P wave

Wide P wave:

- Left atrial hypertrophy or enlargement

Tall P wave:

- Right atrial hypertrophy or enlargement

Small P wave :

- High nodal rhythm
- High nodal ectopic
- Atrial tachycardia
- Atrial ectopics

Inverted P wave:

- Nodal rhythm with retrograde conduction
- Low atrial and high nodal ectopic beats
- Dextrocardia

Variable P wave morphology:

- Wandering pacemaker

Multiple P waves:

- Third degree heart block
- Atrial flutter (saw teeth)

Absent P wave:

1. Atrial fibrillation
2. Atrial flutter
3. Mid nodal rhythm
4. Ventricular ectopic
5. Ventricular tachycardia
6. Supraventricular tachycardia
7. Idoventricular rhythm
8. Hyperkalemia

T wave

Tall T wave :

1. Hyperkalemia
2. Acute MI
3. Acute true posterior MI (in V1 and V2)

Small T wave :

1. Hypokalemia
2. Hypothyroidism
3. Pericardial effusion

T inversion :

1. MI
2. Myocardial ischemia
3. Subendocardial MI
4. Ventricular ectopic
5. Ventricular hypertrophy with strain
6. Acute pericarditis

QT interval

Short QT interval:

1. Tachycardia
2. Hyperthermia
3. Hypercalcemia
4. Digoxin effect
5. Vagal stimulation

Long QT interval:

1. Bradycardia
2. Hypocalcemia
3. Acute MI
4. Acute myocarditis
5. Cerebrovascular accident
6. Hypertrophic cardiomyopathy
7. Hypothermia
8. Hereditary syndrome
   a. Jervell, Lange-Nielsen syndrome
      (congenital deafness, syncope and sudden death)
   b. Romano-Ward syndrome
      (syncope and sudden death)

R wave

Tall R wave in V1:

1. Right ventricular hypertrophy
2. True posterior MI
3. WPW syndrome
4. RBBB
5. Dextrocardia

Small R wave:

1. Improper ECG standardization
2. Obesity
3. Emphysema
4. Pericardial effusion
5. Hypothyroidism
6. Hypothermia

Poor progression of R wave:

1. Anterior or anteroseptal MI
2. LBBB
3. Dextrocardia
4. Left sided massive pleural effusion
5. COPD
6. Left sided pneumothorax
7. Marked clockwise rotation of heart

QRS Complex

High voltage QRS:

- Improper standardization
- Thin chest wall
- Ventricular hypertrophy
- WPW syndrome

Low voltage QRS

(less than 5 mm in leads I, II, III and <10 mm in chest leads):

1. Improper standardization
2. Obesity or thick chest wall
3. Pericardial effusion
4. Emphysema
5. Chronic constrictive pericarditis
6. Hypothyroidism
7. Hypothermia

Wide QRS:

1. LBBB and RBBB
2. Ventricular ectopic
3. Ventricular tachycardia
4. Idioventricular rhythm
5. WPW syndrome
6. Hyperkalemia

Change in shape of QRS:

1. RBBB
2. LBBB
3. Ventricular tachycardia
4. Ventricular fibrillation
5. WPW syndrome

Variable QRS:

1. Torsades de pointes
2. Multifocal ventricular ectopics
3. Ventricular fibrillation

U wave

Prominent U wave:

1. Normally present
2. Hypokalemia
3. Bradycardia
4. Ventricular hypertrophy
5. Hypercalcemia
6. Hyperthyroidism

+ digitalis toxicity

ST segment

ST elevation:

1. Acute myocardial infarction
2. Acute pericarditis
3. Prinzmetal's angina (Non-infarction transmural ischemia)
4. Normal variant (Early repolarization pattern)
5. Ventricular aneurysm

ST depression:

1. Acute MI
2. Angina pectoris
3. Ventricular hypertrophy with strain
4. Acute true posterior MI (in V1 and V2)
5. Digoxin toxicity

