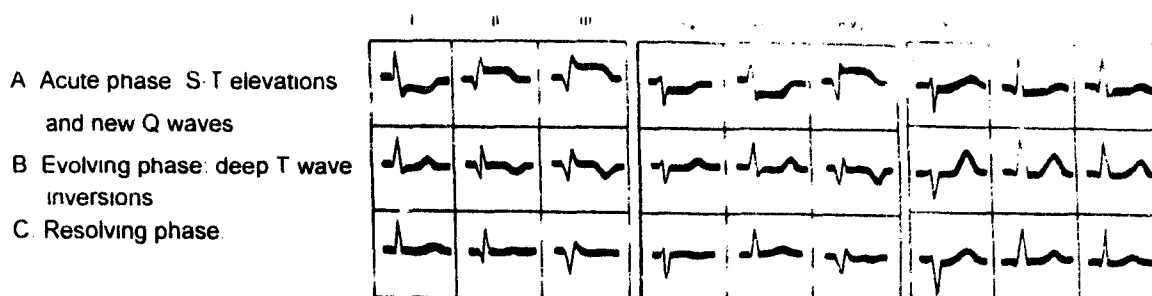


ECG SEQUENCE WITH ANTERIOR WALL INFARCTION

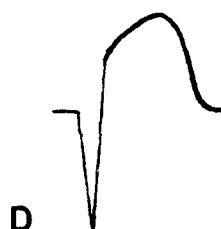
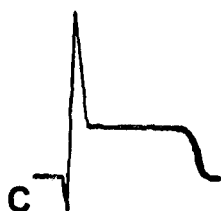
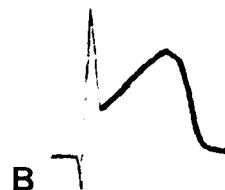
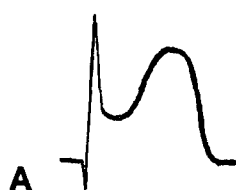


Sequential QRS and ST-T changes seen with anterior wall infarction.
 Note reciprocal ST-T changes in inferior leads (II, III, and AVF).

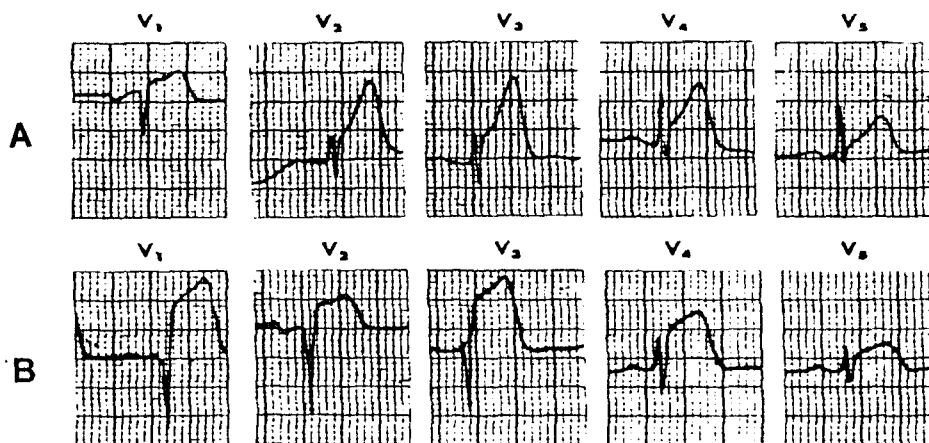
ECG SEQUENCE WITH INFERIOR WALL INFARCTION



Sequential QRS and ST-T changes with inferior wall infarction. Note reciprocal ST-T changes in anterior leads.



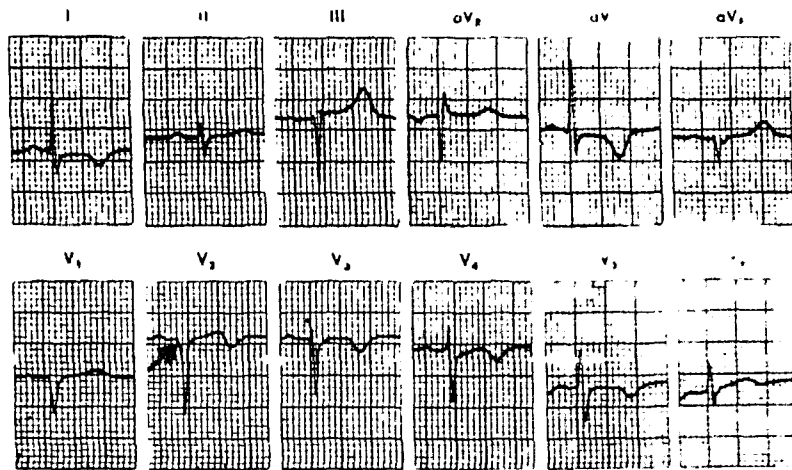
S-T segment elevations seen with acute infarction may have variable shapes, as shown in A to D.



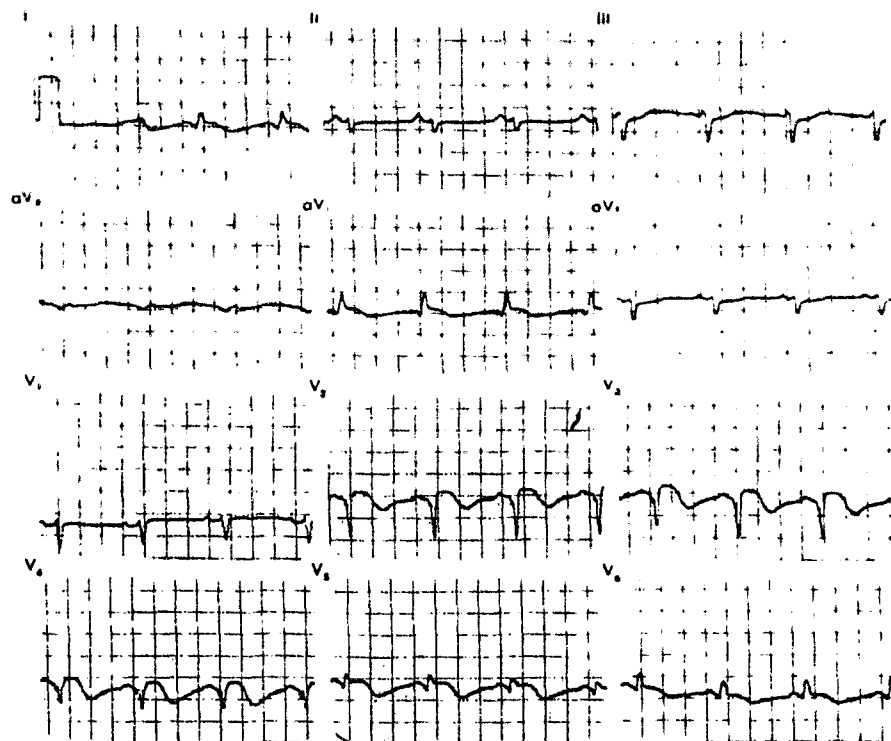
Chest leads from patient with acute anterior wall infarction. A, Note tall positive T waves (hyperacute T waves) seen in leads V2 to V5 in earliest phase of infarction. B, Recorded several hours later, shows marked S-T segment elevation in same leads (current of injury pattern) with abnormal Q waves in leads V1 and V2.



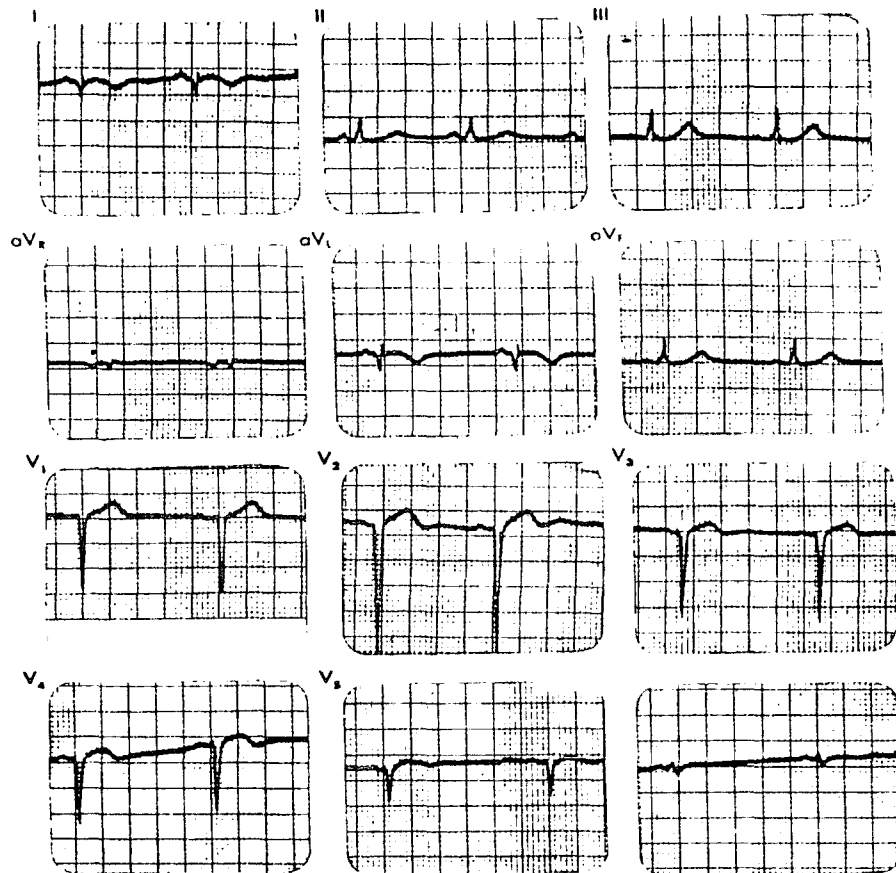
Hyperacute T waves with anterior wall infarction, Patient was complaining of severe chest pain. Note very tall, hyperacute T waves in chest leads. There is also slight S-T segment elevation in lead aVF with reciprocal S-T depressions in leads II, III, and aVF. Note premature atrial contraction (PAC) in lead V4.



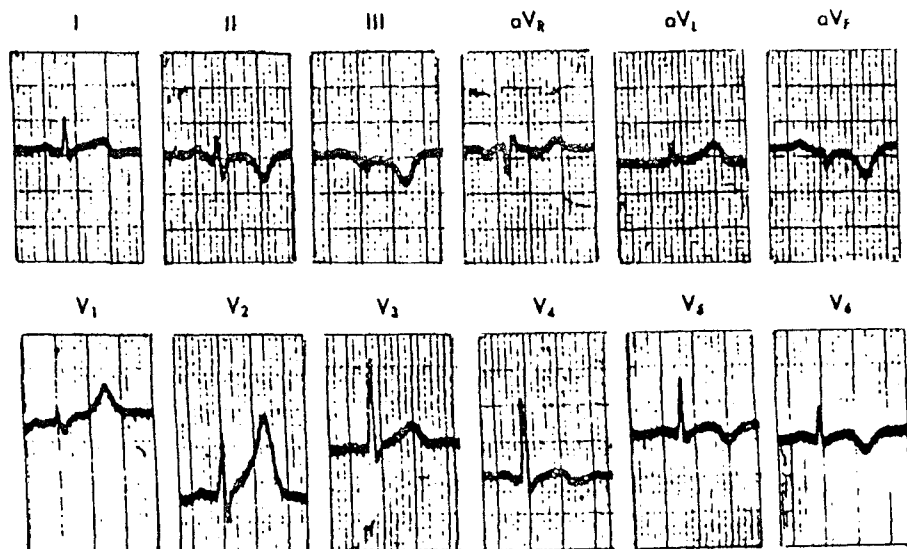
Anterior wall infarction. Note QS complexes in leads V1 and V2 indicating anteroseptal infarction. Also note characteristic notching (arrow, V2) of QS complex often seen with infarcts. In addition, ECG shows diffuse ischemic T wave inversions in leads I, aV1, and V3 to V5, indicating generalized anterior wall ischemia.



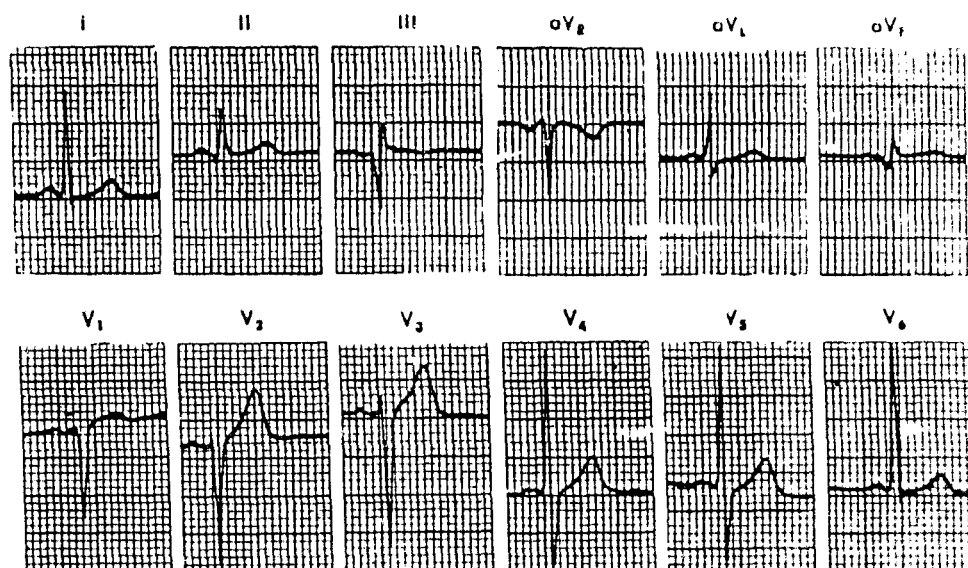
Evolving anterior wall infarction. Patient sustained anterior wall infarct 1 week earlier. Note abnormal Q waves (leads I, aV1, and V2, to V5) with slight S-T segment elevations and deep T wave inversions. Left axis deviation resulting from left anterior hemi block is present as well.



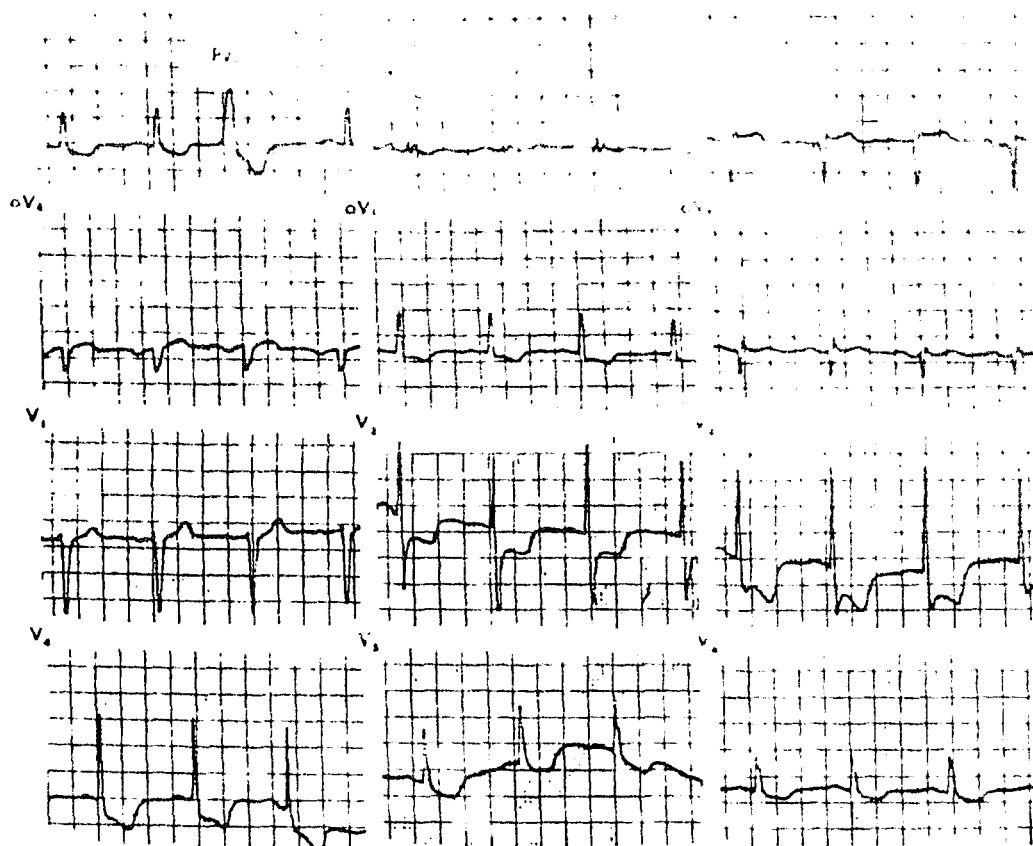
Evolving anterior wall infarction. Infarct occurred 1 week earlier. Note poor R wave progression in leads V1 to V5 along with Q waves in leads I and aVL. T waves are slightly inverted in these leads. Right axis deviation in this case is the result of loss of lateral wall forces, with Q waves in I and aVL.



Posterior infarction. Note tall R waves in V1 and V2. In addition there is evidence of prior inferior MI (Q waves in II, III, aVF) and probably lateral infarction (T wave inversions in V4 to V6).

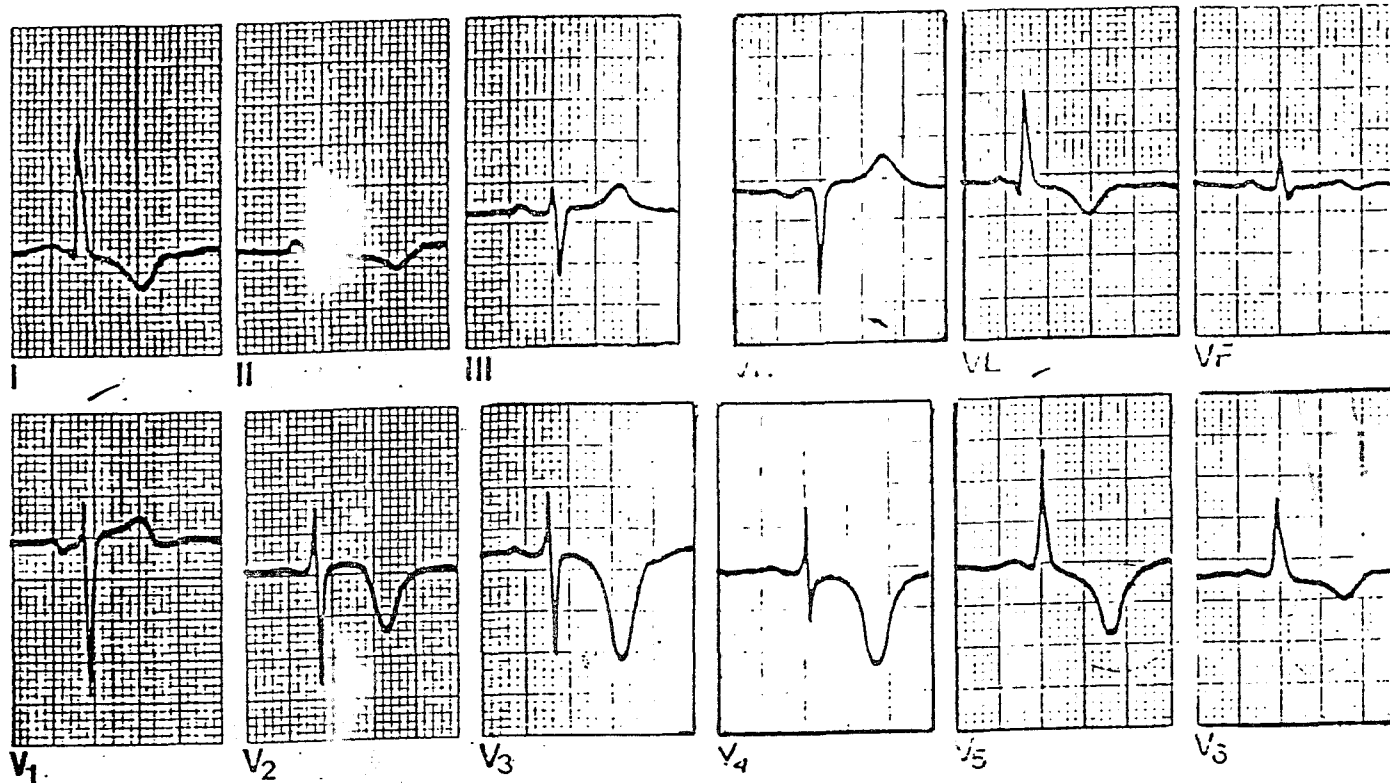


Old inferior wall infarct. Note prominent Q waves in leads II, III, and aV F from patient with infarct 1 year previously. ST-T changes have essentially reverted to normal.



Subendocardial infarction. Patient with severe chest pain who subsequently developed cardiac enzyme elevations. Note marked S-T depressions best seen in chest leads V2 to V5. Pattern is consistent with subendocardial infarction. Note premature ventricular contraction (PVC) in lead I. Slight reciprocal S-T elevation is seen in lead aVR and lead III.

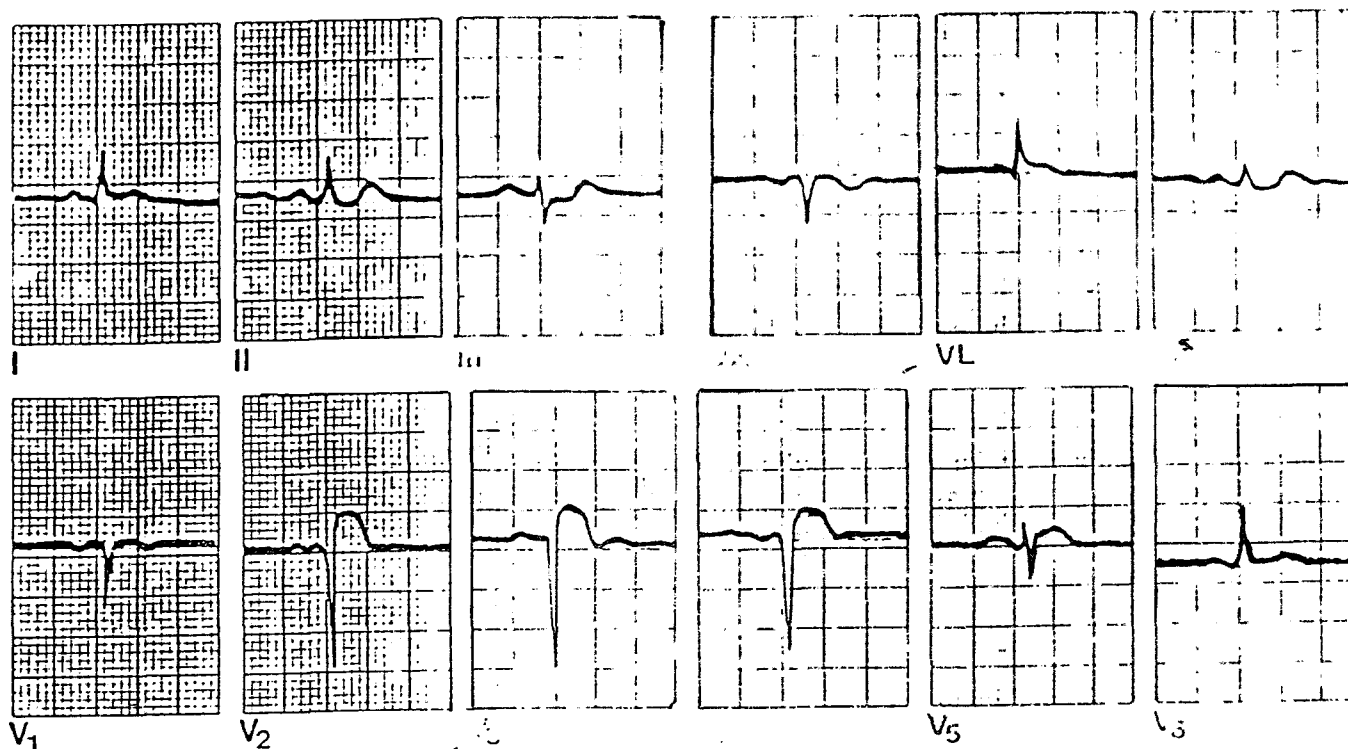
Subendocardial infarction (ant. wall):



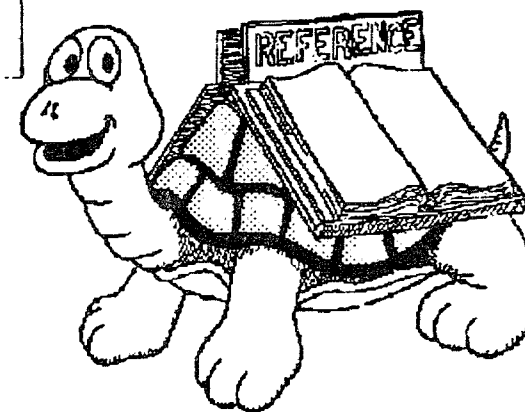
- T wave is inverted in I, aVL, V2 → V6.
- S-T segment depressed in V3, V4 subendocardial
- Finding V2 → V6.