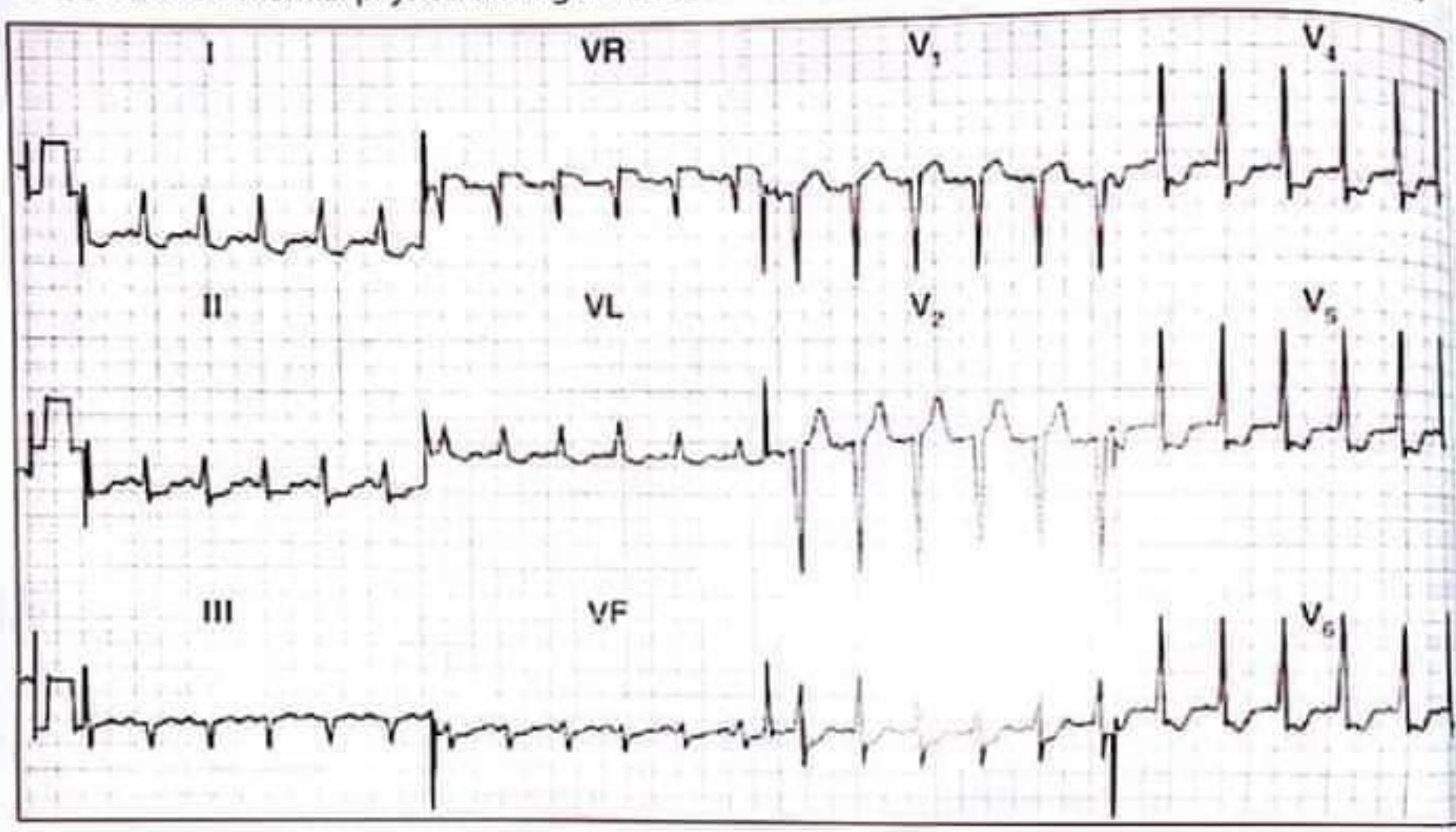
Q wave

Pathological Q wave:

1. MI
2. Left ventricular hypertrophy (in V1, V2 and V3)
3. LBBB
4. Pulmonary embolism (only in lead III)
5. WPW syndrome (in lead III and aVF)

Ex : 10

This ECG was recorded in the A & E department from a 55-year-old man who had had chest pain at rest for 6 h.
There were no abnormal physical findings. What does the trace show, and how would you manage him?



Comment

- **Rhythm :** regular
- **Rate :** about 150 bpm
- **Axis :** left
- **P wave :** normal
- **QRS complex :** regular
- **ST segment :** depressed ST in leads LI , aVL , V3,4,5,6.
- **T wave :** normal

Diagnosis :

Antero-lateral Ischemia.

Clinical interpretation

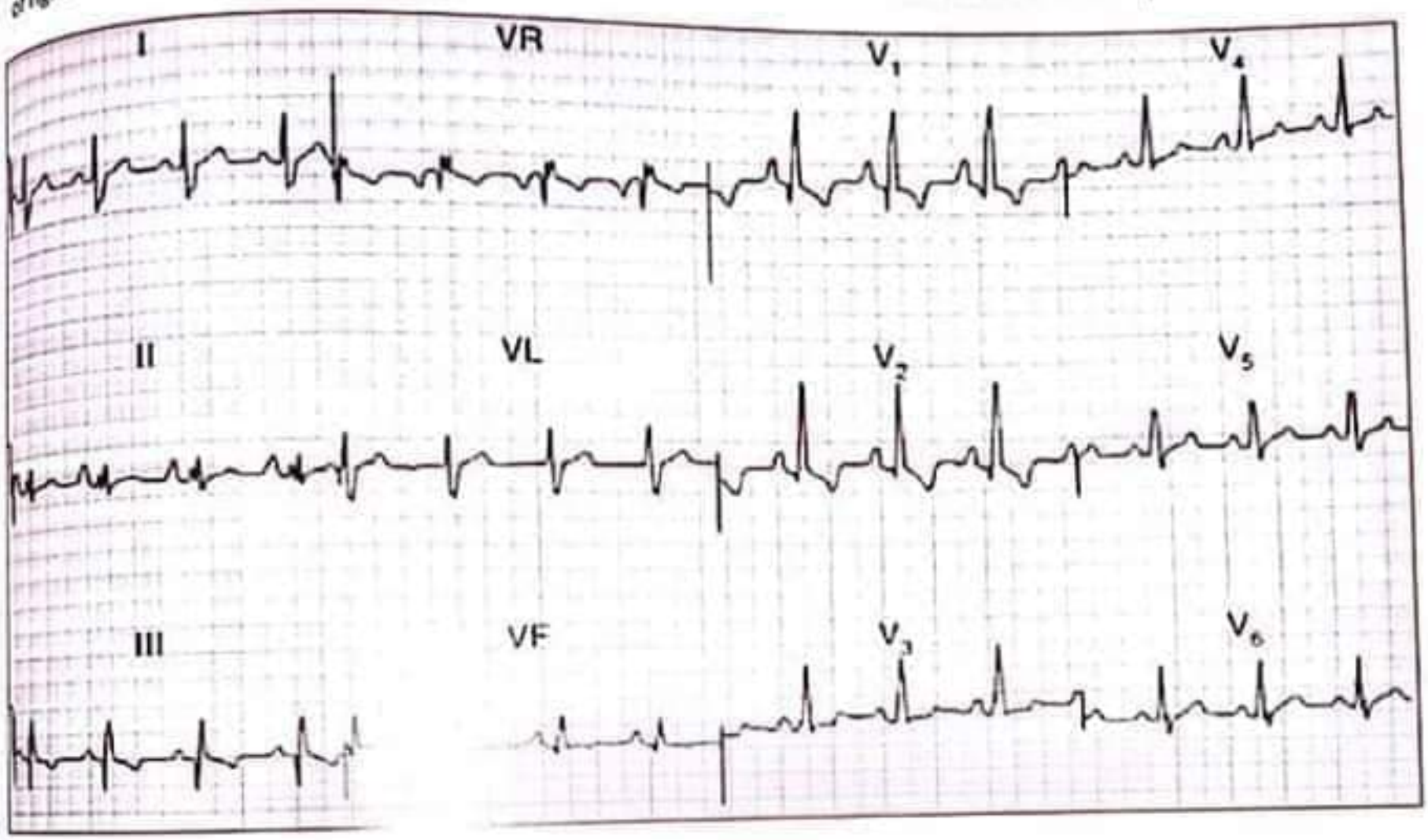
This ECG shows anterior and lateral ischaemia without evidence of infarction.
Taken with the clinical history, the diagnosis is clearly 'unstable' angina.

What to do ?

- There is no evidence of any benefit from thrombolysis.
- The patient should be given aspirin and intravenous heparin and nitrates.
- At the time the record was taken, he had a sinus tachycardia (at a rate of about 130/min) . and if this does not settle quickly, intravenous beta-blockers help.

Ex : 7

This ECG was recorded from a 17-year-old girl who was breathless, had marked ankle swelling with signs of right heart failure, and who had been known to have a heart murmur since birth. She was acyanotic.



Comment

- **Rhythm :** regular
- **Rate :** about 85 bpm
- **Axis :** normal.
- **P wave :** peaked P best seen in LII and V1
- **P-R interval :** normal
- **QRS complex :** Dominant R wave in lead VI,2
- **ST segment :** normal
- **T wave :** normal

Diagnosis :

Right atrial and right ventricular hypertrophy

Clinical interpretation

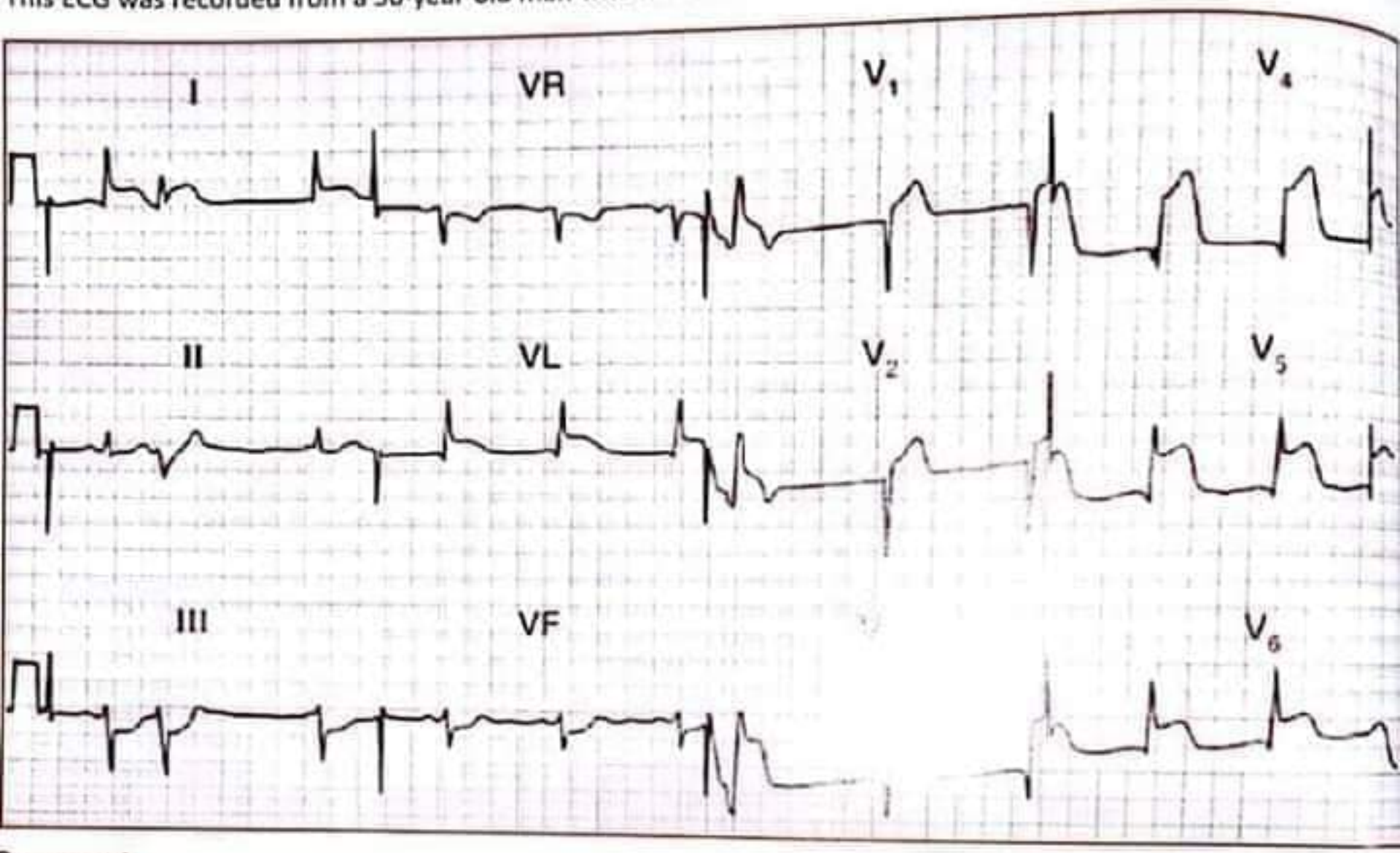
The ECG shows right atrial and right ventricular hypertrophy.