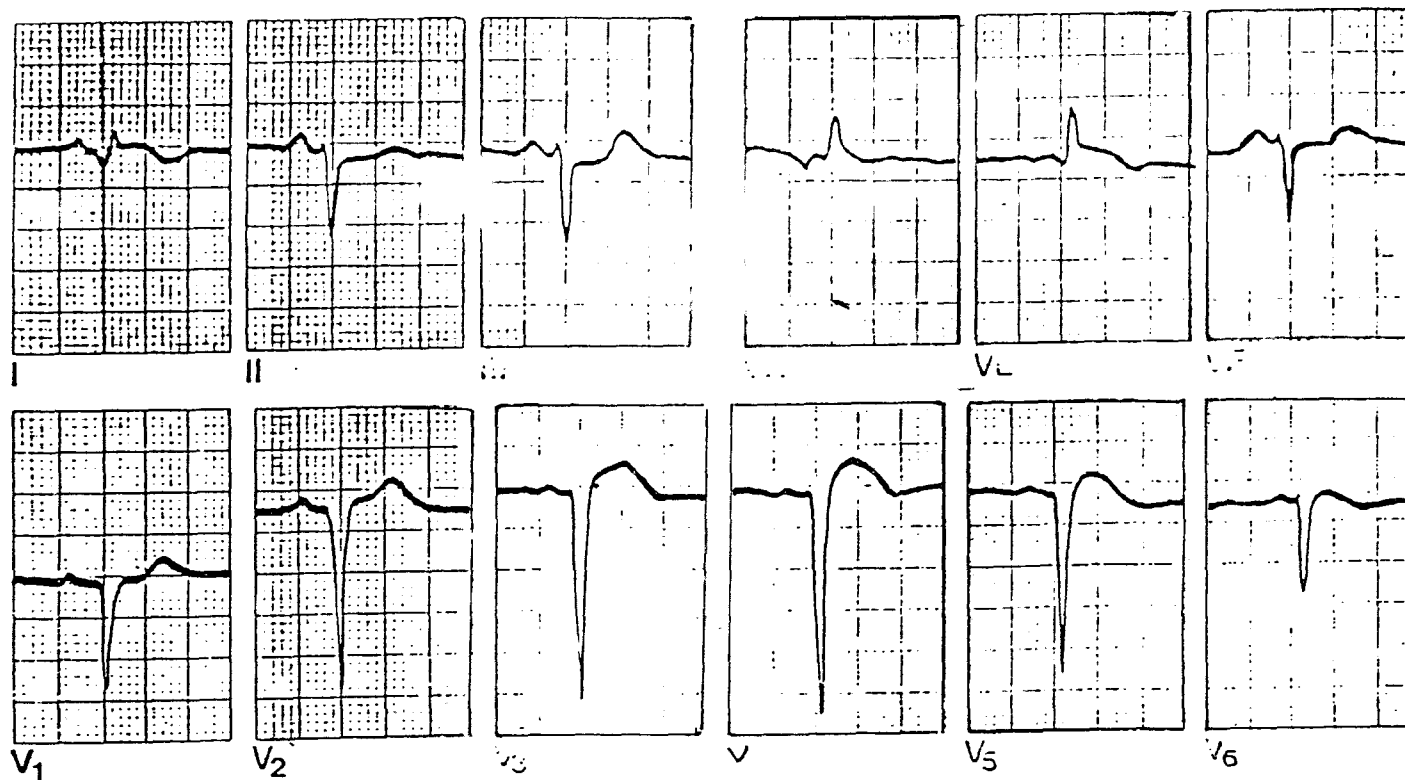
Anterior infarction:



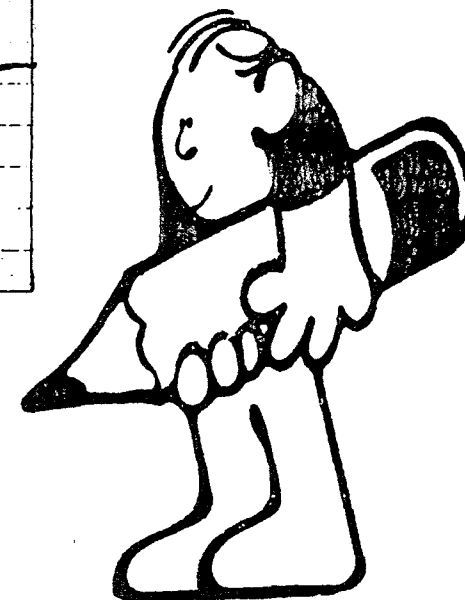
- Elevated S-T segment is V2, V3, V4→ transmural.
- Finding in V2, V4, V5= anterior wall infarction
- Segment elevated= recent.



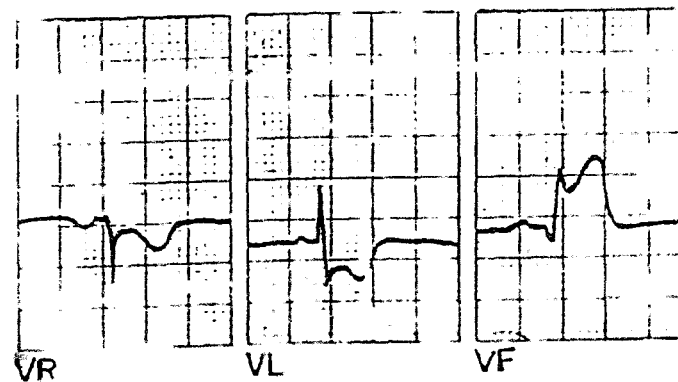
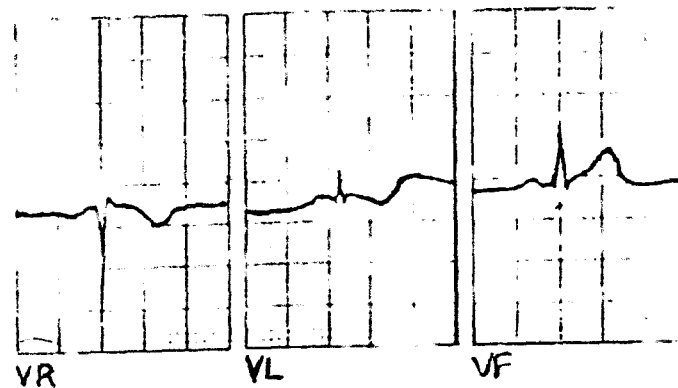
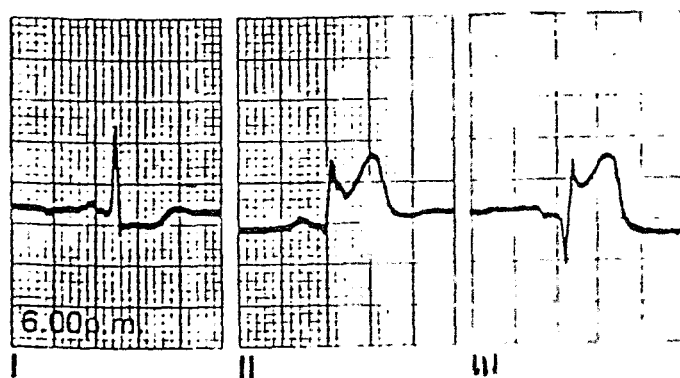
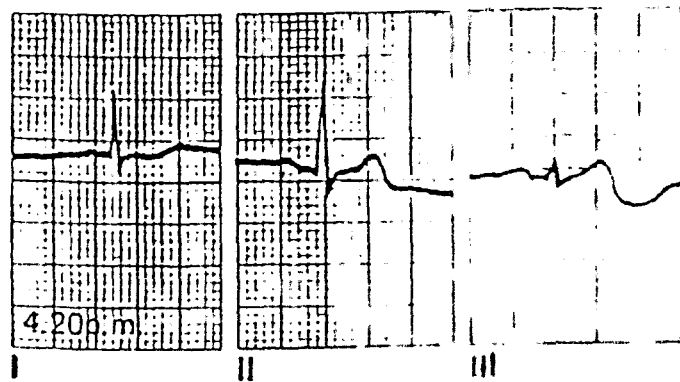
Antero-lateral infarction with left axis deviation:



- QS Pattern in V1→V5 transmural infarction.
- Elevated S-T segment in V3, V4=anterior wall.
- Finding in V1, V5, I, and aVL =anterior wall infarction.



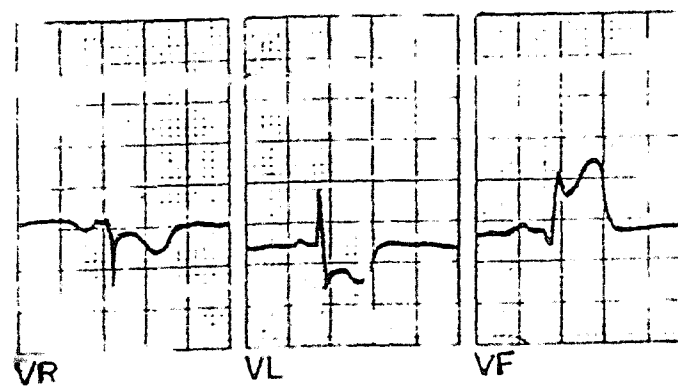
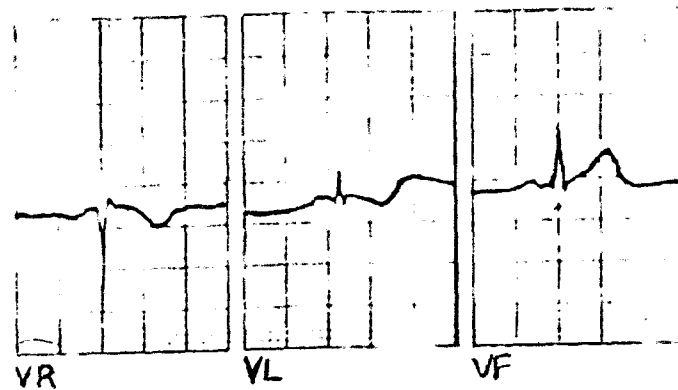
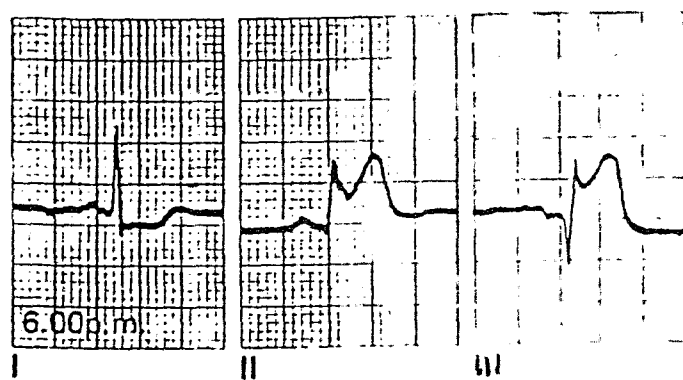
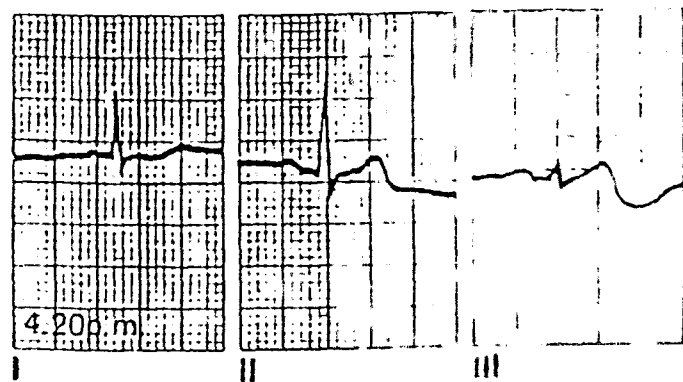
Development of inferior infarction



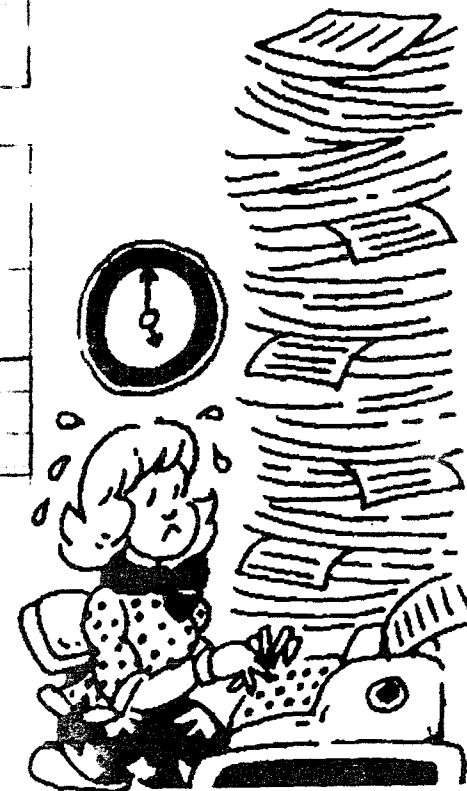
Notice leads II, III, aVL = inferior leads
Elevated S-T segment = recent transmural inferior wall infarction



Development of inferior infarction



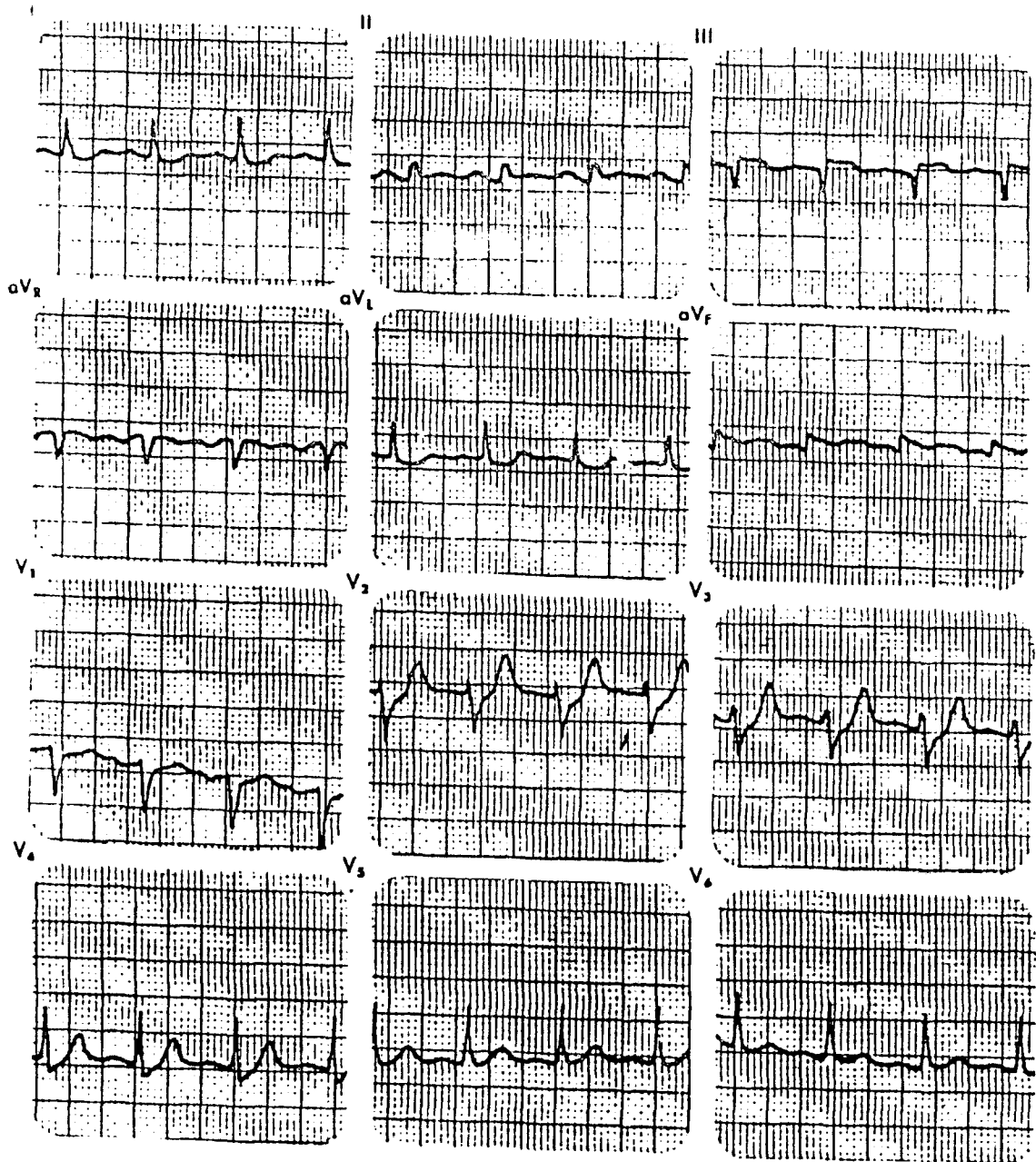
Notice leads II, III, aVL = inferior leads
Elevated S-T segment = recent transmural inferior wall infarction



♠ Questions:

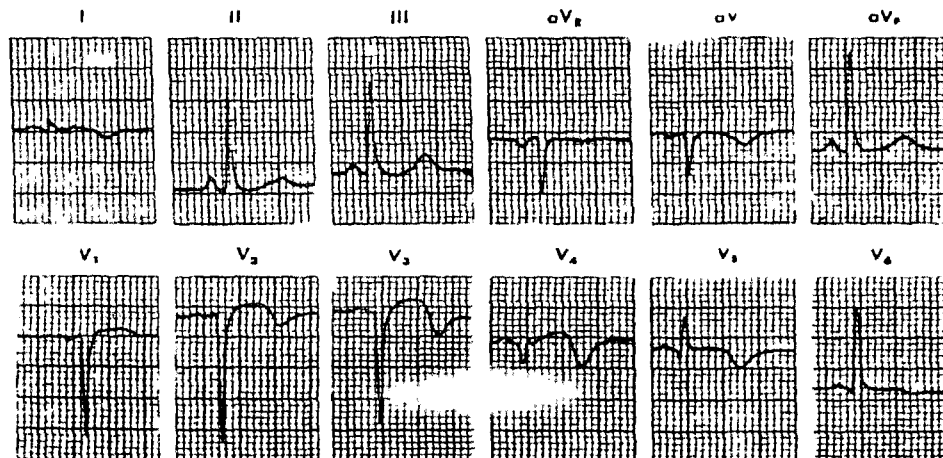
1. Answer the following questions about the ECG below:

- What is approximate heart rate?
- Are there any S-T segment elevations?
- Are there any abnormal Q waves?
- What is the diagnosis?

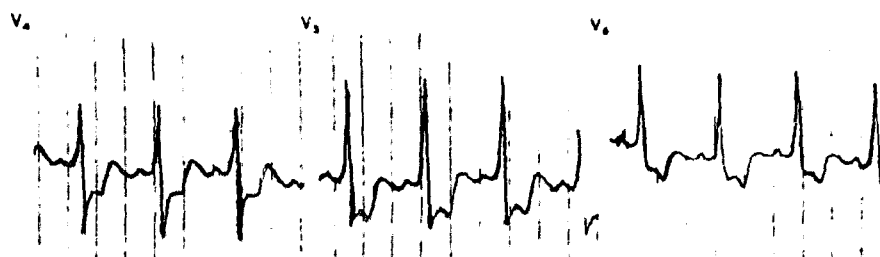


2. Answer the following questions about the ECG below:

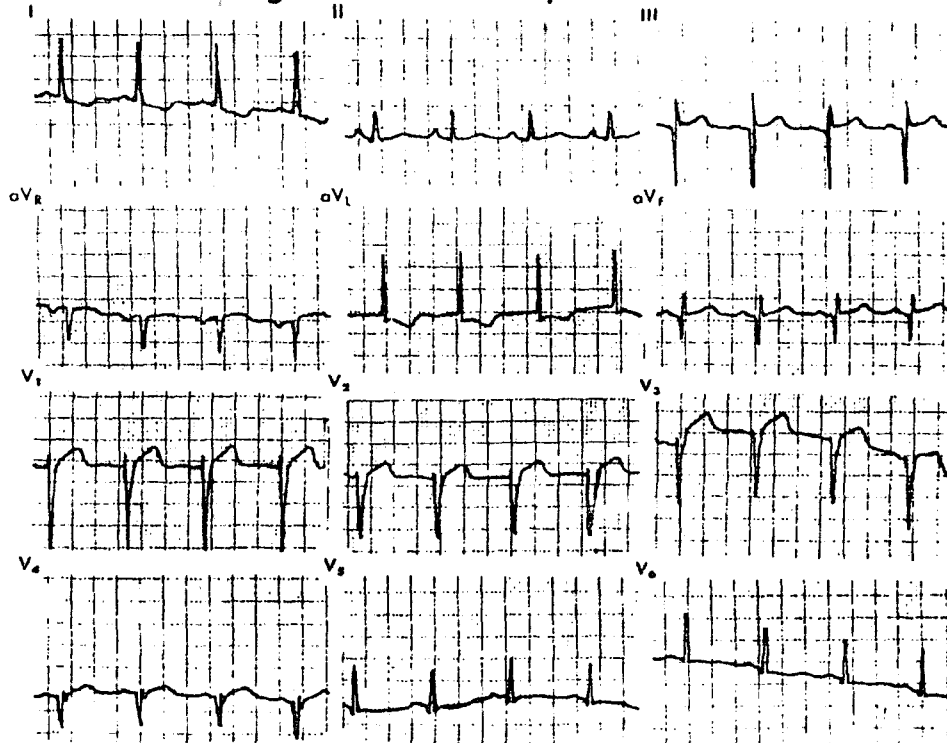
- Is sinus rhythm present?
- What is the approximate mean QRS axis?
- Is the R wave progression in the chest leads normal?
- Are the T waves normal?
- What is the diagnosis?



- With an acute anterior wall infarction, the S-T segments in leads II, III, and aVF are likely to be
- Persistent S-T segment elevations several weeks or more after an infarct may be a sign of.....
- A patient with severe chest pain shows persistent diffuse S-T segment depressions with abnormal elevations of the cardiac enzymes. The most likely diagnosis is:
 - Prinzmetal's angina.
 - Subendocardial infarction
 - Hyperacute infarction.
 - Angina pectoris.
- What ECG abnormality is shown and what symptom might this patient have complaining about?



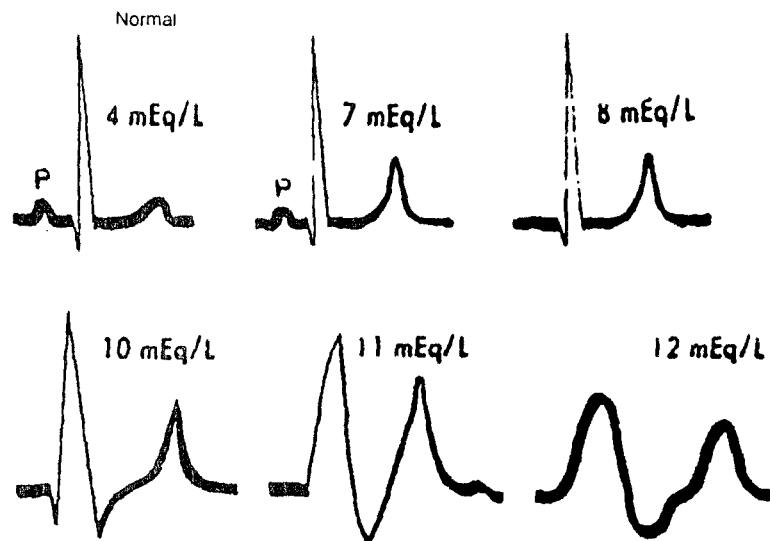
7. Does this ECG tracing show evidence of previous MI?



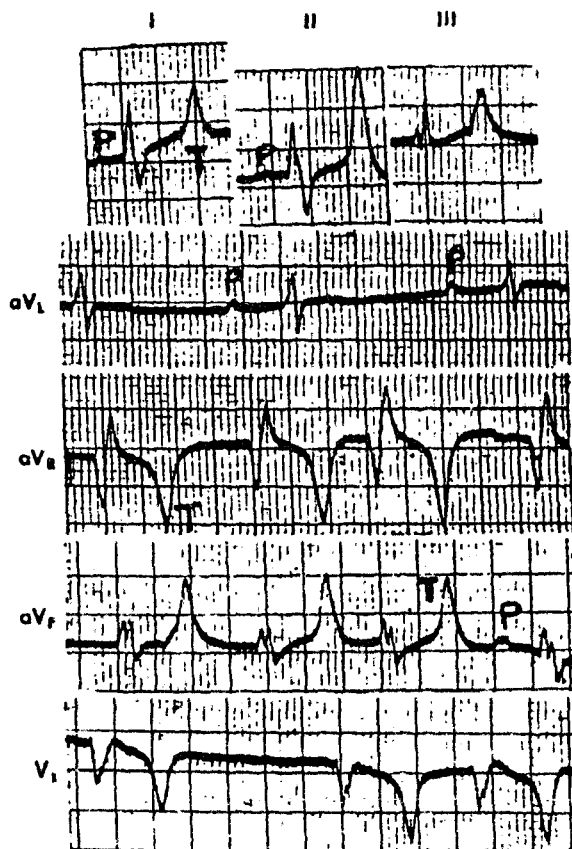
♠ **Answers:**

1. a) 100 beats/min.
b) Yes. Leads II, III, and aVF (with reciprocal S-T depressions in leads V2 to V4, I, and aVL).
c) Yes. Best seen in leads III and aVF.
d) Acute inferior wall infarction.
2. a) Yes. Positive P wave in leads II, negative in lead aVR.
b) About $+90^\circ$. (Between 80° and 90° is acceptable.)
c) No.
d) No. Note inverted T waves in leads V2 to V6, I, and aVL.
e) (Evolving) anterior wall infarction.
3. Reciprocally depressed.
4. Ventricular aneurysm.
5. b.
6. Marked S-T segment depressions. Patient had severe ischemic chest pain and had a subendocardial infarct.
7. Yes. There is evidence of anterior wall infarction with loss of R wave progression in chest leads. There is also evidence of inferior wall infarction with large Q waves in leads III and aVF. Also note tall R wave in lead aVL. (14 mm) with strain pattern in leads I and aVL. Patient had prior history of hypertension, producing left ventricular hypertrophy.

EFFECTS OF HYPERKALEMIA ON ECG

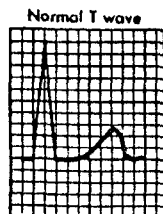
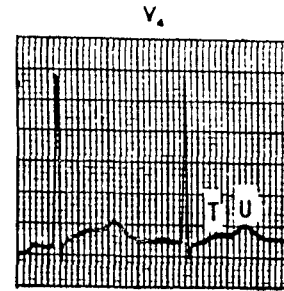
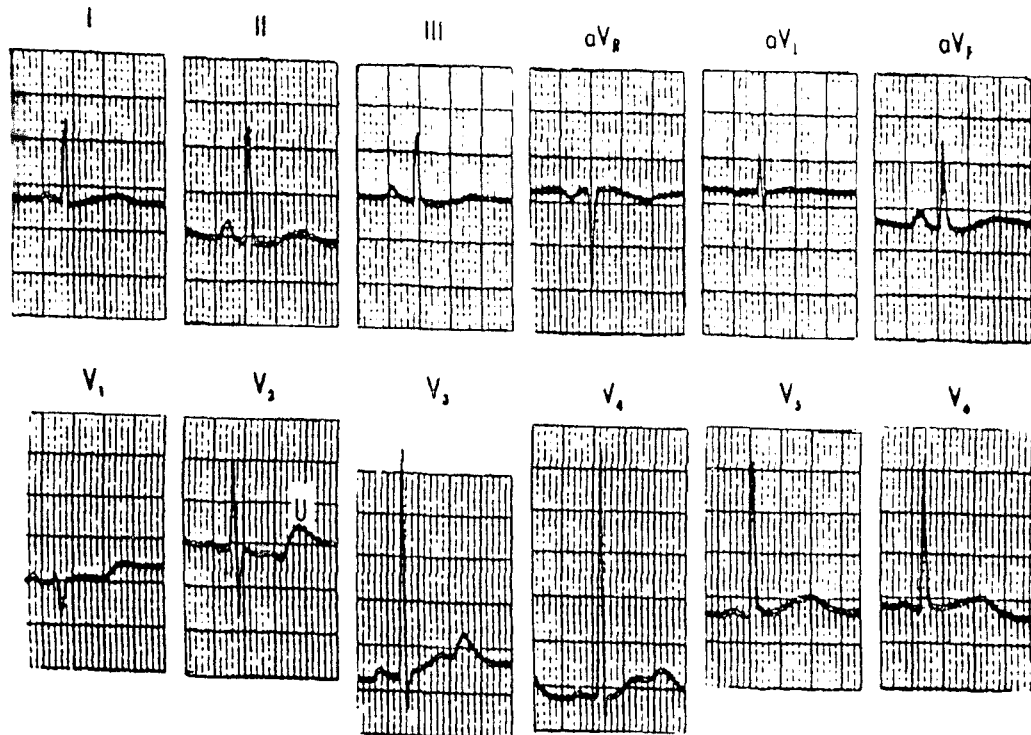


Earliest change with Hyperkalaemia is peaking ("tenting") of T wave. With progressive increases in serum potassium (K^+), there is widening of QRS complex, loss of P waves, and, finally, ventricular fibrillation. These changes do not necessarily occur with a specific serum K^+ level. For example, some patients may have a normal ECG with a K^+ of 7 mEq/L, others may develop ventricular fibrillation at 9 mEq/L.



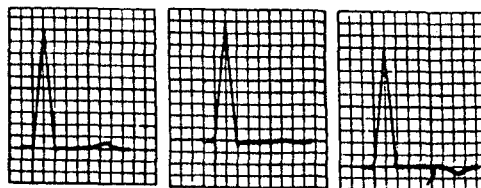
Note peaked T waves, wide QRS complex, and prolonged P-R interval. At other times, junctional rhythm is present with no P waves.

HYPOKALEMIA



Serum K⁺ was 2.2 mEq/L. Notice prominent U waves.

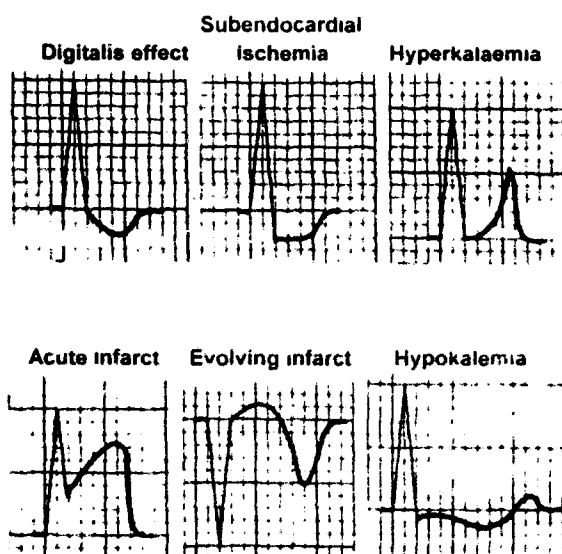
Nonspecific ST-T changes



Flattening of the T wave (left and middle) or slight T wave inversion (right) are abnormal but relatively nonspecific changes that may be caused by numerous factors.



Nonspecific ST-T changes. Note diffuse T wave flattening



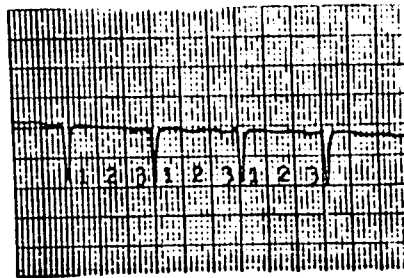
Relatively specific ST-T changes. ST-T changes depicted are relatively but not absolutely specific for abnormalities shown.

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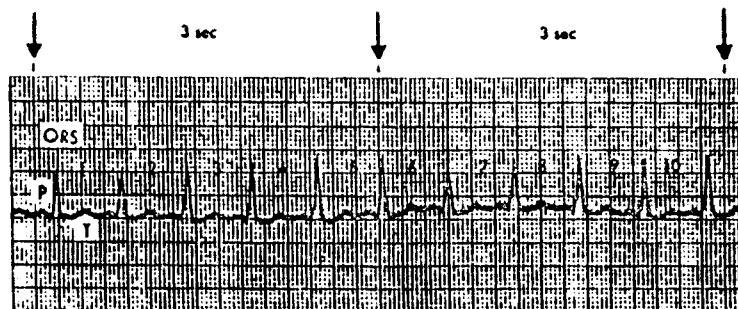
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Rate and Rhythm

Calculation of heart rate

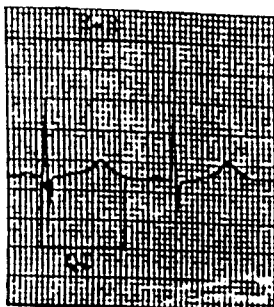
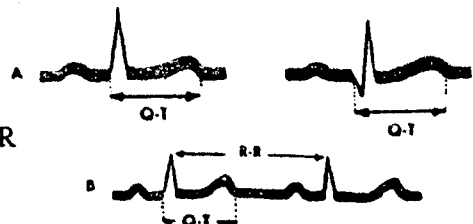


Measurement of heart rate (beats per minute) by counting number of large (0.2 sec) time boxes between two successive QRS complexes and dividing 300 by this number. In this example, heart rate is $300 \div 3 = 100$ beats/min.



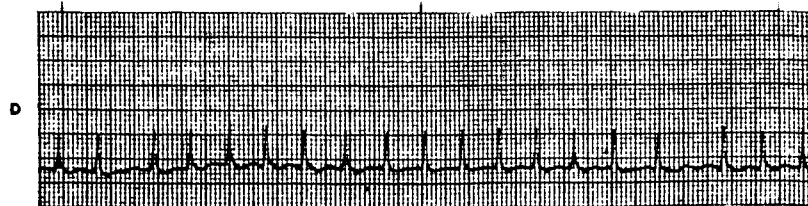
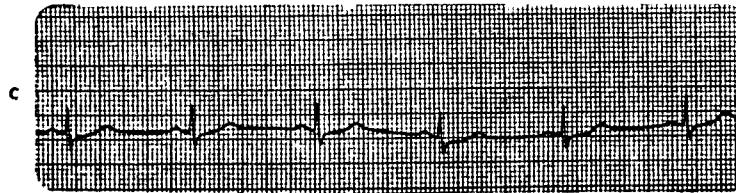
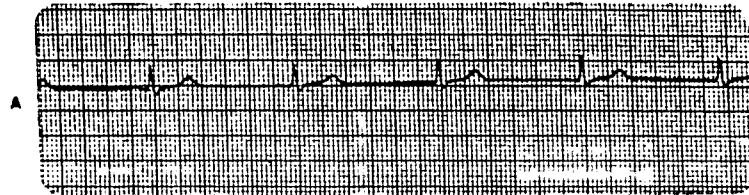
Measurement of heart rate per minute by counting number of cardiac cycles in a 6 sec interval and multiplying by 10. In this example, there are 10 cardiac cycles/6 sec. therefore, heart rate is $10 \times 10 = 100$ beats/min.

Measurement of Q-T interval. P-R interval is interval between two consecutive QRS complexes.

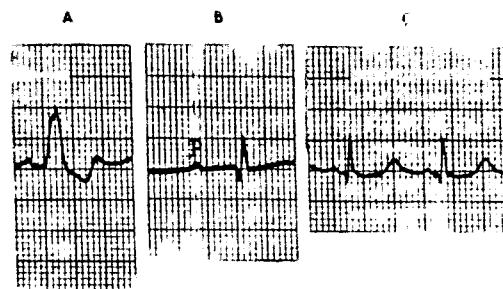


Abnormal Q-T prolongation. Note that Q-T interval (0.6 sec) exceeds one-half the R-R interval ($1/2 \times 0.92 = 0.46$ sec.).

1. Calculate the heart rate in each of the examples



2. Name the major abnormality in each example.



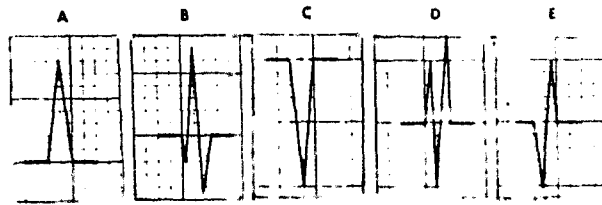
3. A block in the AV node is most likely to

- Prolong the P-R interval
- Prolong the QRS width
- Prolong the Q-T interval.
- None of the above.

4. A block in the left or right bundle branch is most likely to

- Prolong the P-R interval
- Prolong the QRS width
- Shorten the Q-T interval.
- None of the above

5. Name the component waves of the QRS complexes shown.



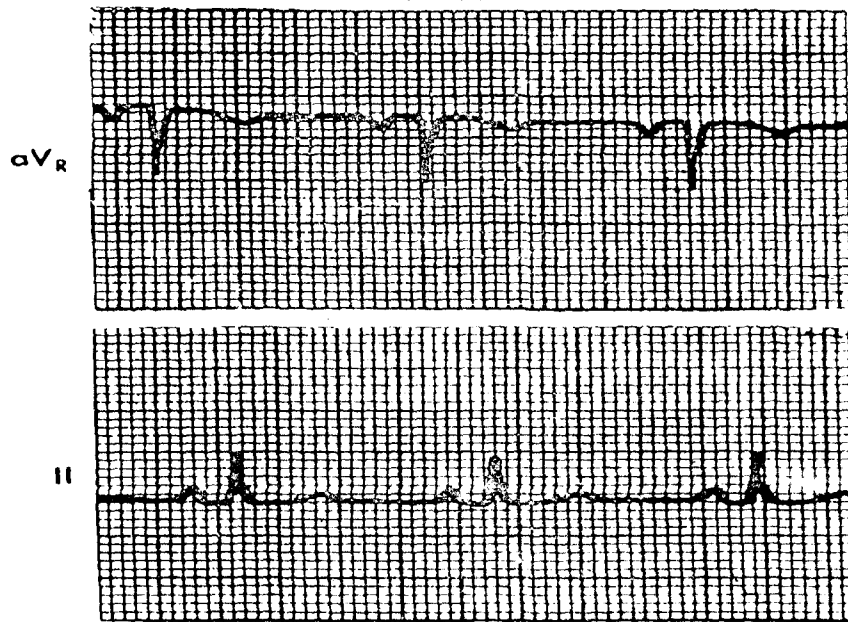
ANSWERS:

1.
 - a. 50 beats/min.
 - b. 150 beats/min.
 - c. 60 beats/min.
 - d. Approximately 160 beats/min (There are 16 QRS waves in 6 sec)***
2.
 - a. Abnormally wide QRS complex (0.14 sec)
 - b. Abnormally long P-R interval (approximately 0.5 sec)
 - c. Abnormally long Q-T interval (Q-T interval measures 0.4 sec. The R-R interval measures 0.6 sec and the heart rate is 100/min)
3. a
4. b
5.
 - a. R
 - b. QRS
 - c. QS
 - d. RSR
 - e. QR

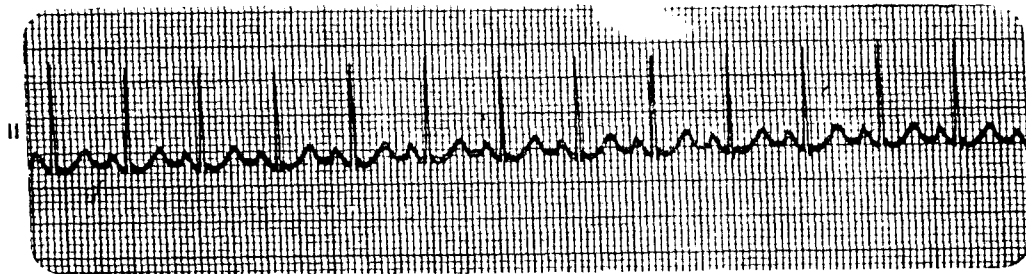
*** Notice the irregularity of the QRS complexes and the absence of P waves. The rhythm here is atrial fibrillation.



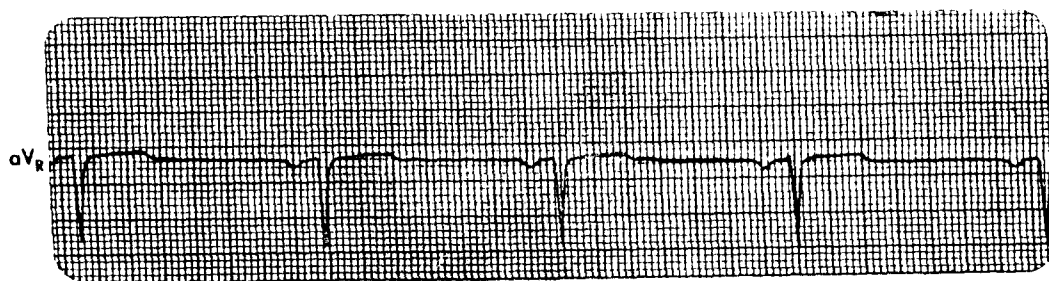
NORMAL SINUS RHYTHM



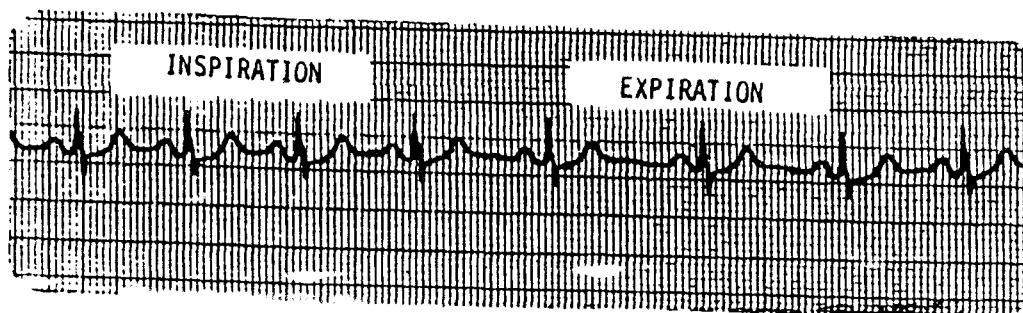
Each QRS complex is preceded by a P wave that is negative in lead aVR and positive in lead II



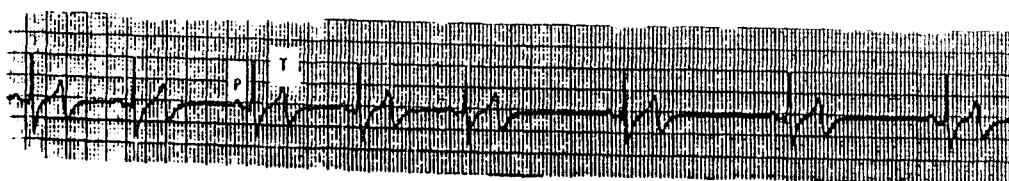
Sinus tachycardia.



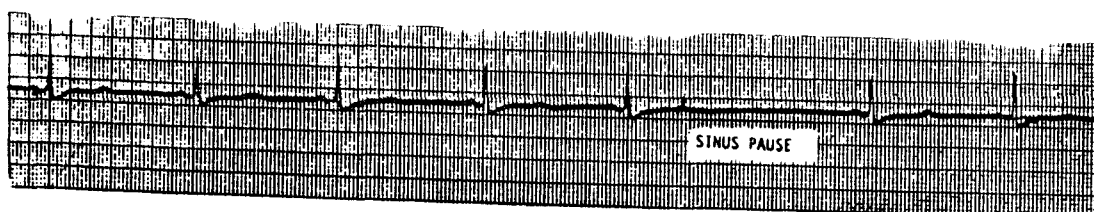
Sinus bradycardia.



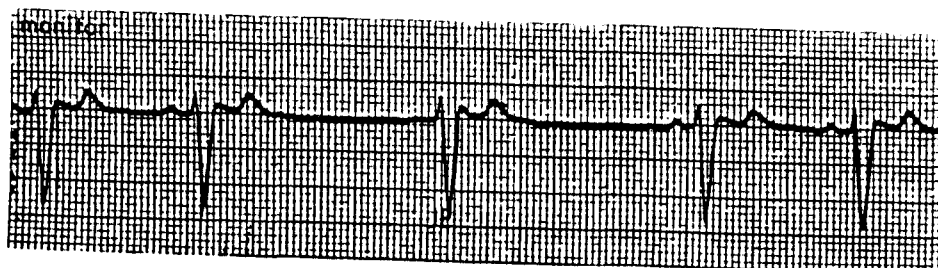
Phasic sinus arrhythmia. Normally there is slight increase in heart rate with inspiration and slight decrease with expiration.



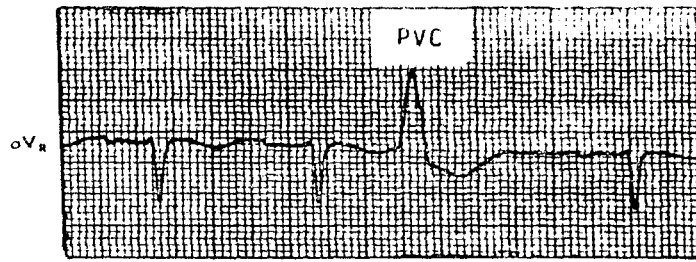
Nonphasic sinus arrhythmia. Monitor lead shows markedly irregular rhythm. Each QRS complex is preceded by P wave with constant P-R interval. Marked nonphasic sinus arrhythmia in this case resulted from viral myocarditis (T waves are biphasic in this tracing.)



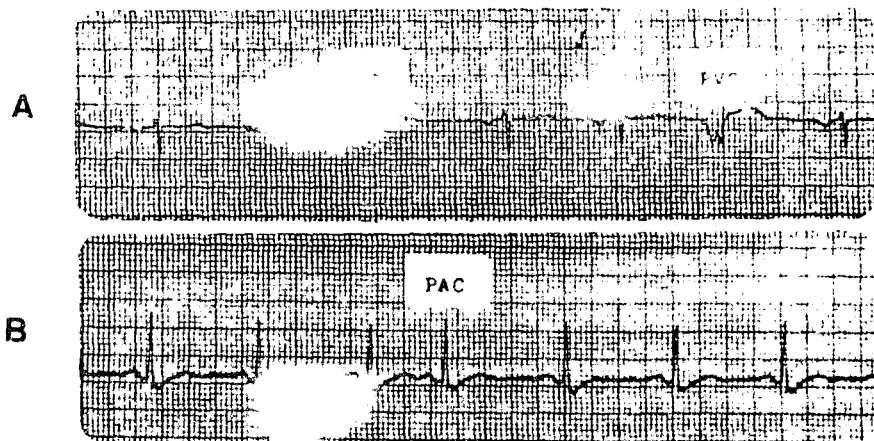
Sinus pause in patient with "sick sinus syndrome." Monitor lead shows marked sinus bradycardia with long sinus pause. Patient had sinus node disease and required a pacemaker.