What to do ?

- Right atrial hypertrophy is seen with pulmonary hypertension of any cause, tricuspid stenosis, and Ebstein's anomaly.
- Right ventricular hypertrophy is seen with pulmonary stenosis and pulmonary hypertension.
- These conditions can all be diagnosed by echocardiography.
- This patient had Ebstein's anomaly and an atrial septal defect.

Ex : 8

This ECG was recorded from a 50-year-old man who had had severe chest pain for 1 h.



Comment

- **Rhythm :** irregular
- **Rate :** about ..... bpm
- **Axis :** left.
- **P wave :** normal
- **P-R interval :** normal
- **QRS complex :** Q waves in leads V3 : V5 with occasion irregular QRS (extrasystole)
- **ST segment :** Raised ST segments in LI, VL, V3 : V6
  Depressed ST in leads III, VF
- **T wave :** normal

Diagnosis :

Acute anterolateral myocardial infarction with ventricular extrasystoles.

Clinical interpretation

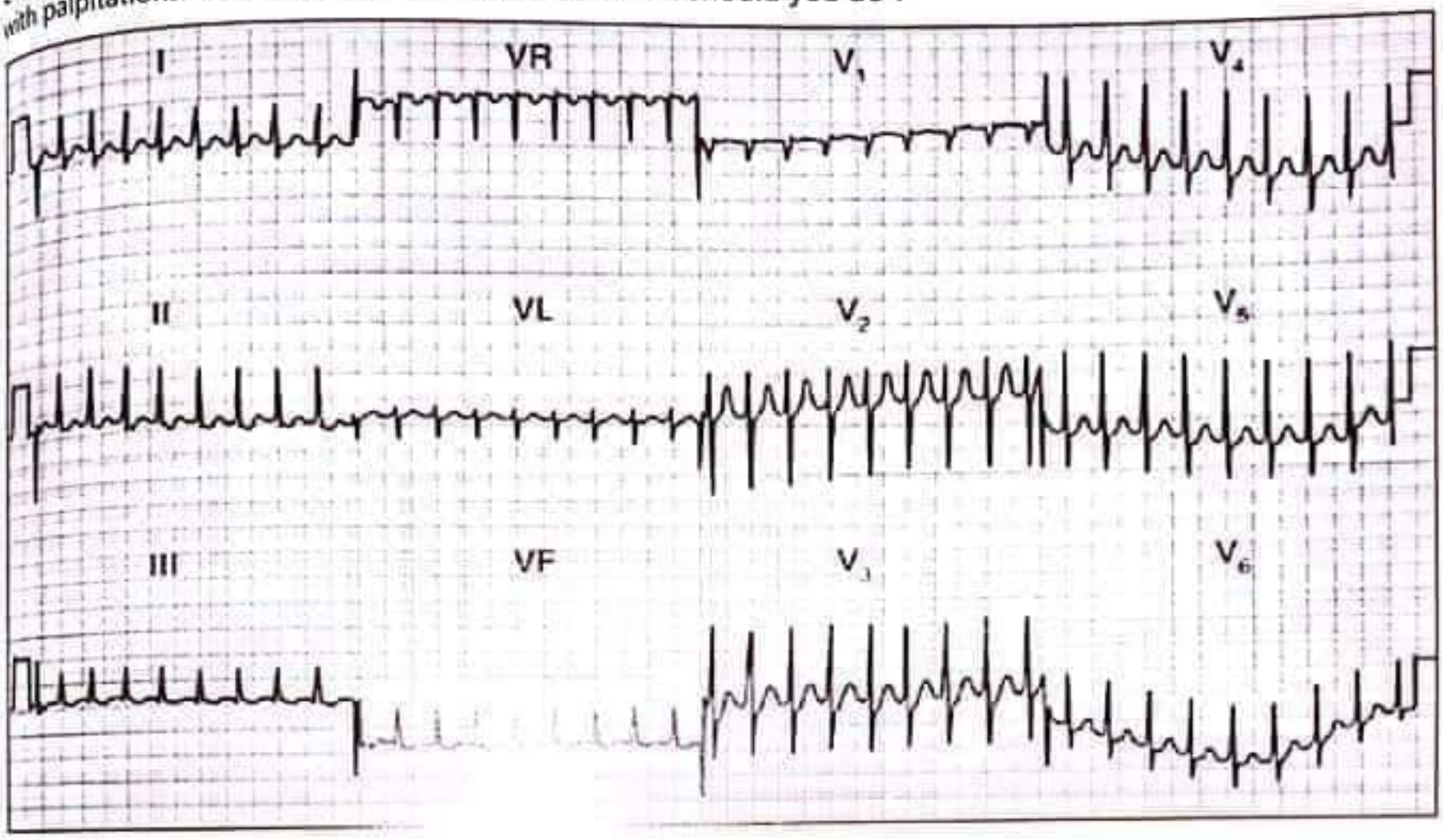
Ventricular extrasystoles associated with an acute anterolateral myocardial infarction and associated inferior ischemia