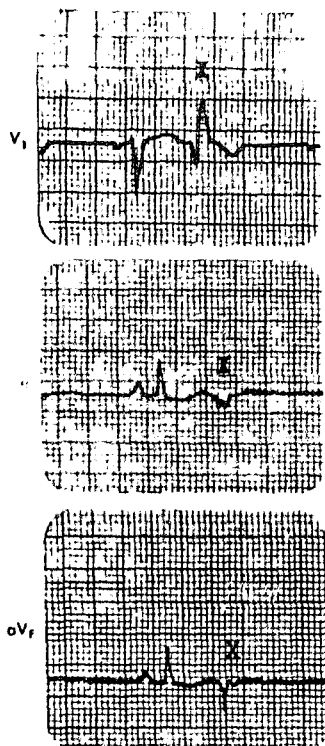
Junctional escape beat. Monitor strip shows sinus pause with junctional escape beat.



Premature ventricular contraction, PVC, PVC is recognized because it comes before the next normal beat is expected and has a wide, aberrant shape. (Also note long P-R interval in the normal sinus beats indicating first-degree AV block)



PVCs compared to PACs. Note wide, aberrant shape of PVC **A** compared to narrow PAC **B**

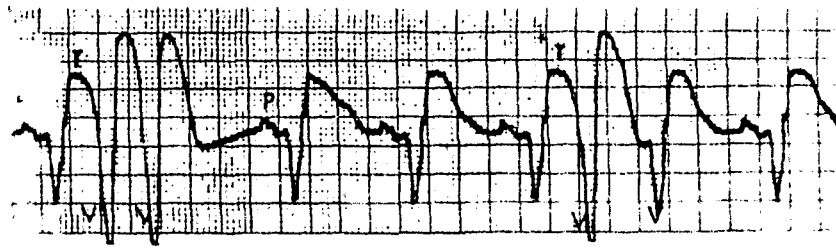


Premature ventricular contraction

Note that the same PVC (marked X) recorded simultaneously in three different leads shows

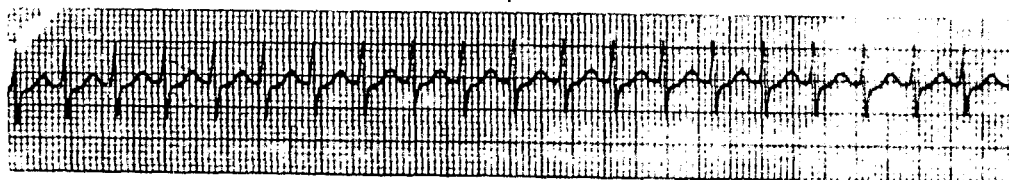
characteristic shape

Monitor lead



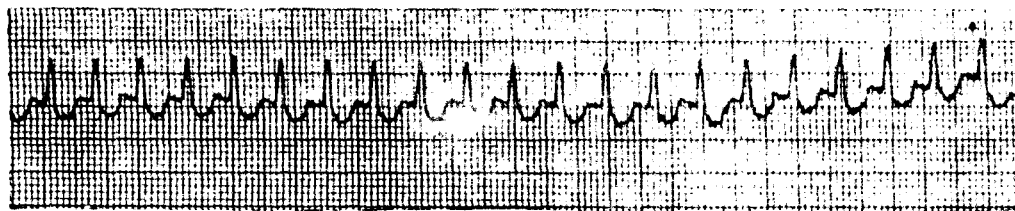
PVCs. Two PVCs (marked V) in a row are called "paired PVCs." PVCs here show "R on T" phenomenon.

PAROXYSMAL ATRIAL TACHYCARDIA (PAT)



PAT is a run of three or more consecutive PACs. This strip shows PAT with rate of about 167 beats/min. Note marked regularity of rhythm. No P waves are visible.

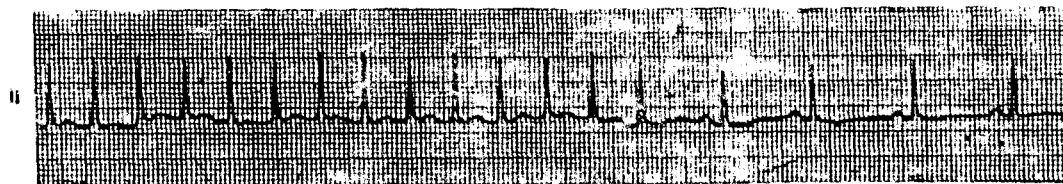
PAROXYSMAL ATRIAL TACHYCARDIA



PAT with rate of about 200 beats/min

PAT

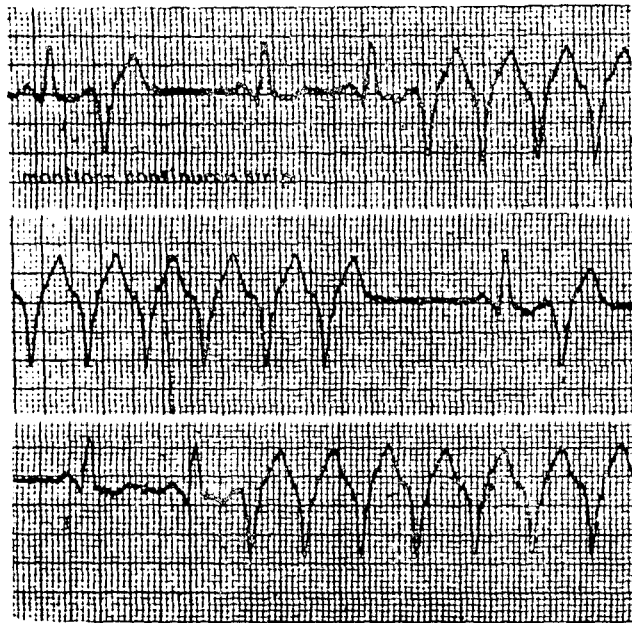
Sinus rhythm



Carotid sinus massage

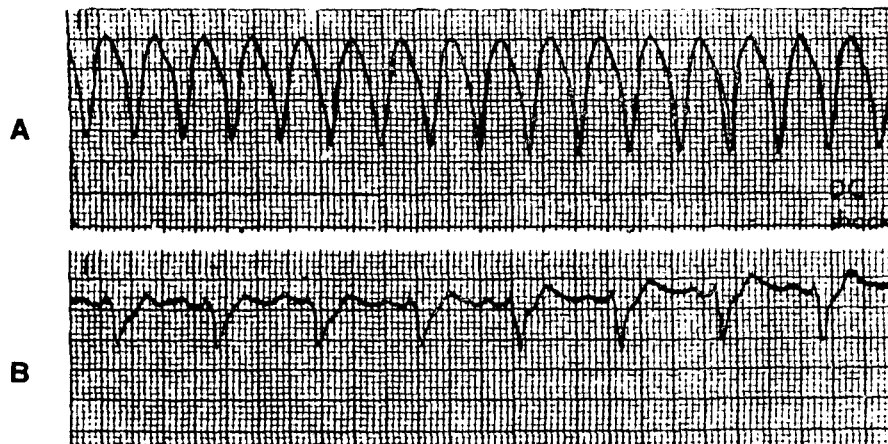
Paroxysmal atrial tachycardia (PAT) treated with carotid sinus massage. The first 14 beats in this rhythm strip show PAT with rate of about 150 beats/min. Carotid sinus massage resulted in abrupt termination of the tachycardia with appearance of normal sinus rhythm.

PAROXYSMAL VENTRICULAR TACHYCARDIA

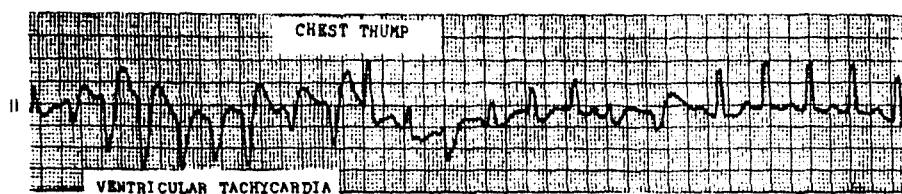


Monitor lead shows bursts of ventricular tachycardia.

VENTRICULAR TACHYCARDIA TERMINATED BY DC SHOCK

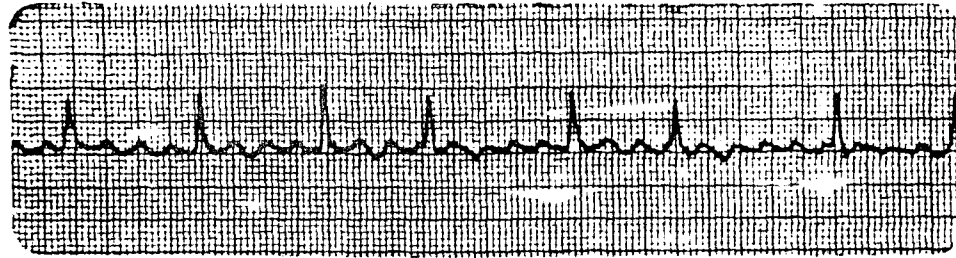


A. Long run of ventricular tachycardia. B, Normal sinus rhythm restored after DC shock (cardioversion).

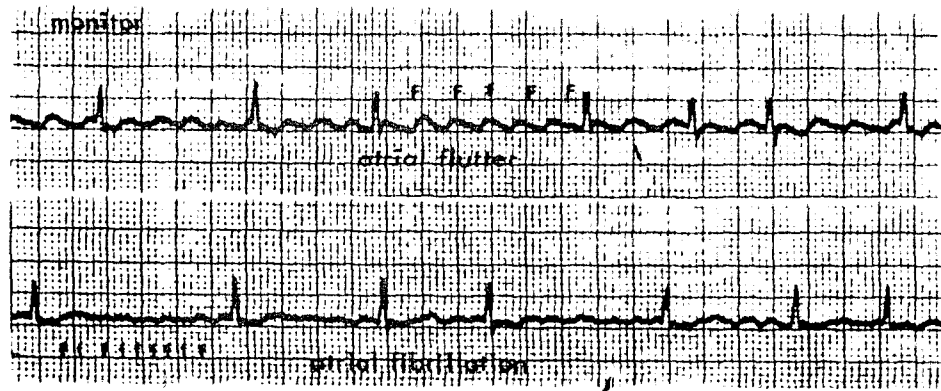


Ventricular tachycardia terminated by thump on chest (thump version)

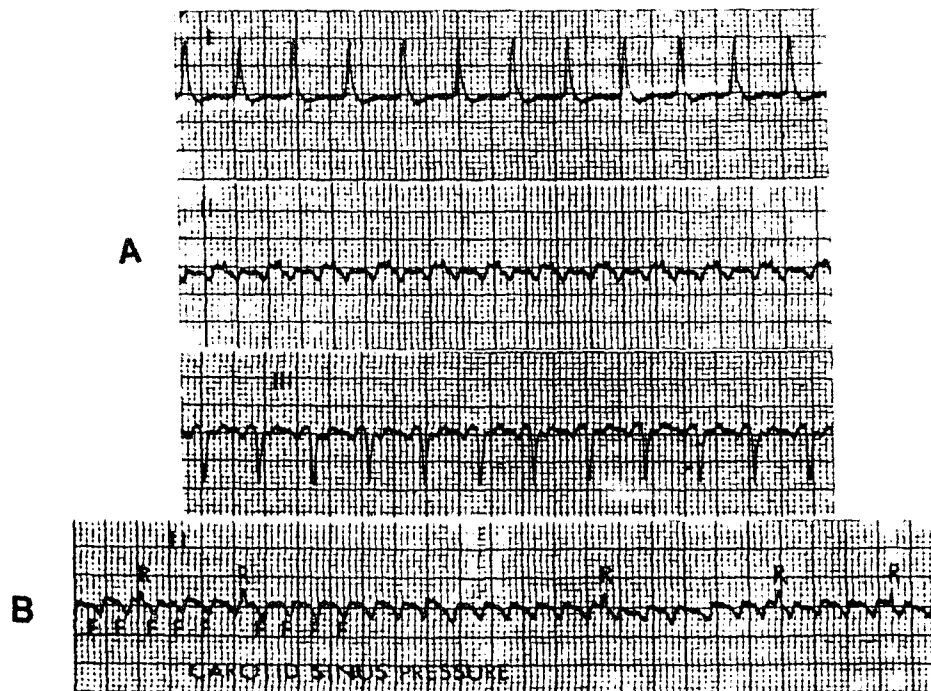
ATRIAL FLUTTER



Atrial flutter with variable ventricular rate.

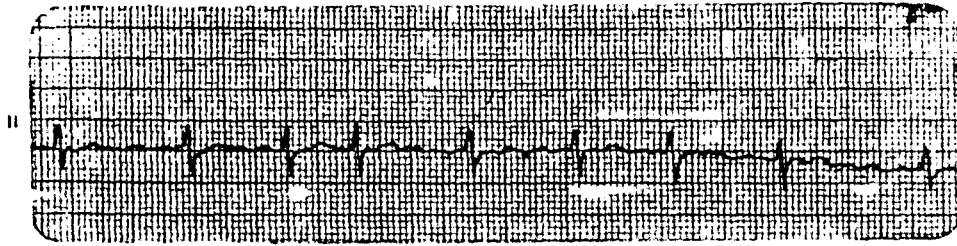


Atrial flutter and atrial fibrillation. Notice sawtooth waves with atrial flutter, F, and irregular fibrillatory waves with atrial fibrillation, f.



Note variable appearance of flutter waves in different leads. In lead I, flutter wave are barely apparent, while leads II and III show classic "sawtooth" waves. Ventricular rate is about 160 beats/min, and flutter rate is about 320 beats/min, so that atrial flutter with 2:1 conduction is present. B, Carotid sinus massage produces marked slowing of the ventricular rate by increasing vagal tone

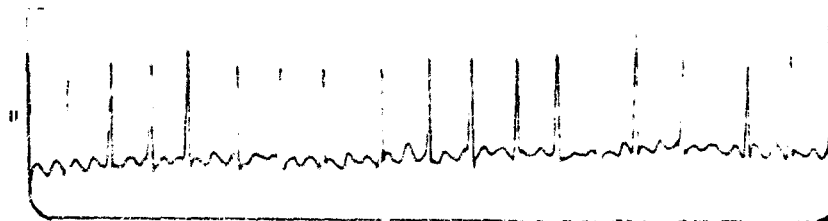
ATRIAL FIBRILLATION



Note irregular undulation of baseline because of fibrillatory waves (f waves). There are no true P waves. Ventricular (QRS) rate is irregular.

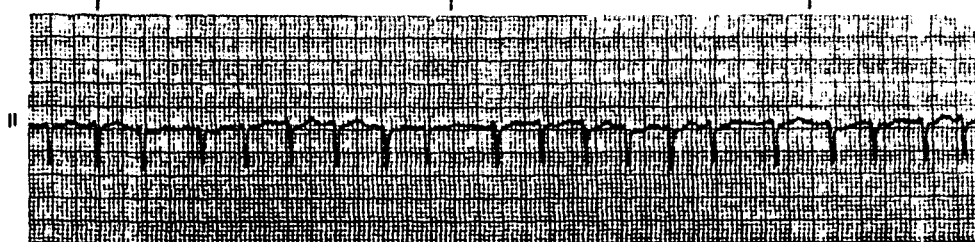
Note irregular undulation of baseline because of fibrillatory waves (f waves). There are no true P waves. Ventricular (QRS) rate is irregular.

RAPID ATRIAL FIBRILLATION



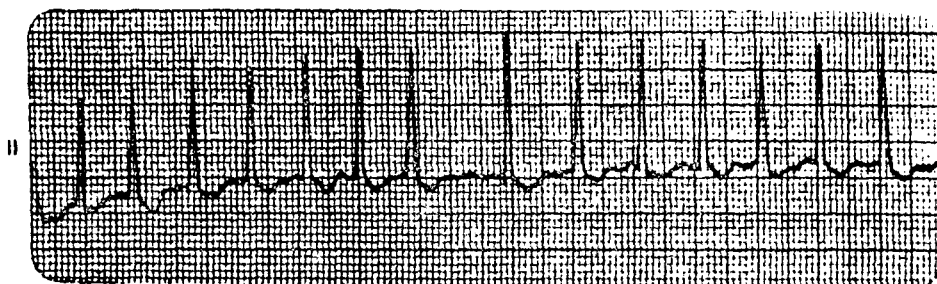
Note coarse fibrillatory waves and rapid ventricular response. Patient had hyperthyroidism. (The commonly used term "rapid atrial fibrillation" is actually a misnomer since the word "rapid" refers to the ventricular rate, not the atrial rate. The same is true for the term "slow atrial fibrillation".)

ATRIAL FIBRILLATION



Fibrillatory waves may be hard to find with rapid atrial fibrillation. A tachycardia is present with ventricular rate of about 140 beats/min (14 R wave cycles in 6 sec). The ventricular rate is irregular. No P waves are seen. The rhythm here is atrial fibrillation although no clear fibrillatory waves can be seen at this rate.

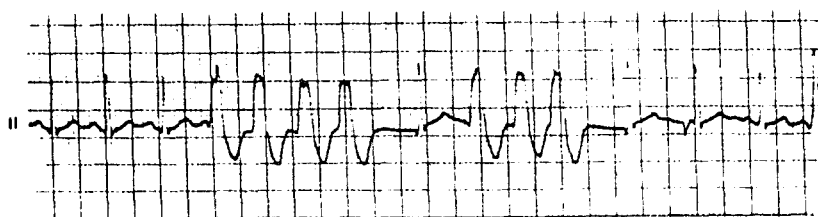
ATRIAL FIBRILLATION



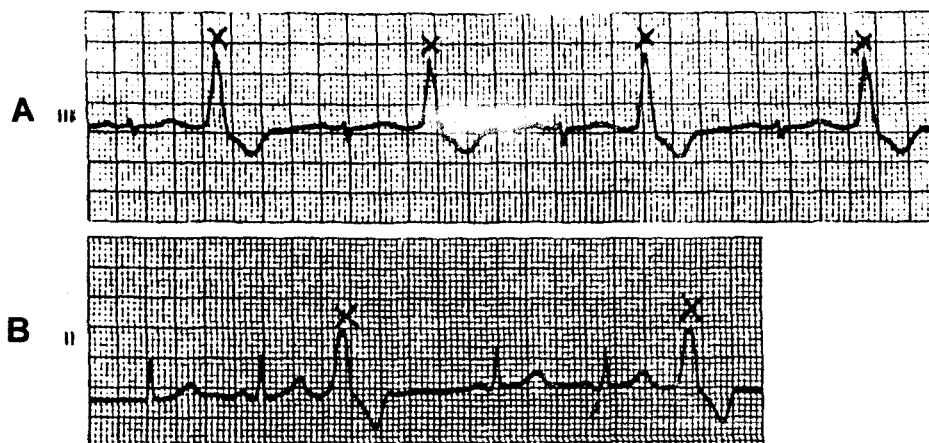
Very irregular ventricular rate is present. No clear P waves are seen. Rhythm here, as in Fig. 13-6, is atrial fibrillation with rapid ventricular rate.

Very irregular ventricular rate is present. No clear P waves are seen. Rhythm here is atrial fibrillation with rapid ventricular rate.

VENTRICULAR TACHYCARDIA

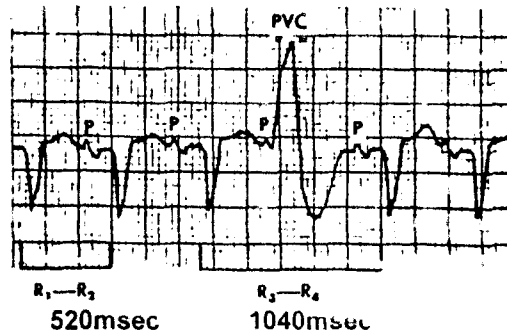


Ventricular tachycardia is, by definition, three or more consecutive PVCs. ECG shows two short bursts of ventricular tachycardia.



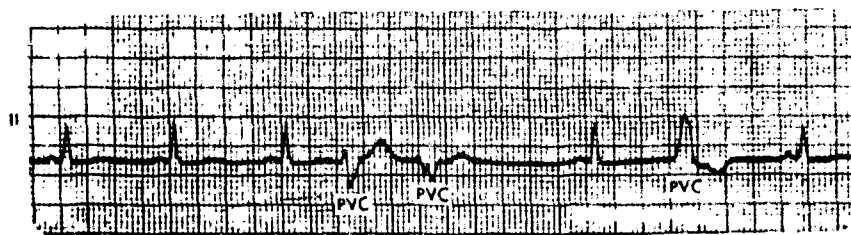
Ventricular premature contractions. **A**, Ventricular bigeminy. Each normal sinus beat is followed by a premature ventricular contraction (marked X). **B**, Ventricular trigeminy. A premature ventricular contraction occurs after every two sinus beats.

FULLY COMPENSATORY PAUSE



Some PVCs cause a fully compensatory pause, such that the interval between the two sinus beats that surround the PVC (R3 and R4 in this case) is exactly two times the normal interval between sinus beats (R1 and R2 in this case). Notice that the P waves come on time, except that the third P wave is interrupted by the PVC and therefore does not conduct normally through the AV-junction. The next (fourth) P wave also comes on time. The fact that the sinus node continues to pace despite the PVC results in the fully compensatory pause.

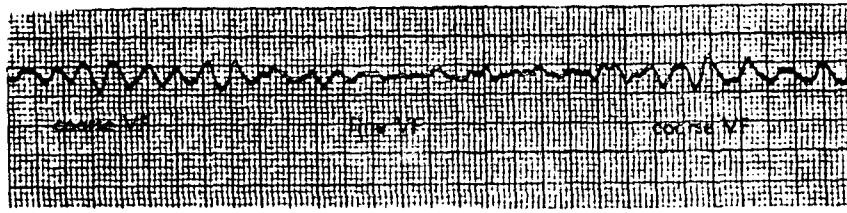
MULTIFOCAL PVCs



PVCs here have different shapes in same lead, indicating multifocal origin.

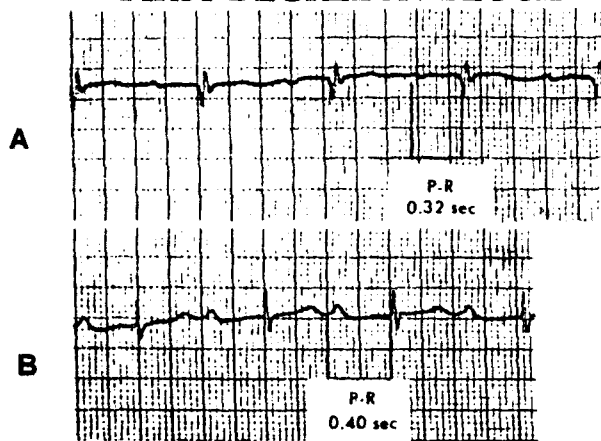


VENTRICULAR FIBRILLATION (VF)



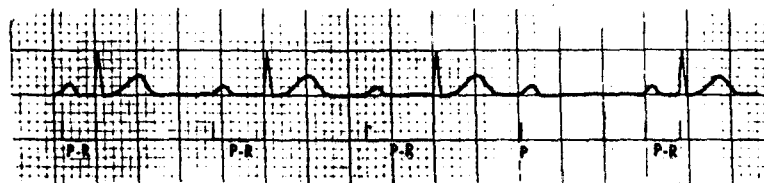
Ventricular fibrillation may produce coarse waves or fine waves. Immediate defibrillation should be performed

FIRST-DEGREE AV BLOCK



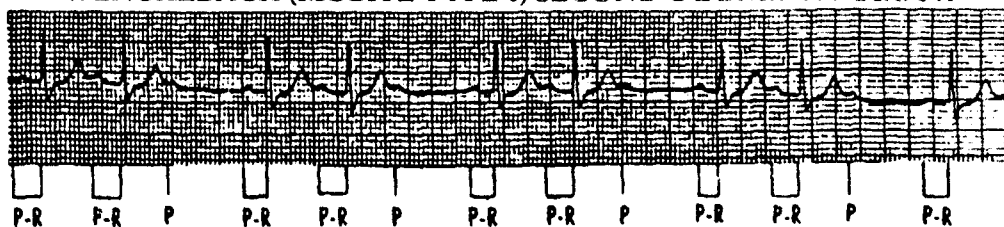
First-degree AV block, P-R interval is uniformly prolonged above 0.2 sec with each beat. **A** and **B** are from different patients.

WENCKEBACH (MOBITZ TYPE I) SECOND-DEGREE AV BLOCK



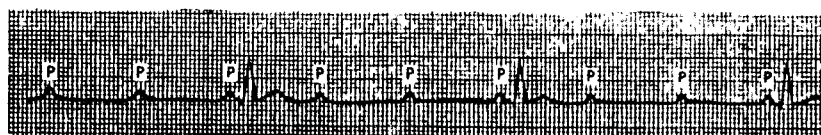
With Wenckebach block, P-R interval lengthens progressively with successive beats until one P wave is not conducted at all. Cycle then repeats itself.

WENCKEBACH (MOBITZ TYPE I) SECOND-DEGREE AV BLOCK



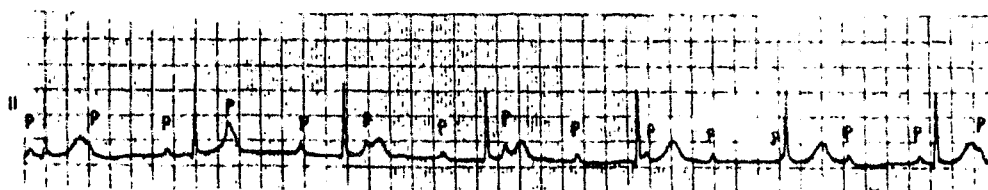
Notice progressive increase in P-R interval, with third P wave in each sequence not followed by QRS complex. Wenckebach block produces characteristically irregular rhythm with grouping of QRS complexes.

MOBITZ TYPE II SECOND-DEGREE AV BLOCK



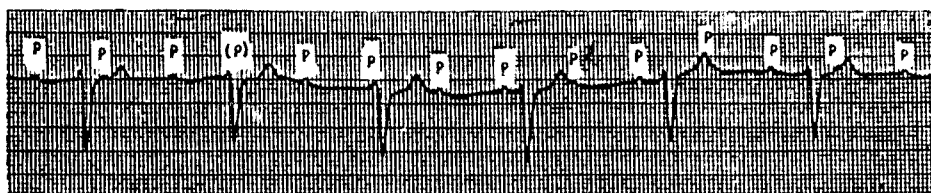
With Mobitz type II AV block there is a series of non-conducted P waves followed by a P wave that is conducted. In this diagrammatic example, 3:1 AV block is present, with three P waves for each QRS complex.

THIRD-DEGREE (COMPLETE) AV BLOCK



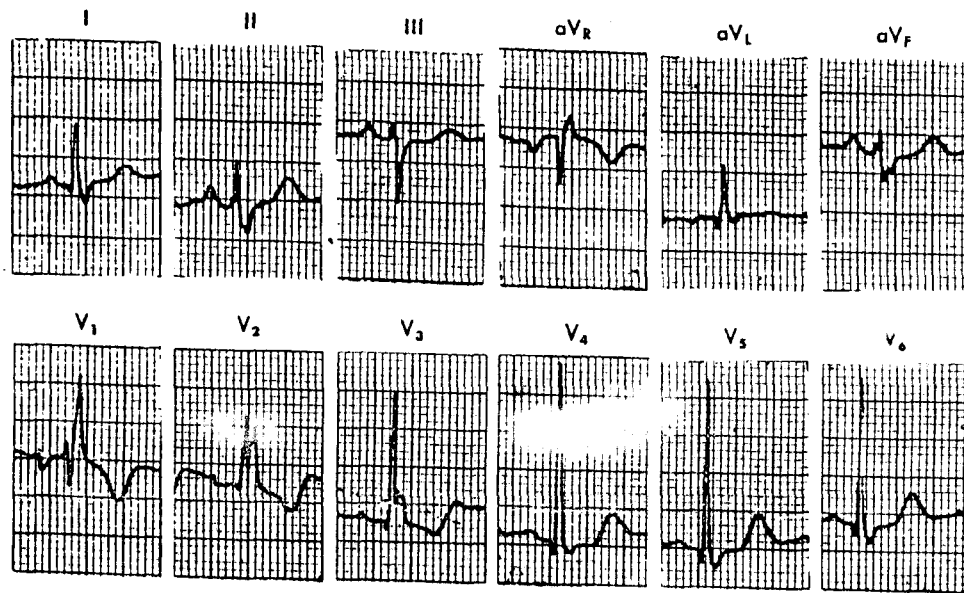
Complete heart block is characterized by independent atrial (P) and ventricular (QRS) activity. The atrial rate is always faster than the ventricular rate. The P-R intervals are completely variable. Some P waves fall on the T wave, distorting the shape of the T wave. Other P waves may fall in the QRS complex and may be "lost." Note that QRS complexes are normal width, indicating that the ventricles are being paced from the AV junction.

THIRD-DEGREE (COMPLETE) AV BLOCK



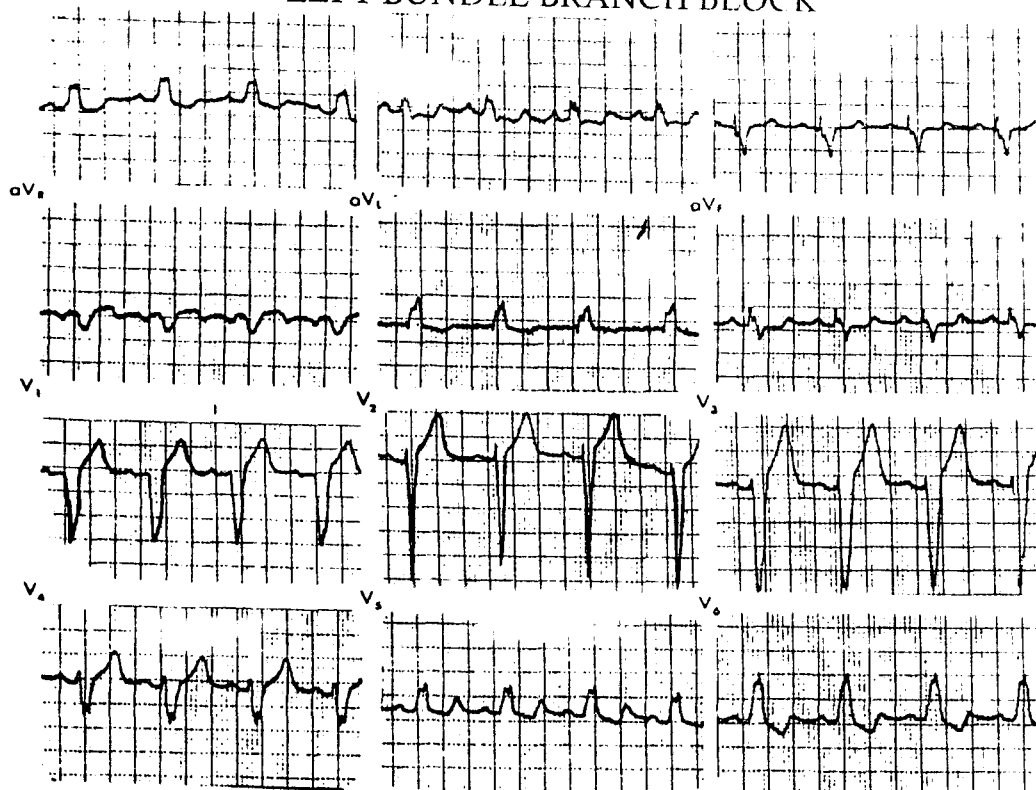
Another example of complete heart block, showing slow idioventricular rhythm and faster, independent atrial rhythm.

RIGHT BUNDLE BRANCH BLOCK



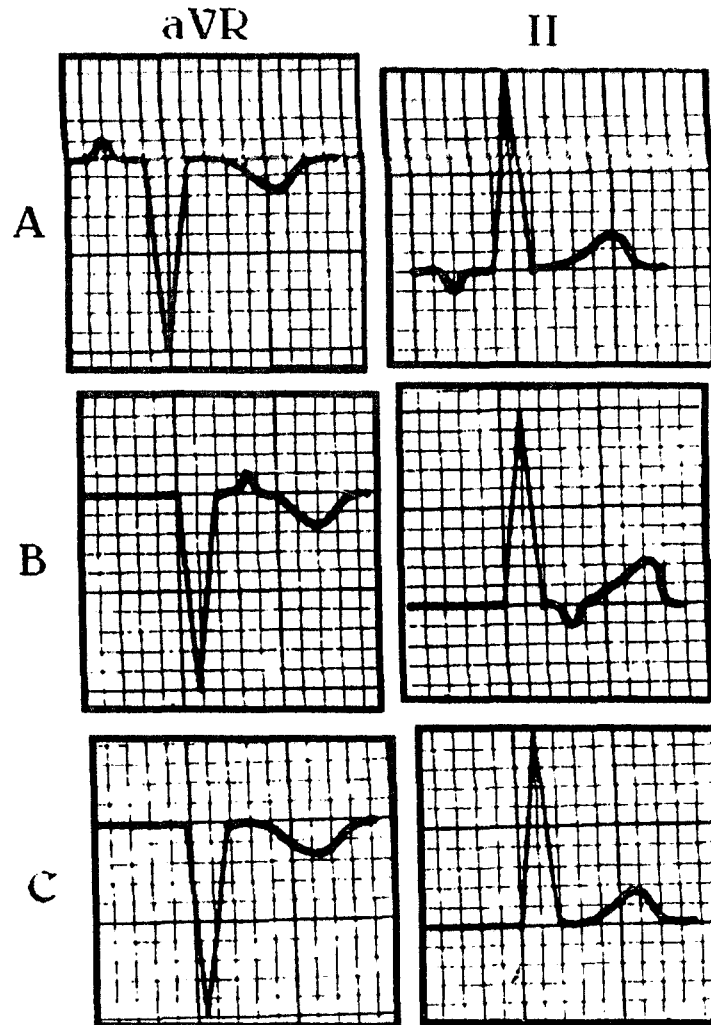
Example of RBBB. Note wide rSR complex in lead V1 and qRS complex in lead V6. Inverted T waves in right precordial leads (V1 to V3) are common with RBBB and are called "secondary T wave inversions."

LEFT BUNDLE BRANCH BLOCK



Example of LBBB. Note characteristic wide QS complex in lead V1 and wide R wave in lead V6 with slight notching at the peak. Note inverted T waves in leads V5 to V6, which are also characteristic of LBBB (secondary T wave inversions).

AV junctional beats



This Fig.: AV junctional beats produce retrograde P waves that are upright in lead aVR and negative in lead II, just opposite of pattern seen with sinus rhythm. The junctional P wave may precede the QRS complex A; follow the QRS complex. B; or occur simultaneously with the QRS complex, in which case no P wave will lie visible. C

To summarize, AV junctional beats can be (recognized on the ECG by one of the following three patterns:

- 1. Retrograde P waves (positive in lead aVR, negative in lead II) preceding the QRS complex.**
- 2. Retrograde P waves following the QRS complex.**
- 3. Absent P waves, so that the baseline between QRS complexes is flat.**

HOW TO INTERPRET AN ECG

In Parts I and II we described the fundamentals of the normal ECG and the major abnormal patterns and arrhythmias. Part III is a collection of test questions to help you review these topics. We will conclude Part II with a brief summary of how to systematically approach any ECG.

ECG INTERPRETATION

Accurate interpretation of ECGs requires, above all, thoroughness and care. Therefore, it is essential to develop a systematic method of reading ECGs that is applied in every case. There are 13 points that should be analyzed in every ECG.

Standardization: Make sure the electrocardiograph has been properly calibrated so that the standardization mark is 10 mm tall (1 mv = 10 mm).

**** In special cases, the ECG may be intentionally recorded at 1/2 standardization (1 mv = 5 mm) or 2x standardization (1 mv = 20 mm)**

Heart rate: Calculate the heart rate. If the rate is faster than 100 beats/min, a tachycardia is present. A rate slower than 60 beats/min means a bradycardia is present.

Rhythm: Decide whether normal sinus rhythm (NSR) is present or whether some arrhythmia is present.

P-R interval: The normal P-R interval (measured from the beginning of the P wave to the beginning of the QRS complex) is 0.12 to 0.2 second. A consistently prolonged P-R interval means first-degree AV block is present. A short P-R interval (with wide QRS complex and delta wave) is seen with the Wolff-Parkinson-White syndrome. A short PR interval with a normal width QRS may represent Lown-Ganong-Levine type pre excitation.

P wave size: Normally, the P wave is less than 2.5 mm tall and 3 mm wide in all leads. Tall peaked P waves are a sign of right atrial enlargement (P pulmonale). Wide P waves are seen with left atrial abnormality.

QRS width: Normally, the QRS width is 0.1 sec or less in all leads.

Q-T interval: A prolonged Q-T interval may be a clue to electrolyte disturbances (hypocalcaemia, hypokalemia), drug effects (quinidine, procainamide), or myocardial ischemia. Shortened Q-T intervals are seen with hypercalcemia and digitalis effect.

QRS voltage: Look for signs of left or right ventricular hypertrophy. Remember that thin-chested people and young adults frequently show tall voltage without left ventricular hypertrophy. Do not forget about low voltage which may result from pericardial effusion, Myxoedema, emphysema, obesity, or myocardial disease.

Mean QRS electrical axis: Estimate the mean QRS axis in the frontal plane. Decide by inspection whether the axis is normal (between -30° and $+100^{\circ}$) or whether left or right axis deviation is present.

R wave progression in chest leads: Inspect leads V1 to V6 to see if the normal increase in R waves is seen as you move across the chest. Poor R wave progression may be a sign of myocardial infarction, but it may also be seen with left ventricular hypertrophy, chronic lung disease, left bundle branch block, and other conditions in the absence of infarction.

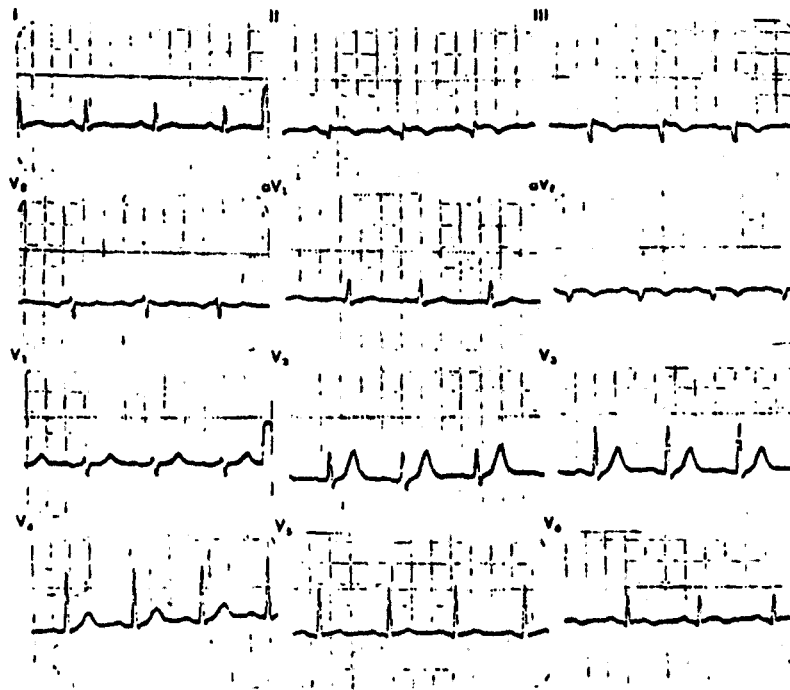
Abnormal Q wave: Abnormal Q waves in leads II, III, and aVF may indicate transmural inferior wall infarction. Abnormal Q waves in the anterior leads (I, aVL, and V1 to V6) may indicate transmural anterior wall infarction.

S-T segment: look for abnormal S-T segment elevations or S-T depression.

T wave and U wave: Inspect the T waves. Normally the T wave is always positive (up-right) in leads with a positive QRS complex.

The T wave is normally positive in leads V3 to V6 in adults. It is normally negative in lead aVR and positive in lead II. The normal polarity of the T waves in the other extremity leads depends on the QRS electrical axis.

Also look for prominent U waves, which may be a sign of hypokalemia or drug effect (as with quinidine).



ECG for interpretation:

1- Standardization: Note normal (10 mm) standardization mark recorded at end of leads I, V1, and V6. Standardization mark need be recorded only once when taking ECG.

2. Heart rate: 88 beats/min.
3. Rhythm: Normal sinus.
4. P-R interval: 0.16 sec.
5. P waves: Normal size.
6. QRS width: 0.08 sec (normal).
7. Q-T interval: 0.36 sec (normal for rate).
8. QRS voltage: Normal.
9. Mean QRS axis: About -30° (biphasic QRS complex in lead II with positive QRS complex in lead I).
10. R wave progression in chest leads: Normal.
11. Abnormal Q waves: Pathologic Q waves in leads II, III, and aVF.
12. S-T segments: Isoelectric.
13. T waves and u waves: Ischemic T wave inversions in leads II, III, aVf, and V6.

Impression: ECG consistent with inferolateral wall myocardial infarction of indeterminate age.

Comment: You cannot determine the age of an infarct from the ECG. The ECG changes here:

(Q waves and T wave inversions) could have been caused by an infarct that occurred the day before or the year before.

After you have analyzed these 13 points, you should formulate an overall interpretation. For example, an ECG might show sinus tachycardia, first-degree AV block, and Q waves and T wave inversions consistent with an evolving anterior wall myocardial infarction. Part III contains other examples for practice. We would like to emphasize that every ECG abnormality you identify should summon up a list of differential diagnostic possibilities. The ECG is a clinical tool, and you should search for a clinical explanation for any ECG abnormality you find. For example, if the ECG shows sinus tachycardia, then the next question to ask is what caused this arrhythmia? Is the sinus tachycardia a result of anxiety, congestive heart failure, shock, Sympathomymetic drugs, or other causes? If you find ventricular tachycardia, what are the diagnostic possibilities? Is the ventricular ectopy caused by myocardial infarction or some potentially reversible cause, such as acidosis, hypoxia, digitalis toxicity or other drugs, hypokalemia, or hypotension? If you see signs of left atrial enlargement or left ventricular hypertrophy, what is the cause: valvular heart disease, hypertensive heart disease, ischemic heart disease, or cardiomyopathy? In this way, the interpretation of an ECG becomes an integral part of diagnosis and patient care. Finally, we will conclude this section with a brief discussion of some important ECG artifacts.

ECG artifacts:

The ECG, like any other electronic recording, is subject to numerous artifacts that may interfere with accurate interpretation. Some of the most common of these ECG artifacts are described here.

60 cycle (Hertz.) interference: Interference from alternating current generators produces the characteristic pattern shown in Fig. below. Note the fine-tooth comb 60 cps (Hz) artifacts. By switching the electrocardiograph plug to a different outlet or by turning off other electrical appliances in the room, 60 cycle interference can usually be eliminated.

Muscle tremor: Involuntary muscle tremor can produce undulations in the baseline that may be mistaken for atrial fibrillation or flutter.

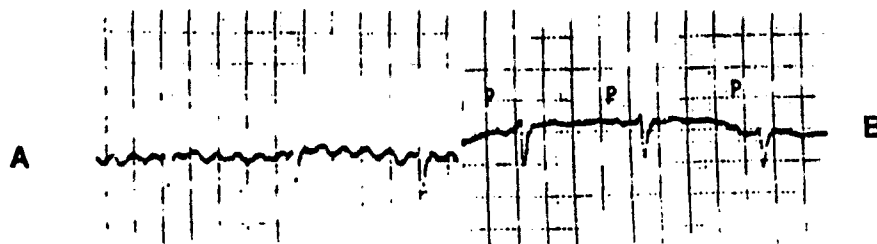
Wandering baseline: Upward or downward movement of the baseline may produce spurious S-T segment elevations or depressions.

Poor electrode contact or patient movement: Poor electrode contact or patient movement can produce artifactual deflections in the baseline, which may obscure the underlying pattern or be mistaken for abnormal beats.

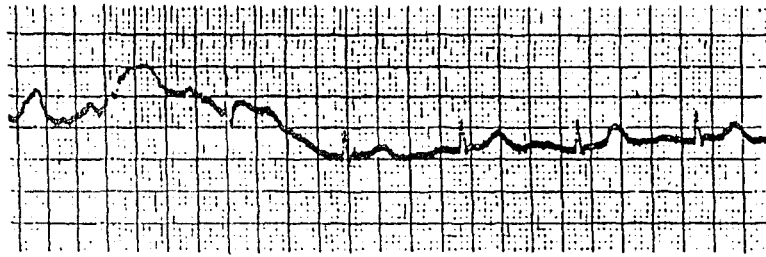
Improper standardization: The electrocardiograph, as mentioned, should be standardized before each tracing so that a 1 mv pulse produces a square wave 10 mm high. Failure to properly standardize will result in complexes that are either spuriously low or high. Furthermore, most electrocardiographs are equipped with half standardization and double standardization settings. Inadvertent recording of an ECG on either of these settings will also result in spuriously low or high voltage.



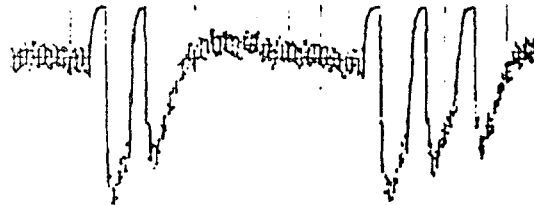
Common ECG artifacts A, 60-cycle (Hertz) electrical artifact produces fine oscillations of the baseline. B, Same pattern without artifact.



A, Muscle tremor artifact produces wave baseline resembling atrial flutter. B, Same pattern without artifact showing normal P waves



Wandering baseline resulting from patient movement.



Patient movement artifact produced deflections simulating PVCs.
60-cycle artifact is also present.