What to do ?

- The patient should be given diamorphine and aspirin immediately, and thrombolysis as soon as possible.
- The extrasystoles should not be treated.

Ex : 9

26-year-old woman, who has complained of palpitations in the past, is admitted via the A & E department^ with palpitations. What does the ECG show and what should you do ?



Comment

- **Rhythm : regular**
- **Rate : about 200 bpm**
- **Axis : normal.**
- **P wave : not visible**
- **QRS complex : regular**
- **ST segment and T wave : normal**

Diagnosis :

Supraventricular (nodal) tachycardia.

Clinical interpretation

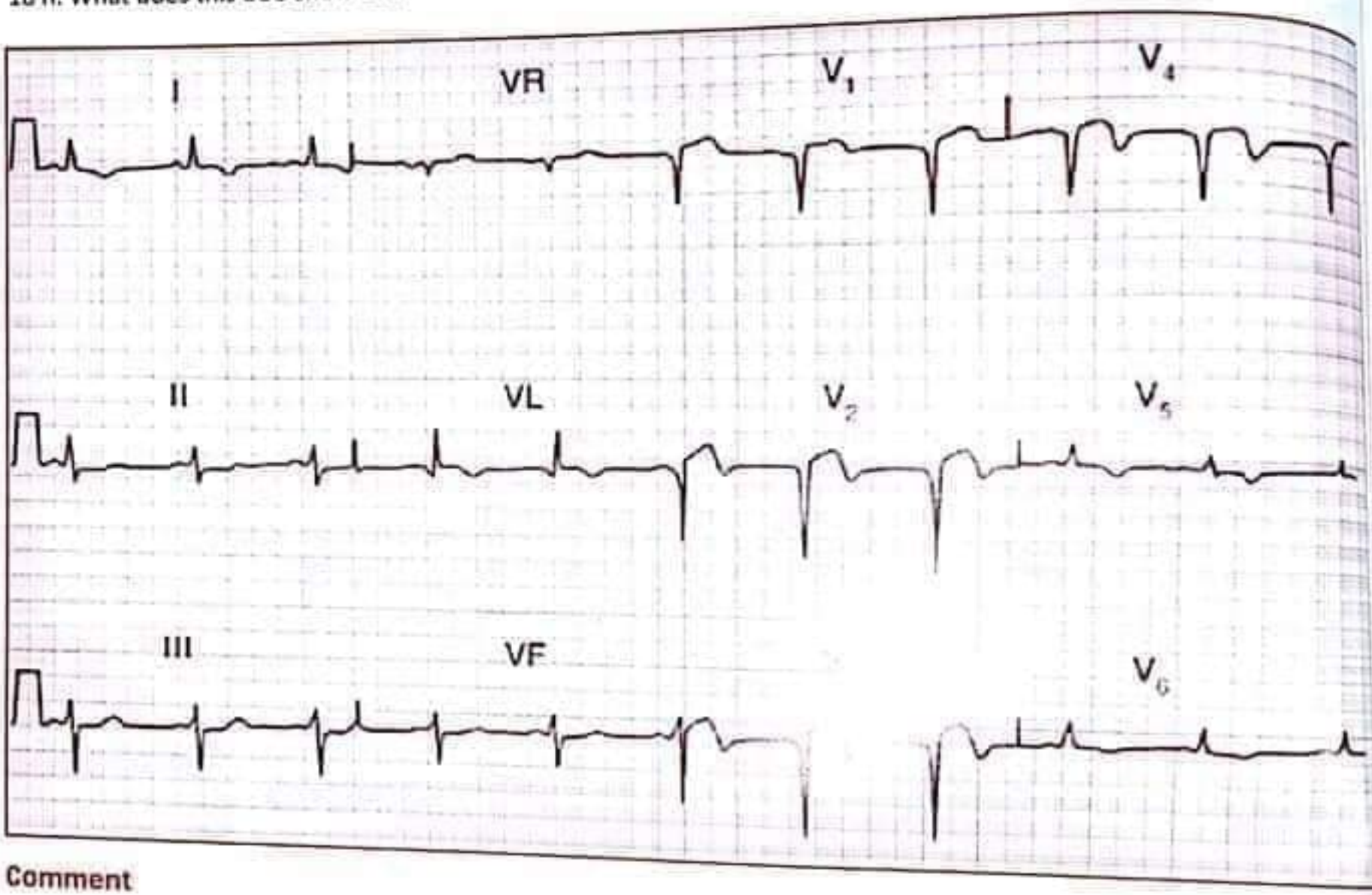
This is a supraventricular tachycardia, and since no P waves are visible this is a junctional, or atrioventricular nodal, tachycardia.

What to do ?

- Junctional tachycardia is the commonest form of paroxysmal tachycardia in young people, and presumably explains her previous episodes of palpitations.
- Attacks of junctional tachycardia may be terminated by any of the manoeuvres that lead to vagal stimulation - Valsalva's manoeuvre, carotid sinus pressure, or immersion of the face in cold water.
- If these are unsuccessful, intravenous adenosine should be given by bolus injection.
- Adenosine has a very short half-life, but can cause flushing and occasionally asthma.
- If adenosine proves unsuccessful, verapamil 5-10 mg given by bolus injection will usually restore sinus rhythm. Otherwise, DC cardioversion is indicated.

Ex : 4

A 50-year-old man is seen in the A & E department with severe central chest pain which has been present for 18 h. What does this ECG show and what would you do?



Comment

- **Rhythm :** regular
- **Rate :** about 65 bpm
- **Axis :** left.
- **P wave :** normal
- **P-R interval :** normal
- **QRS complex :** pathological Q in leads V2 to V4
- **ST segment :** elevated in leads V2 : V4
- **T wave :** inverted in LI , aVL , V2 : V6

Diagnosis :

classical anterior wall MI

Clinical interpretation

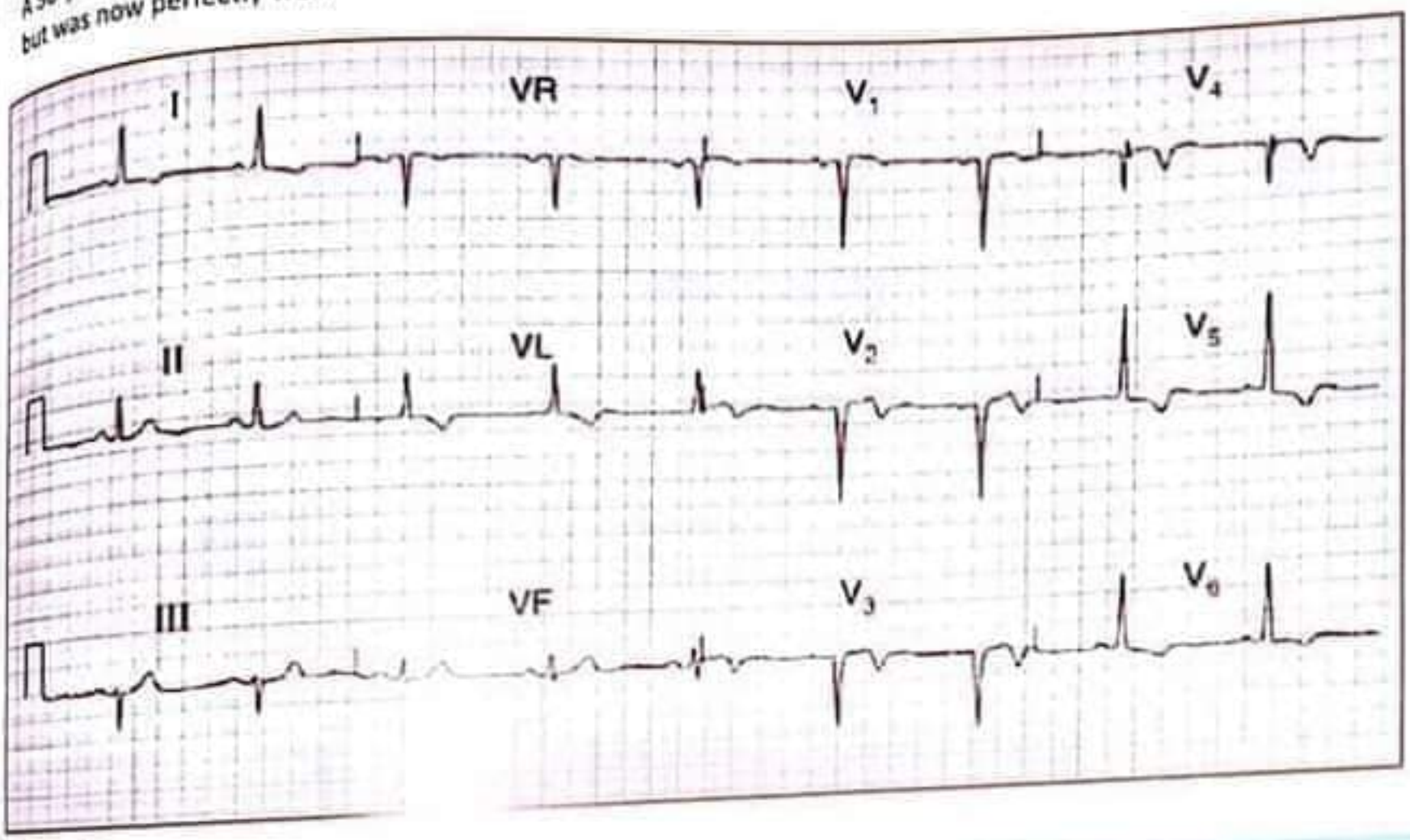
This is a classic acute anterior myocardial infarction.

What to do ?