♠♠ Remember:

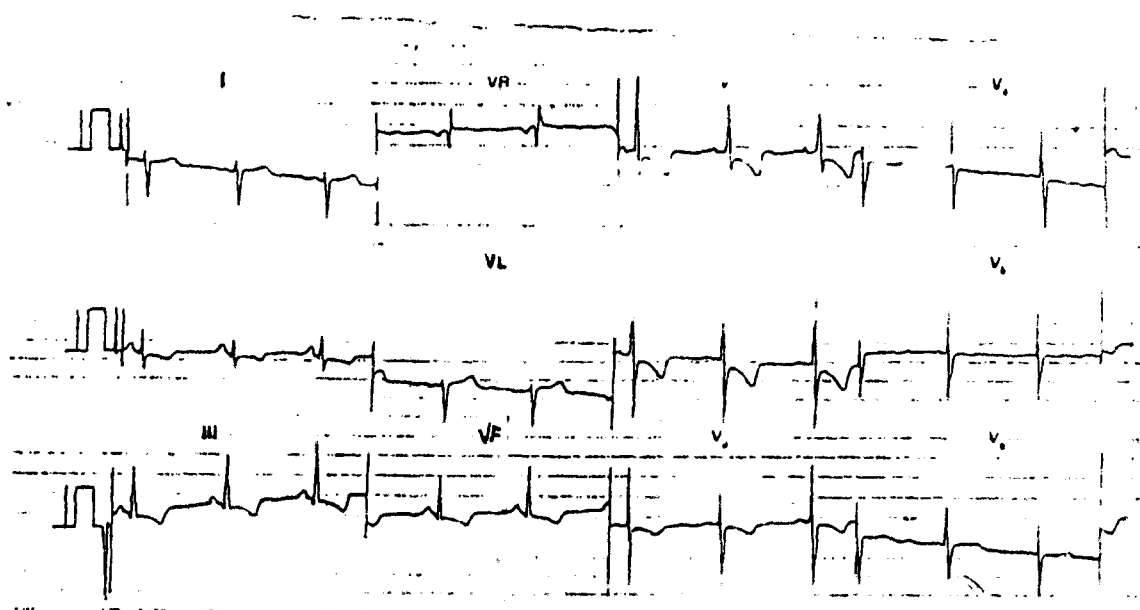
The following 13 points should be evaluated in every ECG:

1. Standardization
2. Heart rate
3. Rhythm
4. P-R interval
5. P wave size
6. QRS width
7. Q-T interval
8. QRS voltage
9. Mean QRS axis
10. R wave progression in chest leads
11. Abnormal Q waves
12. S-T segment
13. T wave and U wave

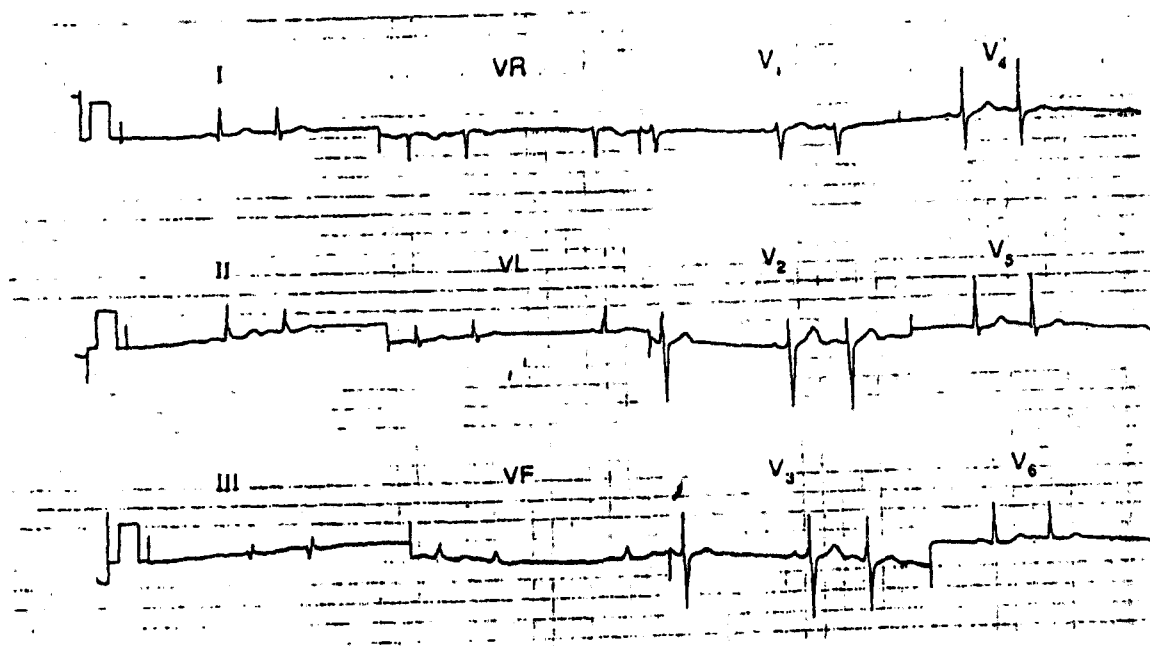
Any ECG abnormality should be related to the clinical status of the patient.

The ECG can also be affected by numerous artifacts, including 60 cps (Hz) interference, patient movement, poor electrode contact, muscle tremor, and so on.

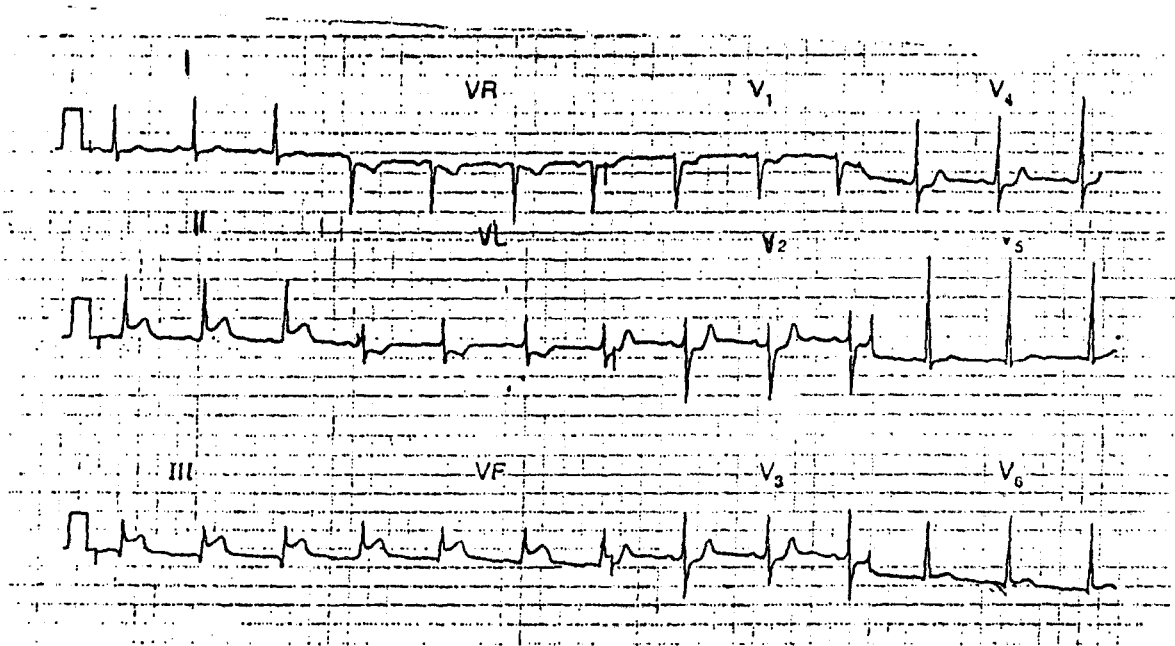
Test questions



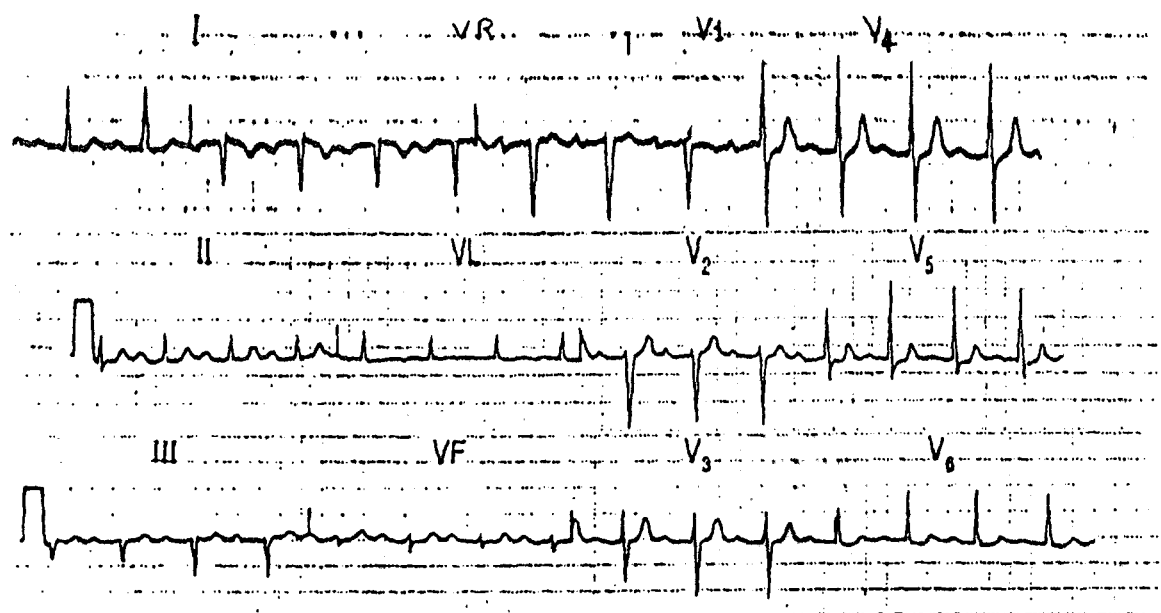
- 1) A 40-year-old woman is referred to the Out-patient Department because of increasing breathlessness. What does this ECG show, what physical signs might you expect, and what might be the underlying problem? What might you do? *Comment QRS or chamber enlargement.*



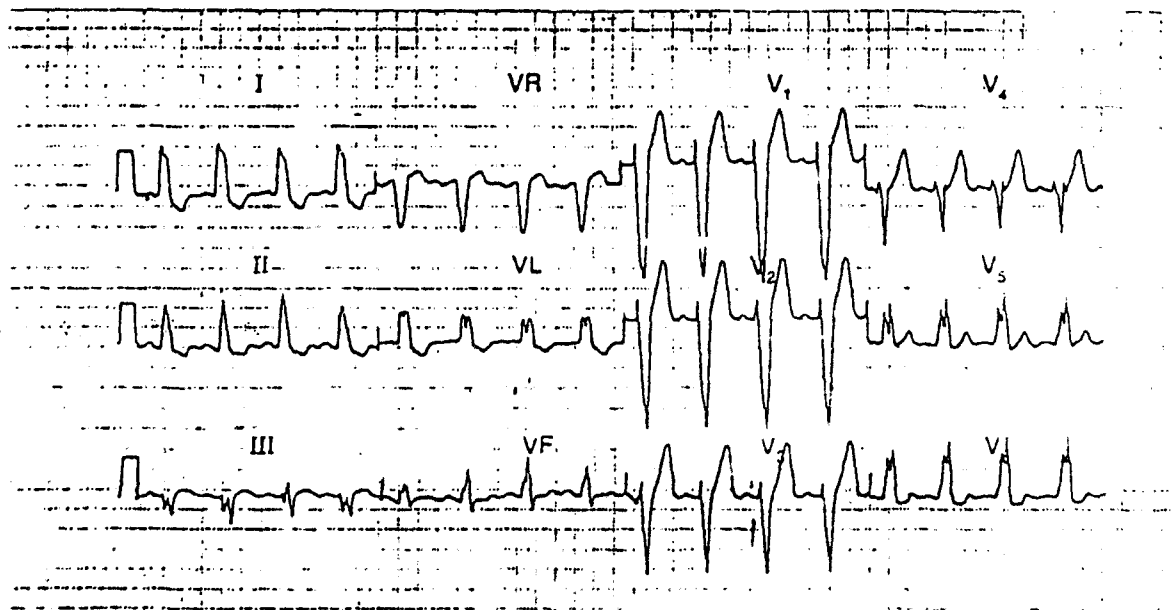
- 2) This ECG came from a 40-year-old woman who complained of palpations, which were present when the recording was made. What abnormality does it show? *Comment on rhythm.*



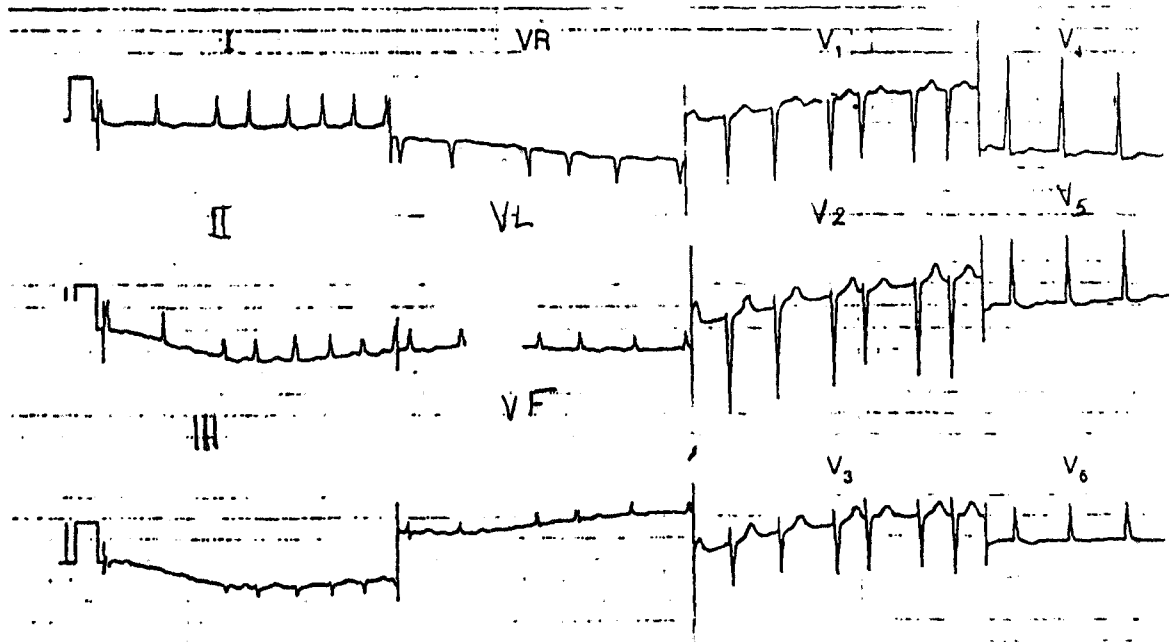
- 3) A 50-year-old man is admitted to hospital as an emergency, having had chest pain characteristic of a myocardial infarction for 4 hours. Apart from the features associated with pain there are no abnormal physical findings. What does this ECG show and what would you do? *Comment on S-T segment.*



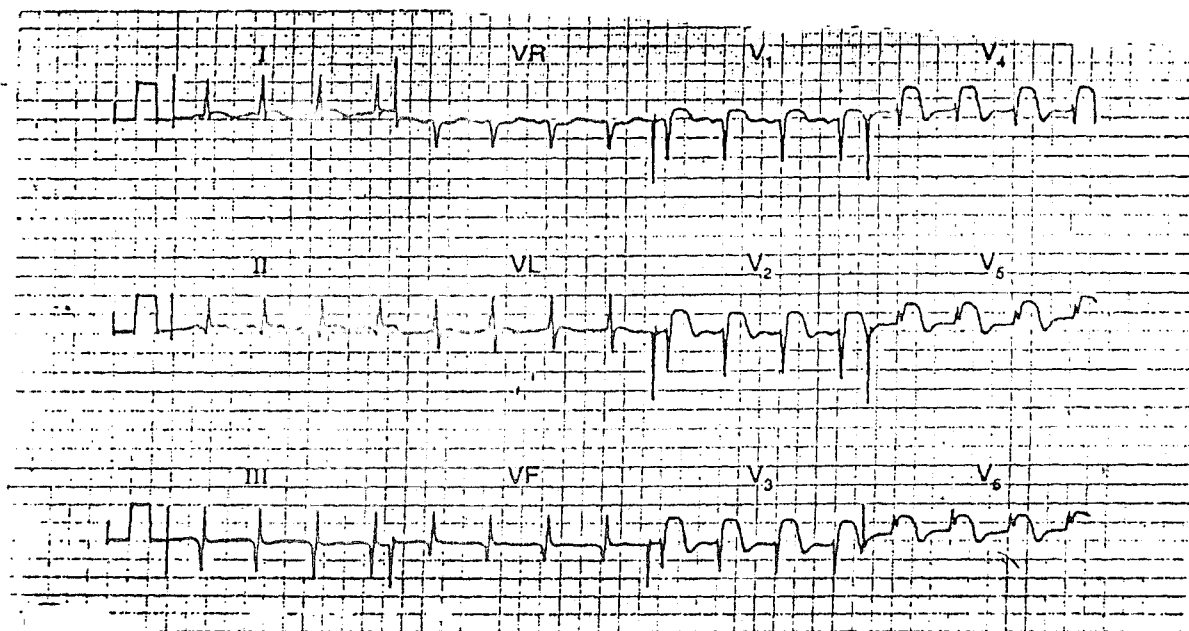
- 4) This ECG was recorded from a 75-year-old woman who complained of attacks of dizziness. It shows one abnormality: what is its significance? *Comment on P-R interval.*



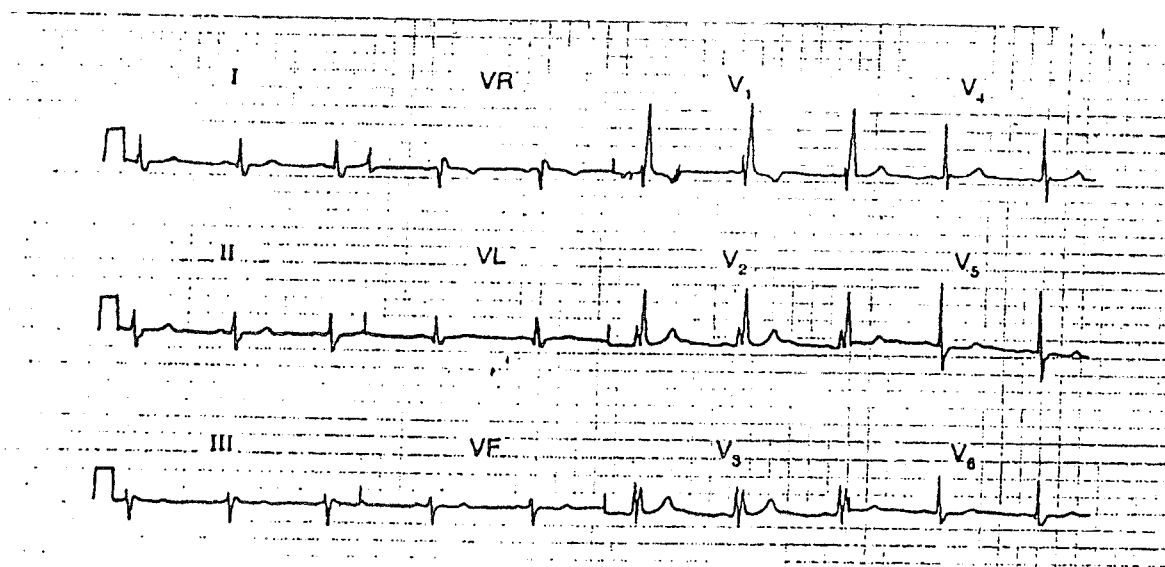
- 5) A 75-year-old woman complained of central chest discomfort on climbing hills, together with dizziness; on one occasion she had "fainted" while climbing stairs. What abnormality does this ECG show and what physical signs would you look for?
Comment on QRS.



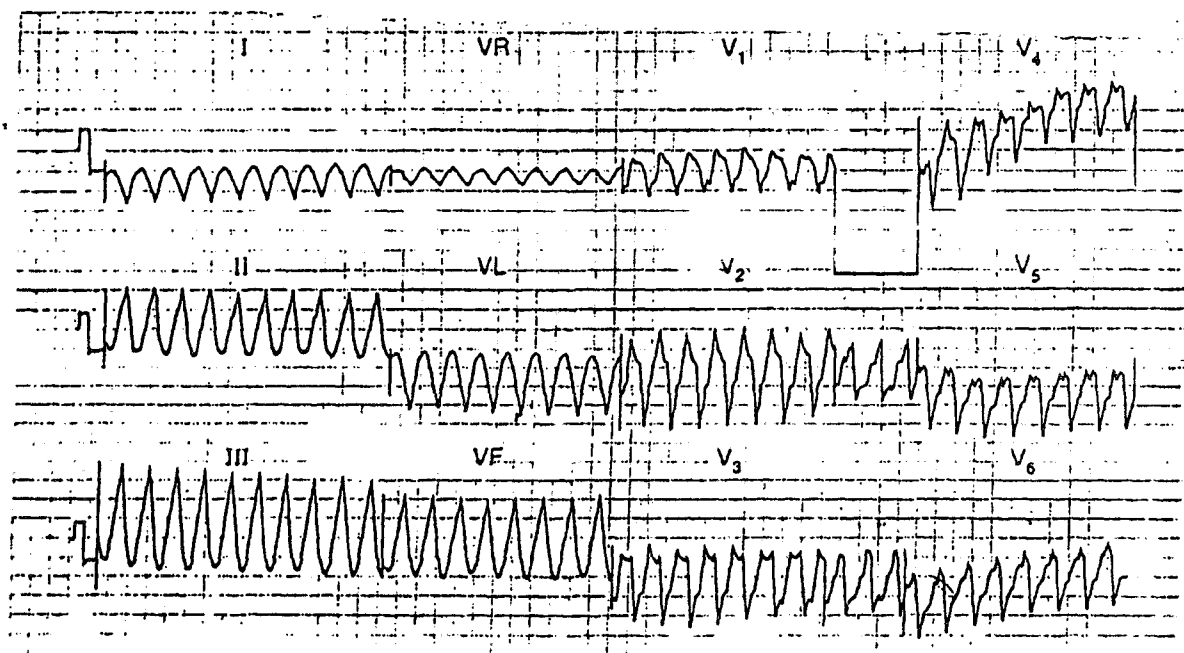
- 6) This ECG was recorded from a 60-year-old man being treated as an out-patient for severe congestive cardiac failure. What might be the diagnosis of the underlying heart condition and what would you do? *Comment on fate & rhythm.*



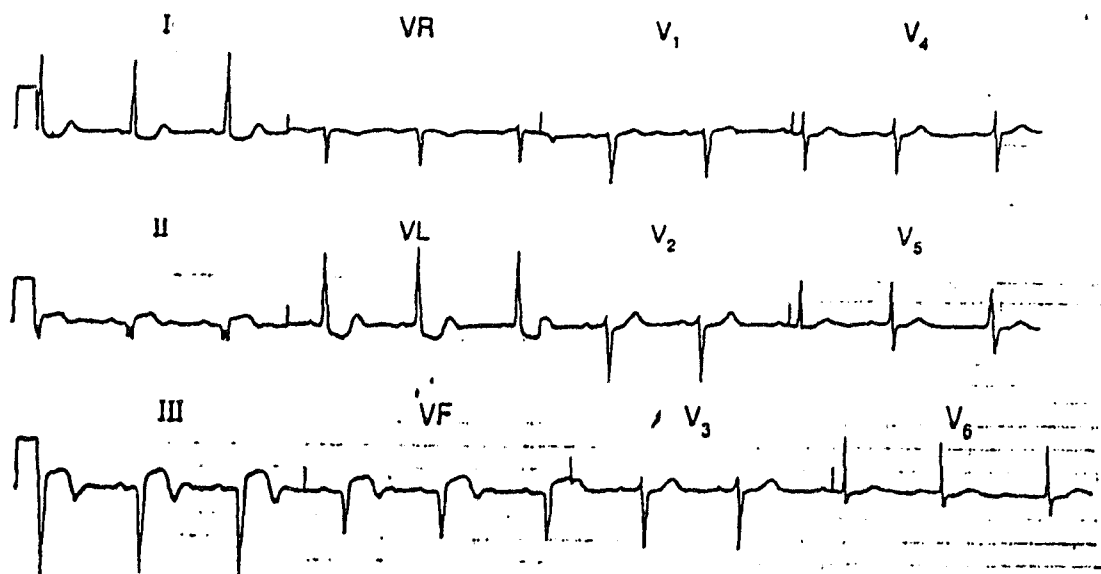
- 7) A 60-year-old man, who 3 years earlier had had a myocardial infarction followed by mild angina, was admitted to hospital with central chest pain that had been present for 1 hour and had not responded to sublingual nitrates. What does his ECG show, and what would you do? *Comment on QRS & S-T segment.*