- More than 18 h have elapsed since the onset of pain, so this patient is outside the conventional limit for thrombolysis.
- Nevertheless, if he is still in pain and still looks unwell, thrombolytic treatment should be given unless there are good reasons not to do so.
- In any case he should be given pain relief (opioids) and aspirin, and must be admitted to hospital for observation.

Ex : 5

A 50-year-old man returned from holiday in Spain saying that while there he had had some bad indigestion, but was now perfectly well.



Comment

- **Rhythm :** regular
- **Rate :** about 60 bpm
- **Axis :** normal.
- **P wave :** normal
- **P-R interval :** normal
- **QRS complex :** pathological Q in leads V2 to V4
- **ST segment :** Slightly elevated in leads V2 : V4
- **T wave :** inverted in LI , aVL , V2 : V6

Diagnosis :

Old anterior wall MI

with Lateral Ischemia

Clinical interpretation

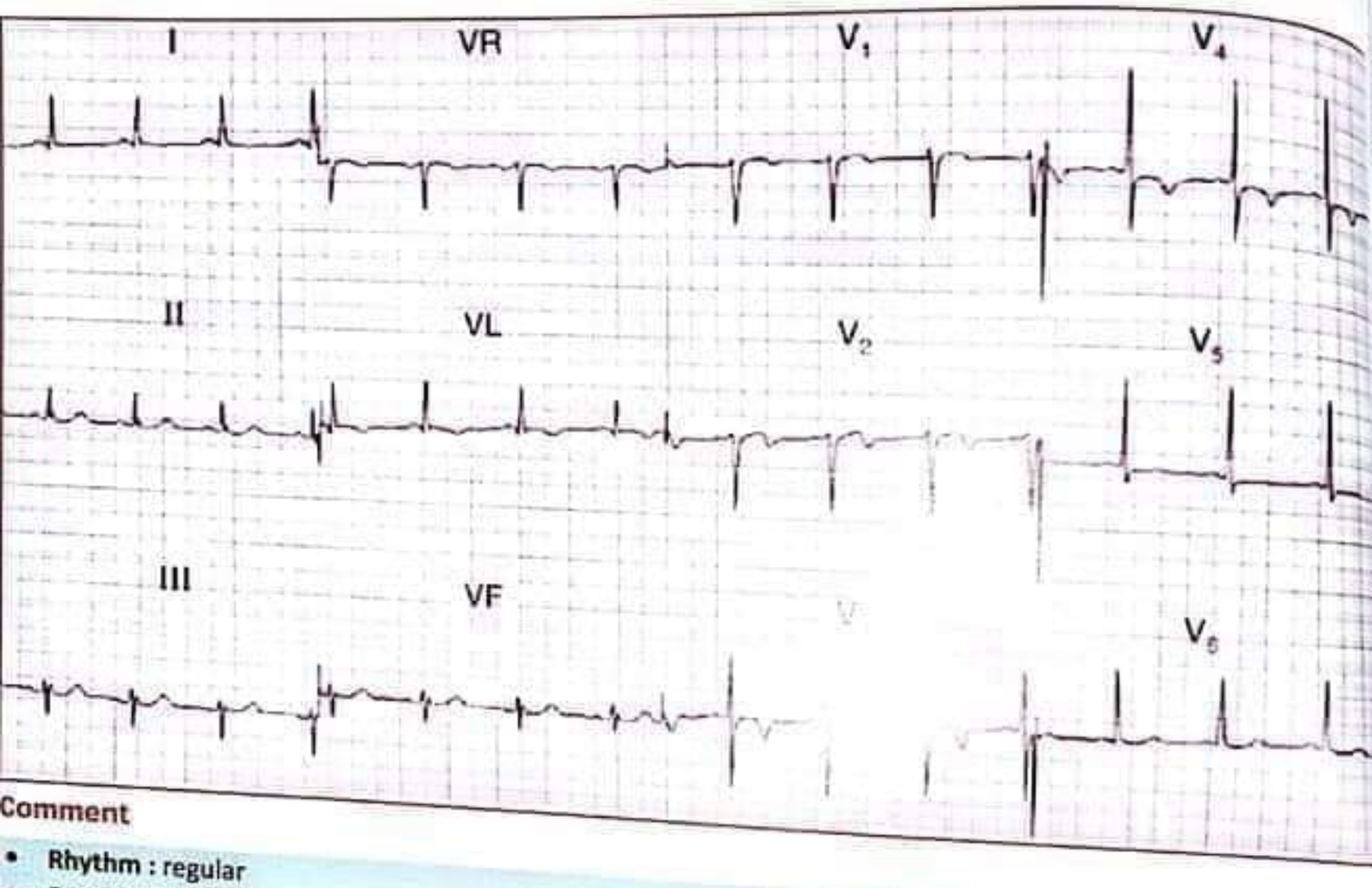
This ECG shows an old anterior myocardial infarction with lateral ischaemia. The slight elevation of ST segments might suggest an acute process if the pain was recent, but with this story the changes are almost certainly old.

What to do ?

- I assumme that the 'indigestion' was actually a myocardial infarction.
- Since he is now well, the important thing is to ensure that he takes the appropriate steps to prevent a further attack - he must stop smoking and reduce weight if necessary, and he should be treated with aspirin.
- a beta-blocker, an angiotensin-converting enzyme inhibitor and a statin.
- In view of his age it might be worth doing an exercise test to ensure that there is no evidence of ischaemia at a low workload.