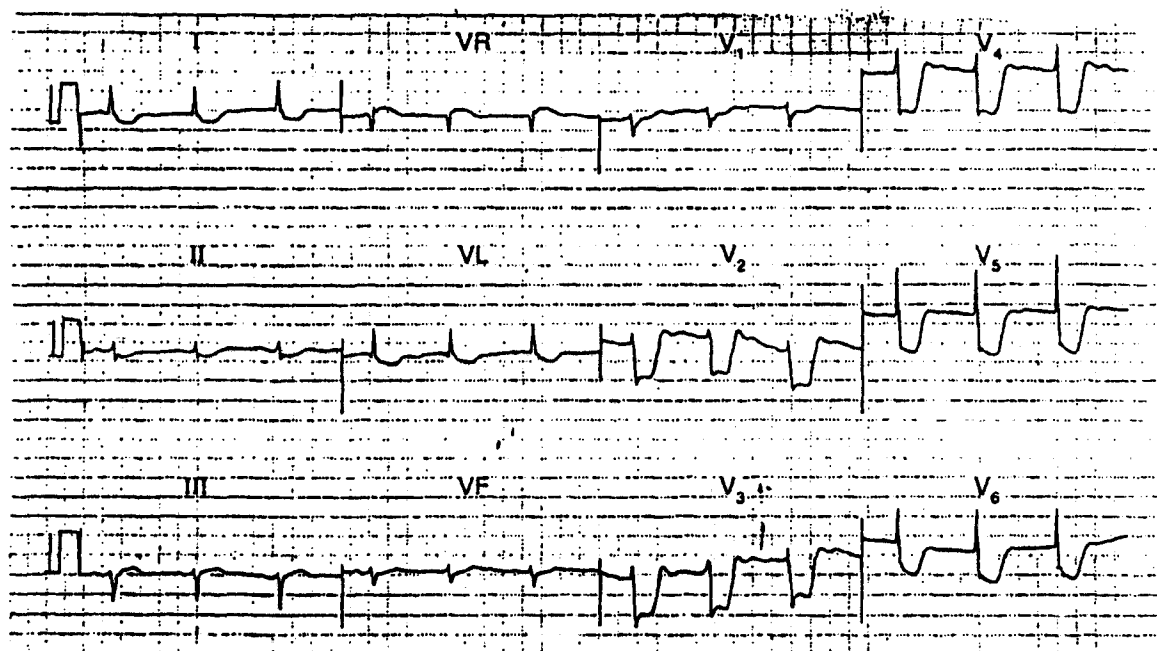
- 8) A 15-year-old boy was referred to the Out-patient Department because of a heart murmur. He had no symptoms. What does this ECG show and what physical signs would you look for? *Comment on QRS.*



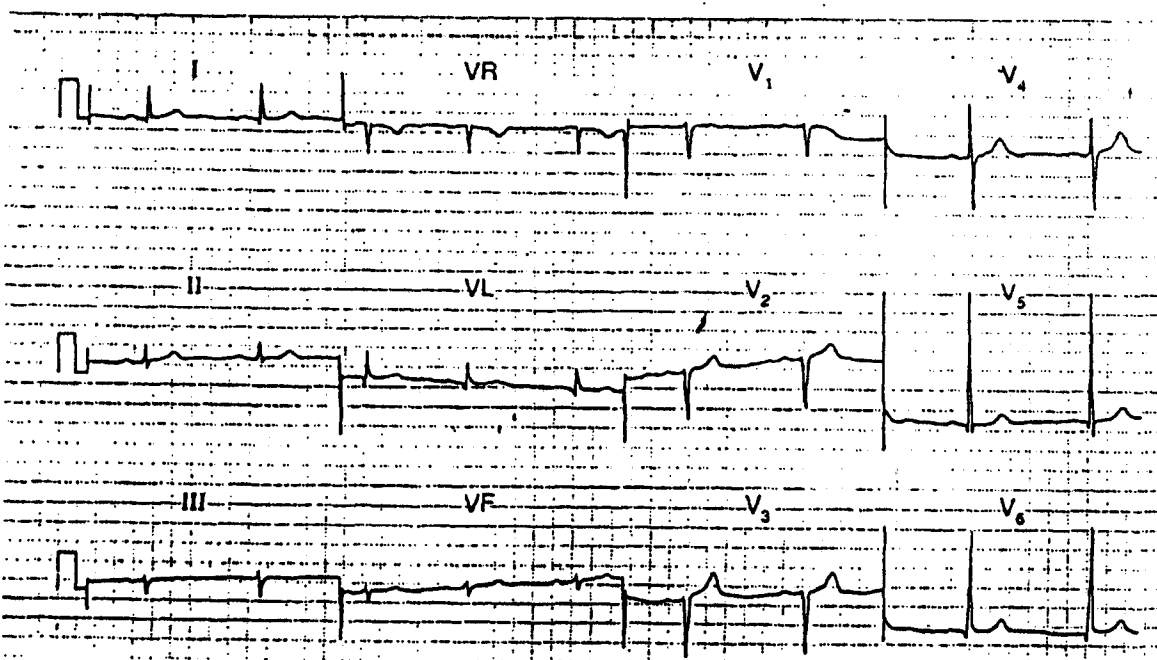
- 9) This ECG was recorded in a Coronary Care Unit from a patient admitted 2 hours previously with an acute anterior myocardial infarction. The patient was cold and clammy, he was confused, and his blood pressure was unrecordable. What does the ECG show and what would you do? *Comment on complex.*



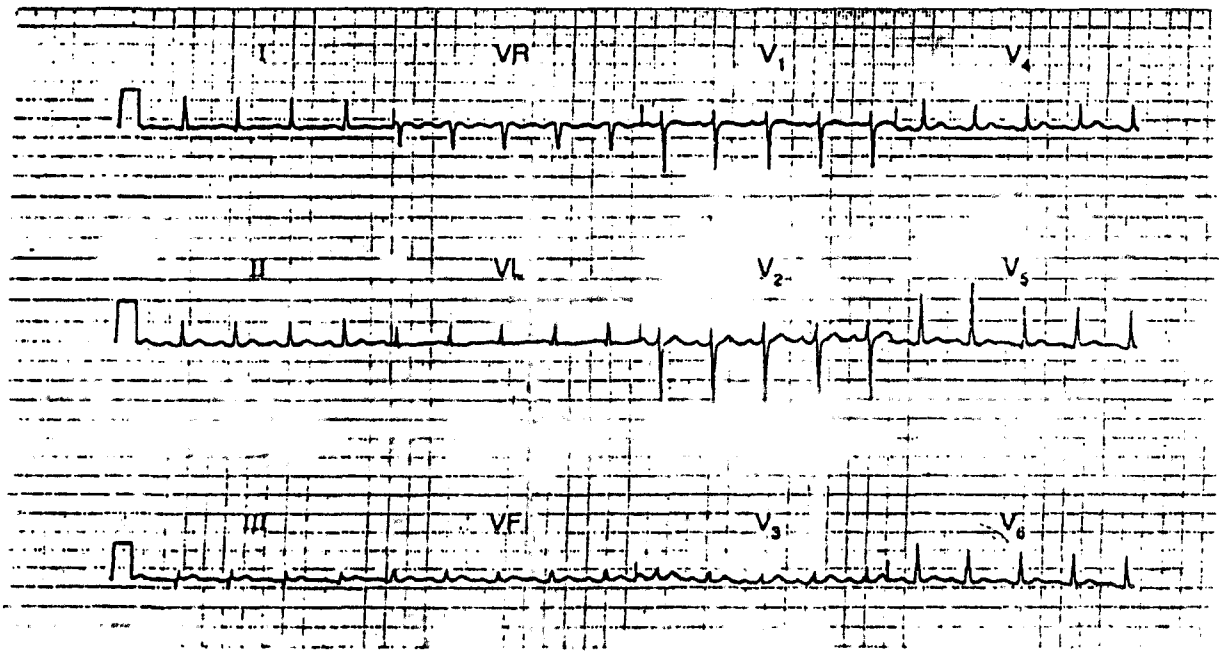
- 10) A 50-year-old man is admitted to hospital as an emergency, having had chest pain for 4 hours. The pain is characteristic of a myocardial infarction. Apart from signs due to pain, the examination is normal. What does this ECG show and what would you do? *Comment on S-T segment.*



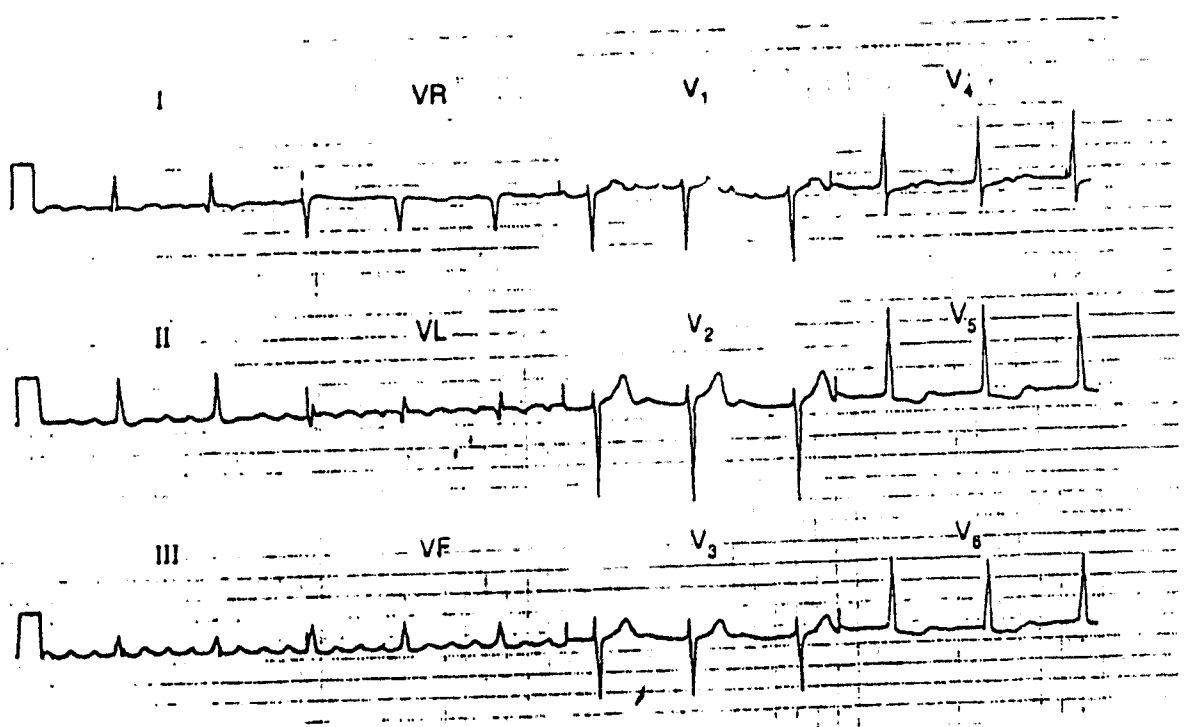
- 11) An 80 years old man being observed in the recovery room following a femoral popliteal bypass operation was noticed to have an abnormal ECG. What dose it show and what would you do? *Comment on S-T segment.*



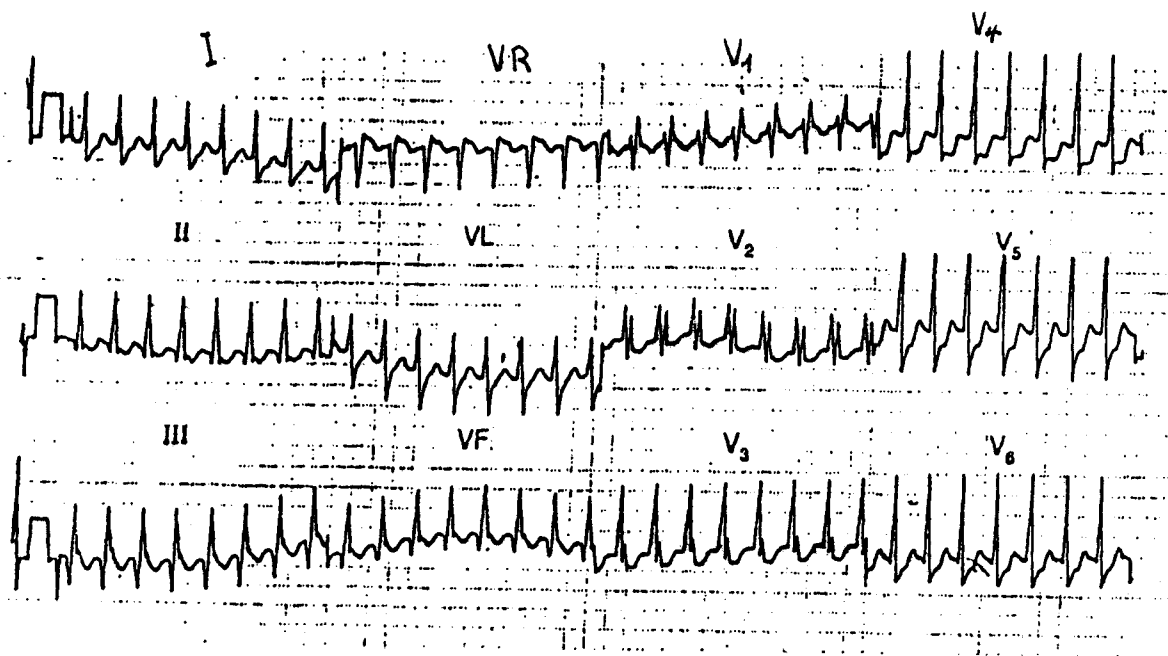
- 12) This ECG was recorded from a fit 22-year-old male medical student. He was worried - should he have been? *Comment on QRS voltage.*



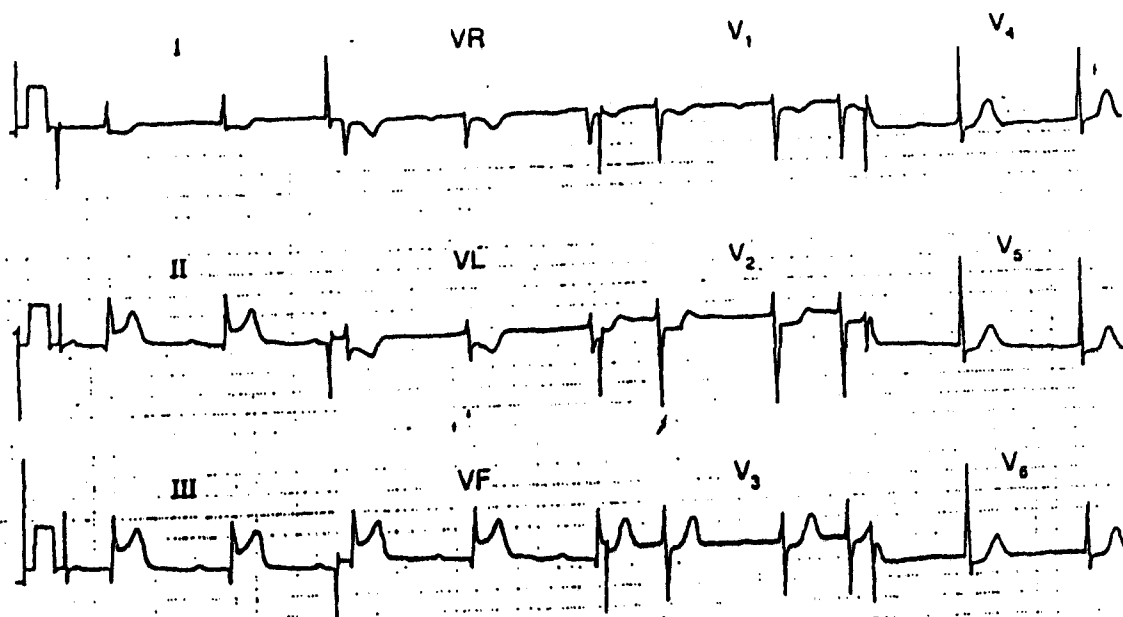
- 13) This ECG was recorded from a 30-year-old woman who complained of palpitations. Does it help make a diagnosis? *Comment on rate & rhythm.*



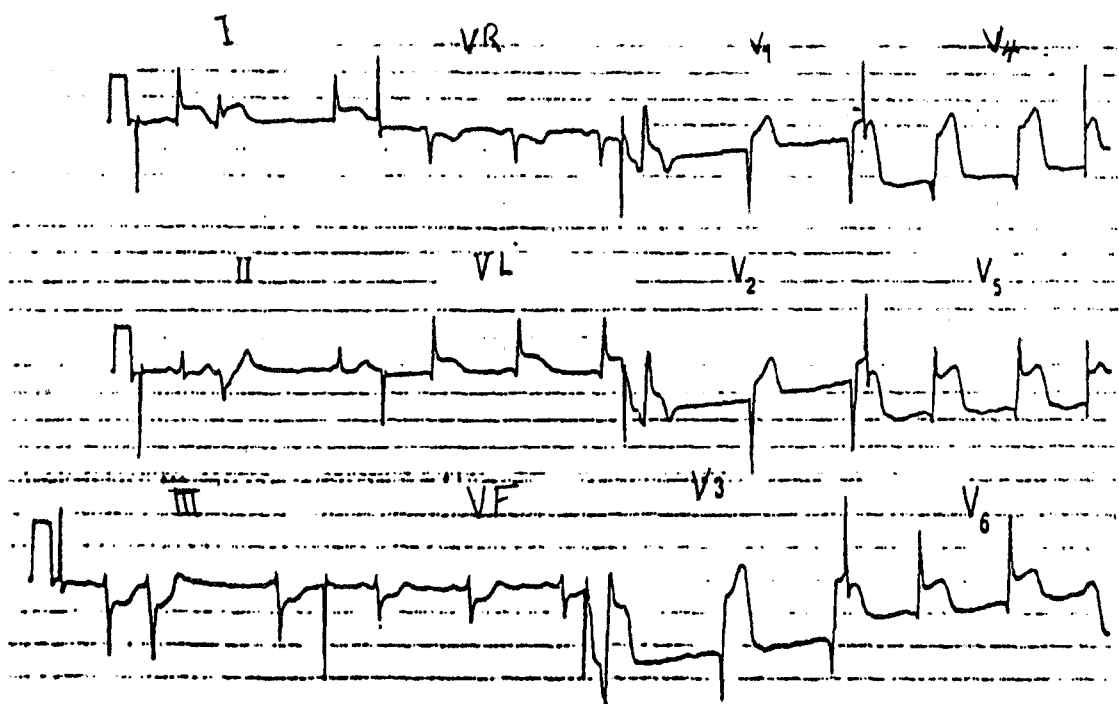
- 14) A 60 years old woman is seen in the out-patient department complaining of breathlessness. There are no abnormal physical findings. What does this ECG show, what might be the underlying problem, and how would you treat her? (*Rate & Rhythm*)



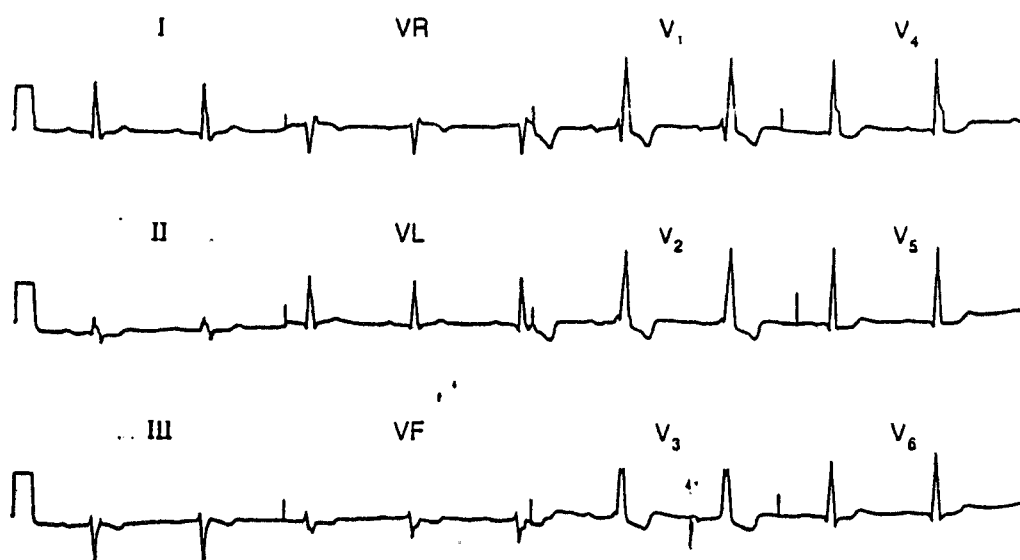
- 15) A 25-year-old man, known to have an atrial septal defect, was admitted to hospital as an emergency because of palpitations. His heart rate was 170 per minute, his blood pressure was 140/80 and there were no signs of heart failure. What is the cardiac rhythm and what would you do? *Comment on rate & rhythm.*



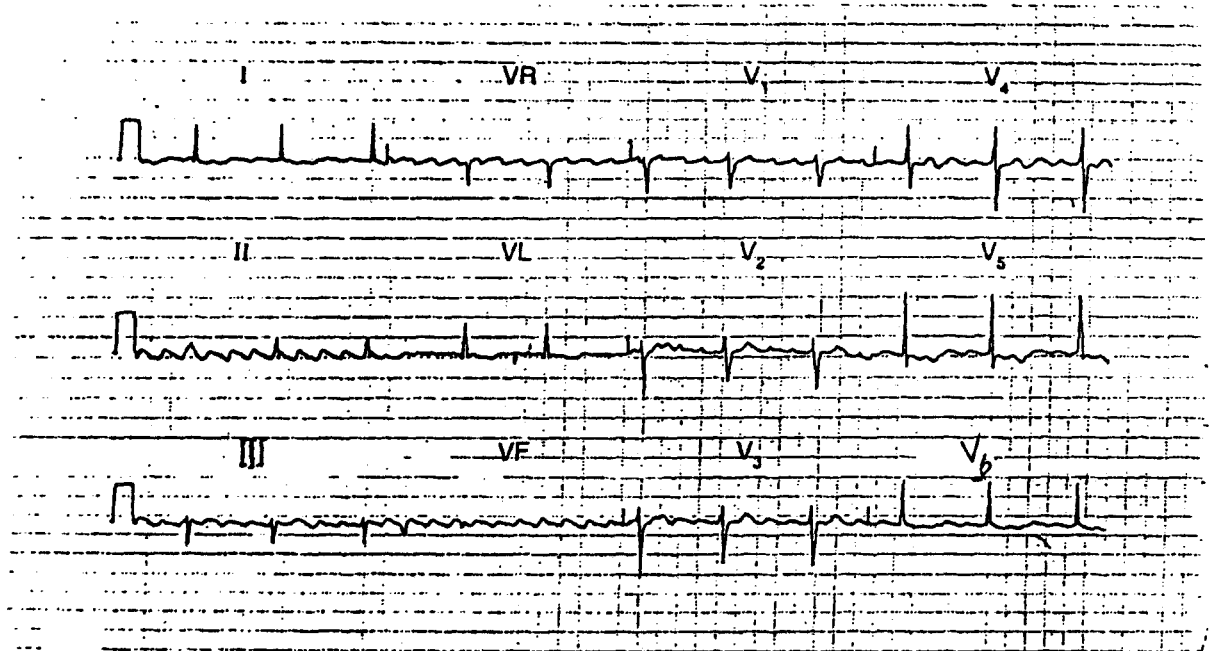
- 16) This ECG was recorded from a 55 years old man who was admitted to hospital as an emergency with severe central chest pain that had been present for about an hour. He was pale, cold and clammy; his blood pressure was 100/80 but there were no signs of heart failure. What does this ECG show? Does anything about it surprise you? *Comment on S-T segment & P-R interval.*



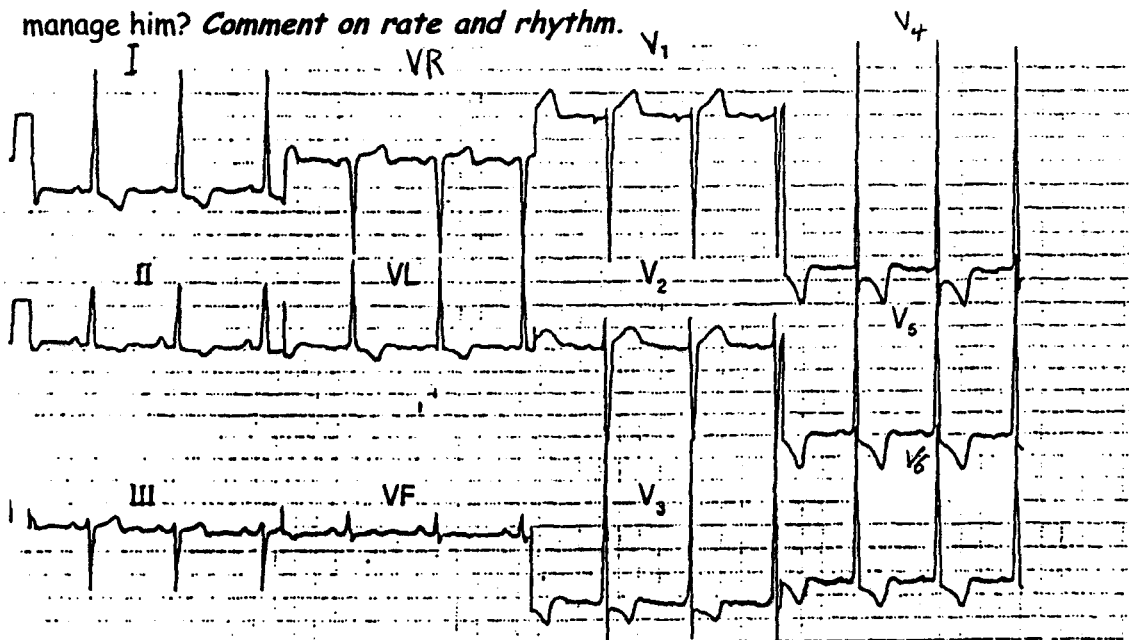
- 17) This ECG was recorded from a 50-year-old man who had had severe chest pain for 1 hour. What does it show and what would you do?
Comment on S-t segment.



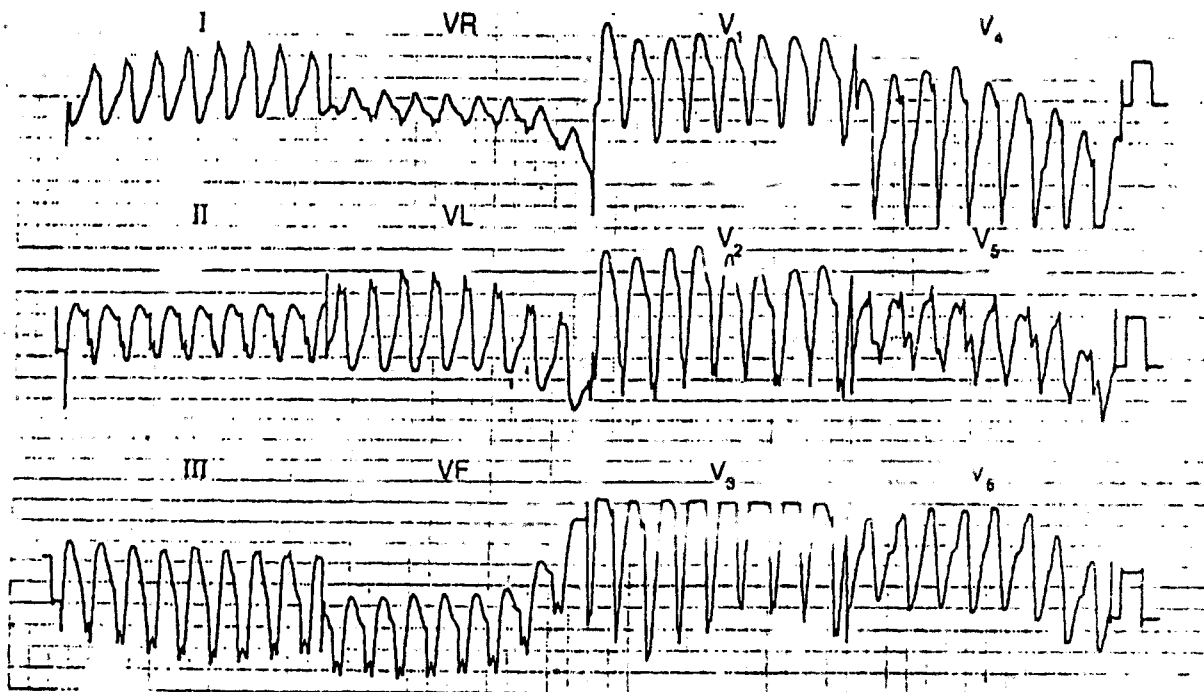
- 18) This ECG was recorded as a part of the routine pre-operative assessment of a 65 years old man who had no cardiovascular symptoms, and whose heart was clinically normal. What does it show? Is any action necessary? *Comment on QRS.*



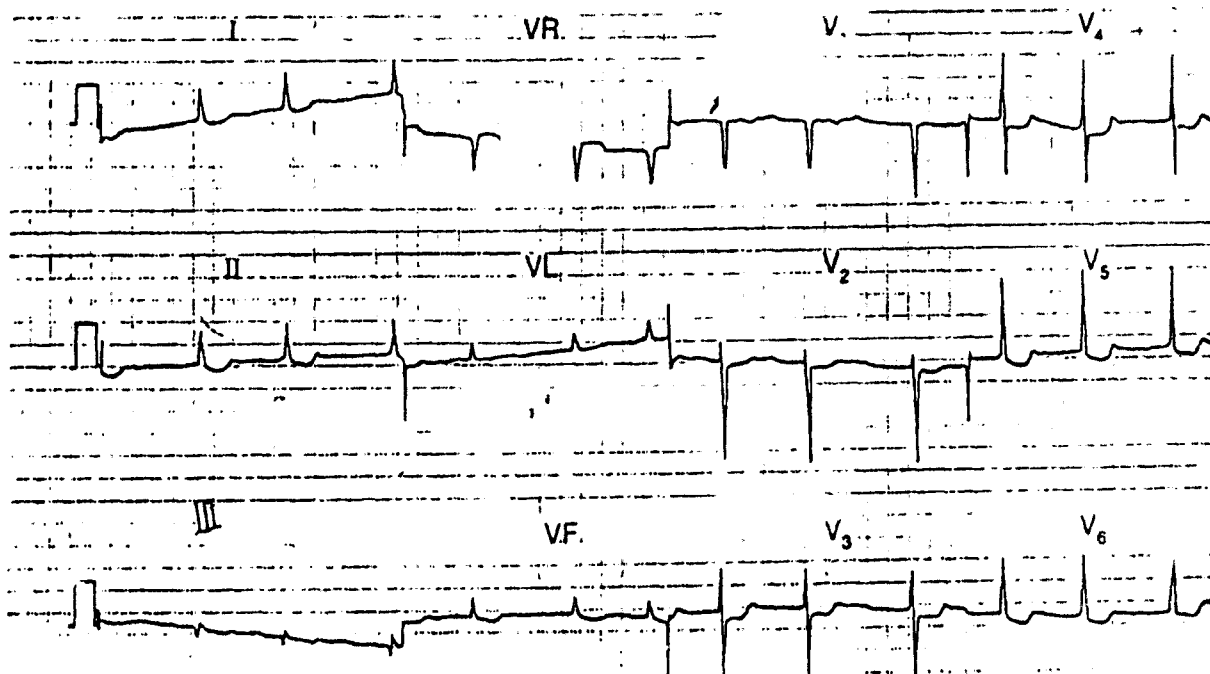
- 19) A 60-year-old man who complains of ankle swelling is found to have a regular pulse, a blood pressure of 115/70, an enlarged heart, and signs of congestive cardiac failure. This is his ECG. What does it show? He is untreated so how would you manage him? *Comment on rate and rhythm.*



- 20) An 85-year-old man is seen in the Out-patient Department complaining of typical angina and of occasional dizziness when walking up hills. This was his ECG. What is the diagnosis and what would you do? *Comment on QRS-(Chamber enlargement).*



- 21) A 60-year-old man had complained of occasional episodes of palpitations for several years. Between attacks he was well, there were no physical abnormalities, and his ECG was normal. Eventually this ECG was recorded during one of his attacks. What is the arrhythmia and what would you do? *Comment Rate & Rhythm.*



- 22) This ECG was recorded from a 60-year-old woman with rheumatic heart disease. She had been in heart failure, but this had been treated and she was no longer breathless. What does the ECG show and what question might you ask her? *Comment on rate & rhythm.*

Answers

1) The ECG shows:

- Sinus rhythm.
- Peaked P wave, best seen in lead II.
- Right axis deviation.
- Domination R waves in lead V1.
- Deep S waves in lead V6.
- Inverted T waves in leads II, III, VF, V1-V3.
- Diagnosis: right ventricular hypertrophy.

2) The ECG shows:

- Sinus rhythm
- Atrial extra systole identified by early beats with broad and abnormal P waves (best seen in V2 and V3).
- Extra systole is followed by a compensatory pause.
- Normal axis.
- There is an RSR pattern in lead III, but the QRS complex is narrow.
- The ST segment and T waves are normal.
- Diagnosis: sinus rhythm+ atrial extra systole.

3) The ECG shows:

- Sinus rhythm.
- Normal axis.
- Small Q waves in lead III but not elsewhere.
- Elevated ST segment in leads II, III, VF with upright T waves.
- T wave inversion in lead VL.
- Suggestion of ST segment depression in leads V2-V3.
- Diagnosis: recent inferior wall infarction.

4) The ECG shows:

- Sinus rhythm.
- Prolonged PR intervals, of 280 ms (best seen in V1, V2).
- Normal axis.
- Normal QRS complex.
- Normal ST segments and T waves.
- Diagnosis: sinus rhythm +1st degree heart block.

5) The ECG shows:

- Sinus rhythm.
- Wide QRS, -ve QRS V1 - V2, notched complex in V5, V6.
- Diagnosis: LBBB.

6) The ECG shows:

- Atrial fibrillation.
- Ventricular rate 75-200 per min.
- Normal axis.
- Normal QRS.
- Down sloping ST segment depression, especially in V5 and V6 leads.
- Diagnosis: AF + digitalis effect.

7) The ECG shows:

- Sinus rhythm.
- Normal axis.
- Q waves in leads II, III, VF
- Normal QRS complexes in the anterior leads.
- Marked ST segment elevation in leads V1-V6.
- Diagnosis: old inf. Infarction+ recent anterior wall.

8) The ECG shows:

- Sinus rhythm.
- Normal axis.
- Broad QRS complexes (duration 140ms).
- RSR pattern in lead I.
- Wide and slurred S waves in lead V5.
- Normal ST segment and T waves.
- Diagnosis: sinus rhythm + BBB.

9) The ECG shows:

- Broad-complex tachycardia, rate about 250 per min.
- Regular QRS complexes.
- QRS duration 200 ms.
- Indeterminate axis and QRS configurations.
- Diagnosis: ventricular tachycardia.

10) The ECG shows:

- Sinus rhythm.
- Left axis deviation.
- Q waves in leads II, III, and VF.
- Elevated ST segments in leads II, III, VF with biphasic T waves.
- Down sloping ST segments in lead VL.
- Normal QRS complexes, ST segment and T waves in the chest leads.
- Diagnosis: recent inf. wall infarction.

11) The ECG shows:

- Sinus rhythm.
- Normal axis.
- Normal QRS.
- Marked (about 8mm) horizontal ST segment depression in leads V2-V4 and down sloping ST segment depression in the lateral leads.
- Diagnosis: severe antero-lateral ischemia.

12) The ECG shows:

- Sinus rhythm.
- Normal axis.
- Tall R waves (28 mm in lead V6, 32mm in lead V5).
- Loss of R waves in lead V3.
- Normal ST segments and T waves.
- Diagnosis: left ventricular hypertrophy

13) The ECG shows:

- Sinus rhythm, heart rate 110 per minute.
- Normal axis.
- Small Q waves in lead III.
- Otherwise, normal QRS complexes and T waves.
- Diagnosis: sinus tachycardia.

14) The ECG shows:

- Atrial flutter.
- 4:1 block.
- Normal axis.
- Normal QRS complexes.
- Sloping ST segment depression, best seen in leads V5, V6.
- Diagnosis: A. flutter.

15) The ECG shows:

- Broad-complex tachycardia, rate 170 per minute.
- No clear P waves but possibly some P waves visible in lead VR.
- Normal axis.
- Right bundle branch block pattern.
- Horizontal ST Segment depression in V4, V5.
- Diagnosis: supraventricular tachycardia+ right BBB.

16) The ECQ shows:

- Sinus rhythm, rate 55 per minute.
- First degree block (PR interval 350 ms).
- Normal axis.
- Small Q waves in leads II, III, VF.
- Raised ST segments in leads II, III, VF.
- Depressed ST segments and inverted T waves in leads I, VL
- Slight ST Segment depression in the chest leads.
- Diagnosis: recent inferior wall infarction + 1st degree heart block.

17) The ECQ shows:

- Sinus rhythm with ventricular extra systole.
- Normal axis.
- Q waves in leads V3-V5.
- Raised ST segment in leads I, VL, V1, and V6.
- Depressed ST segment in leads III, VF.
- Diagnosis: recent antero lateral infarction+ ventricular extra systole.

18) The ECQ shows:

- Sinus rhythm.
- 1st degree heart block.
- Normal axis.
- Right BBB.
- Diagnosis: sinus rhythm + 1st degree heart block + Rt. BBB.

19) The ECQ shows:

- Atrial flutter with 4: 1 block.
- Normal axis.
- Slight QRS widening.
- T waves are difficult to identify but at least in VL are inverted.
- Diagnosis: atrial flutter.

20) The ECQ shows:

- Sinus rhythm.
- Normal axis.
- Tall R waves and deep S waves in the chest leads.
- Inverted T waves in leads I, II, VL, V3-V6.
- Diagnosis: left ventricular hypertrophy with strain pattern.

16) The ECQ shows:

- Sinus rhythm, rate 55 per minute.
- First degree block (PR interval 350 ms).
- Normal axis.
- Small Q waves in leads II, III, VF.
- Raised ST segments in leads II, III, VF.
- Depressed ST segments and inverted T waves in leads I, VL
- Slight ST Segment depression in the chest leads.
- Diagnosis: recent inferior wall infarction + 1st degree heart block.

17) The ECQ shows:

- Sinus rhythm with ventricular extra systole.
- Normal axis.
- Q waves in leads V3-V5.
- Raised ST segment in leads I, VL, V1, and V6.
- Depressed ST segment in leads III, VF.
- Diagnosis: recent antero lateral infarction+ ventricular extra systole.

18) The ECQ shows:

- Sinus rhythm.
- 1st degree heart block.
- Normal axis.
- Right BBB.
- Diagnosis: sinus rhythm + 1st degree heart block + Rt. BBB.

19) The ECQ shows:

- Atrial flutter with 4: 1 block.
- Normal axis.
- Slight QRS widening.
- T waves are difficult to identify but at least in VL are inverted.
- Diagnosis: atrial flutter.

20) The ECQ shows:

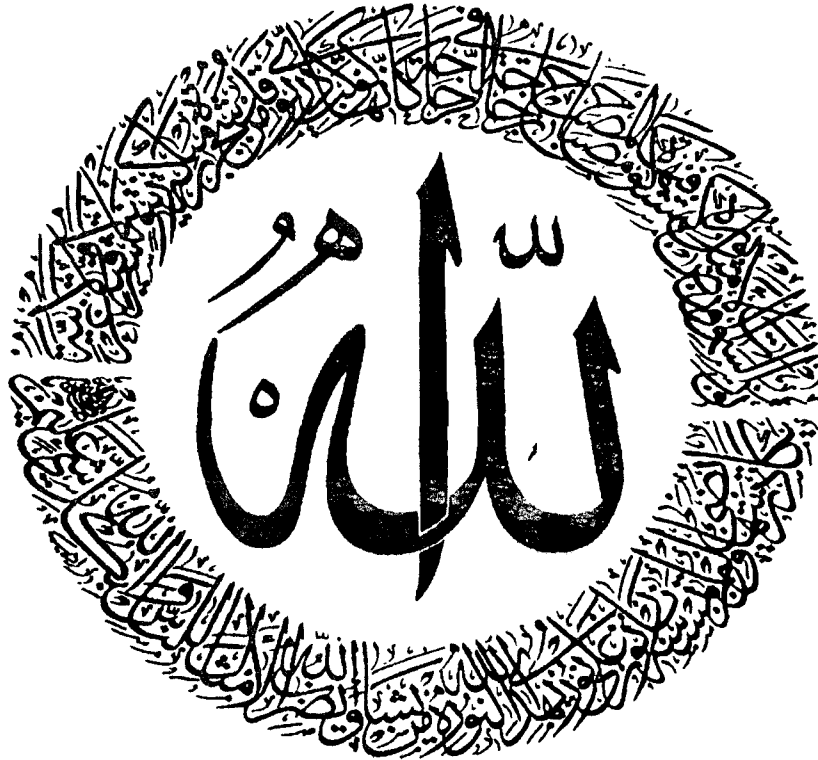
- Sinus rhythm.
- Normal axis.
- Tall R waves and deep S waves in the chest leads.
- Inverted T waves in leads I, II, VL, V3-V6.
- Diagnosis: left ventricular hypertrophy with strain pattern.

21) The ECQ shows:

- Regular broad complex tachycardia.
- QRS complex duration of 160 ms.
- Left axis deviation indeterminate QRS complex configuration, but the complex point downwards in all the chest leads, with QS pattern in lead V6.
- Diagnosis: ventricular tachycardia.

22) The ECQ shows:

- Atrial fibrillation with a ventricular rate of 60-65 per min.
- Normal axis.
- Normal QRS complex.
- Prominent U wave in lead V2.
- Down sloping ST Segments, best seen in leads V5-V6.
- Diagnosis: AF + digitalis effect.



. Ramzy

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dr_ahmed_ramzy@yahoo.com

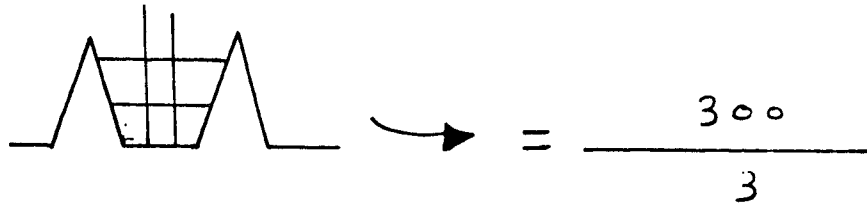
لا تنسونا من صالح دعائكم

① RATE

⊙ normal → 60-90 ⊙ bradycardia → < 60 ⊙ tachycardia → > 100

*** if regular rhythm**

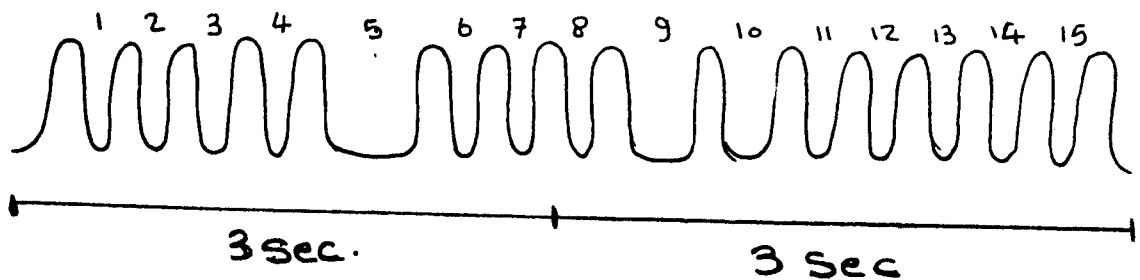
$$\odot \text{HR} = \frac{300}{\text{عدد المرات الكبيرة بين 2 Complex}}$$



Summary of ECG

*** if irregular rhythm :- e.g AF**

$$\odot \text{HR} = \text{No. of cardiac cycles in 6 sec.} \times 10$$



→ 15 × 10

② RHYTHM

*** Regular :-**

المسافات بينه QRS متساوية

١- أول حاجة تعرف مينه focus (pacemaker) :-

① SAN (sinus)

P+ve
II

avR
P-ve

أنظر إلى (II, avR)

|| → > 100 → Sinus Tachycardia
 • Reg. • Rapid • normal shape complexes
 || → < 60 → Sinus bradycardia

② Not Sinus

Ⓐ Paroxysmal Atrial Tachy.

• Reg. • Rapid • normal shaped complexes
 • p wave not clear

Ⓑ Paroxysmal ventricular Tachy.

• Reg. • Rapid • abnormal QRS Bizarre

* Irregular

المسافات بين QRS غير متساوية

① Extrasystole = premature complex (مماية بدري عن ميغادها)

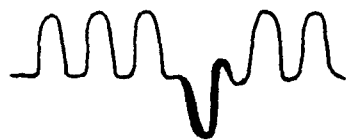
→ Normal shape



(يعني شبه إلى قبلها وإلى بعده)

Atrial ES

→ Abnormal shape



(يعني شكلها غريب عن الباقي)

Ventricular E.S

② AF

(+ absent p)



③ P-WAVE

II, III, V₁ أنظر إلى

① P pulmonale (peaked) → R.A. ++



② P mitrale (notched) → L.A. ++



(N.B.) • sometimes pulmonale in certain leads & Mitrale in others → Bilateral ++

③ Biphasic P in V₁ (حيث الجزء -ve < الجزء +ve)



* N.B. → Absent P + irregular Rhythm
↙ AF

④ P R INTERVAL

(المسافة بين بداية P إلى بداية complex)

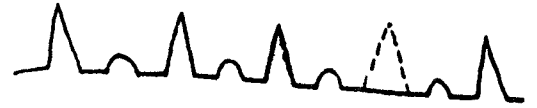
I] 1st degree H.T block :-



(prolonged + fixed)
عمرات أكبر من مربع كبير

II] 2nd degree H.T block (Mobitz I, II)

→ Mobitz I



• progressive prolongation of P-R + dropped complex

→ Mobitz II



(ratio equal)

III] 3rd degree H.T block. → A.V dissociation

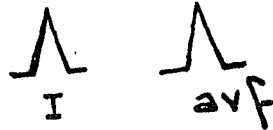
ع $V < P$

5 QRS COMPLEX

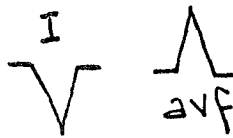
Axis deviation

انظر الى I, aVF

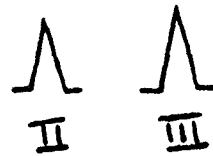
• normal →



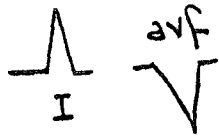
• Right axis deviation →



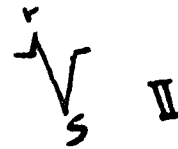
OR



• Left axis deviation →



OR




Voltage

انظر الى V_1, V_6 ← vent. ++

• Left vent. ++

(1) $S_{V_1} + R_{V_6} > 35 \text{ mm}$

(2) $R \text{ in } aVL > 13 \text{ mm}$

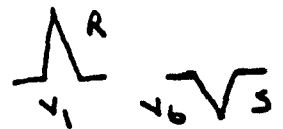
(2) Left AD → V_1, V_5 

• Right vent. ++

(1) $R_{V_1} > 1 \text{ big space}$

(2) Rt. A.D

(2) Deep S in V_6



B.B.B

1. Left B.B.B →

\checkmark
QS in V_1

$\Lambda \Lambda$
 $V_5 + V_6$

+ inverted T wave

2. Right B.B.B →

\checkmark
S Λ V_1
R

* pathological Q → QS fix

= Deep + wide i.e. $>$ مربع صغير
↳ if +ve = old Transmural infarction

* R wave progression *

• if poor = Ischemia OR Lt. vent. hypertrophy
OR emphysema

N.B →

QRS ?

① Axis deviation

② voltage

③ B.B.B

④ Q wave

⑤ R wave

*** N.B**

- if amplitude of QRS in Limb leads
(I, II, III, aVR, aVL, aVF)

منخفض

Low voltage

- pericardial effusion
- obesity
- Emphysema
- hypothyroidism

⑥ ST SEGMENT



Iso . electric (normal)



Depressed



OR



Elevated

* Myocardial infarction *

Transmural	subendocardial
<ul style="list-style-type: none"> • elevated ST (recent) • inverted T ^{2ws} • path. Q (old) • Path. Q, recent, old 	<ul style="list-style-type: none"> • inverted T + • Depressed S.T • Path. Q, recent, old

N.B Localization inf.

inf. wall
• II, III, avf

ant. wall
if changes in
• I, aVL, V₁ → V₆

⑦ T-WAVE

* Strain → inverted T on top of
Rt or Lt vent. ++

* Flat or Inverted → -hypokalemia
-Ischemia (angina)

* hyperacute → -Recent transmural infarction
-hyperkalemia



⑧ U-WAVE

* +ve wave after T in hypokalemia



FINALLY.....

I MUST TO THANK MY DEAR FRIEND:

AHMED ESMAEL

FOR THIER GREAT EFFORT IN THIS NOTE.
WITH MY BEST WISHES,

AHMED RAMZY

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