Ex : 6

This ECG was recorded in the A & E department from a 60-year-old man who had had intermittent central chest pain for 24 h.



Comment

- **Rhythm :** regular
- **Rate :** about 85 bpm
- **Axis :** normal.
- **P wave :** normal
- **P-R interval :** normal
- **QRS complex :** normal
- **ST segment :** normal
- **T wave :** T wave inversion in leads LI, aVL, V2-V4

Diagnosis :

Anterior non Q wave MI

Clinical interpretation

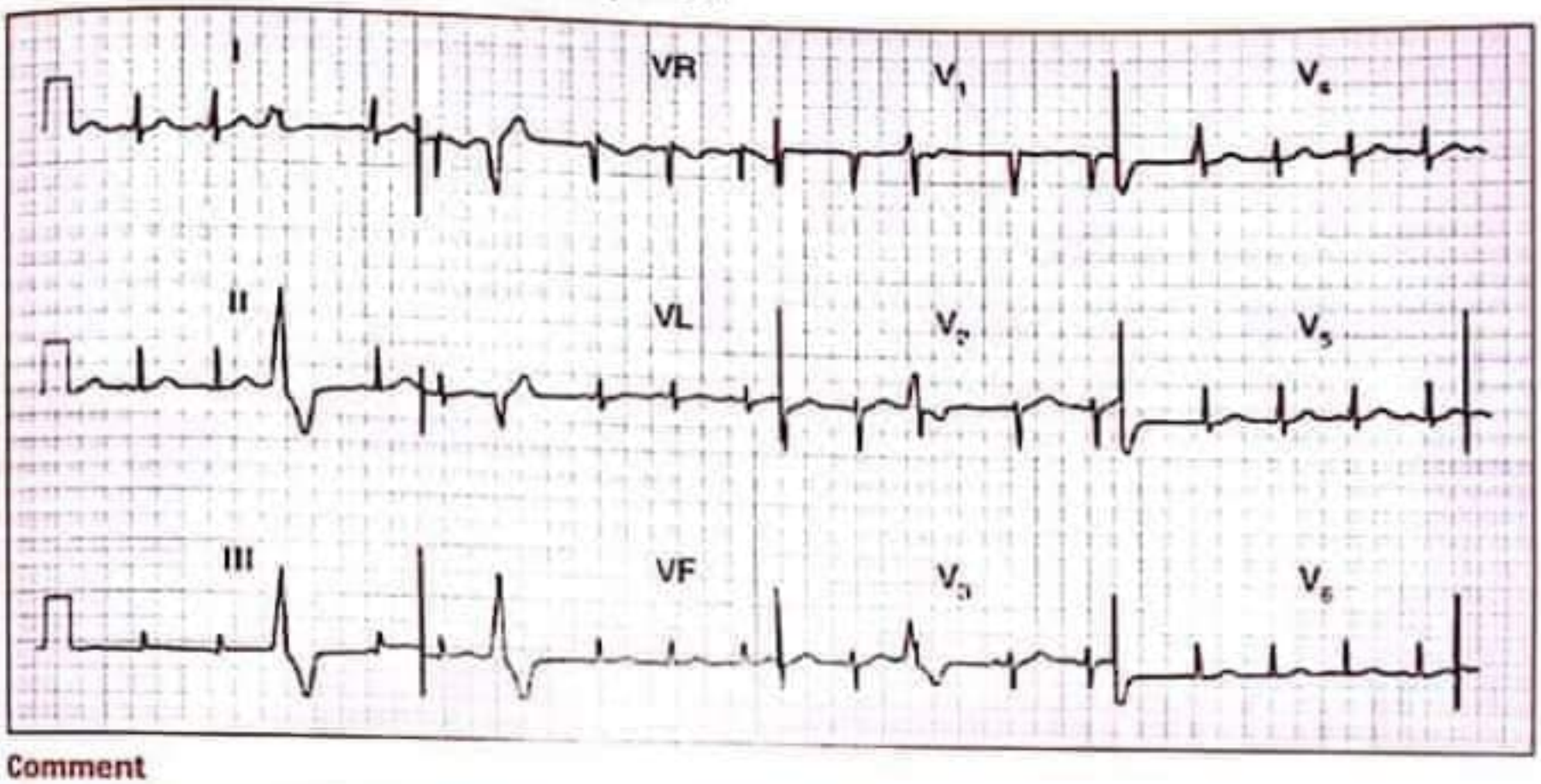
This ECG shows an anterior non-Q wave infarction of uncertain age.

What to do ?

- This patient clearly has an acute coronary syndrome.
- He must be admitted and treated with low-molecular-weight heparin, a nitrate and a beta-blocker.
- If the pain does not settle quickly , glycoprotein IIb/IIIa inhibitor such as abciximab should be considered as a prelude to early angiography and angioplasty.

Ex : 1

This ECG was recorded from a 25-year-old pregnant woman who complained of an irregular heart beat. Auscultation revealed a soft systolic murmur but her heart was otherwise normal. What does the ECG show and what would you do ?



Comment

- **Rhythm :** occasional irregularity.
- **Rate :** about 100 bpm
- **Axis :** normal
- **P wave :** normal
- **P-R interval :** normal
- **QRS complex :** normal with occasional large QRS
- **T wave & ST segment :** normal

Diagnosis :

Ventricular Extrasystole.

Clinical interpretation

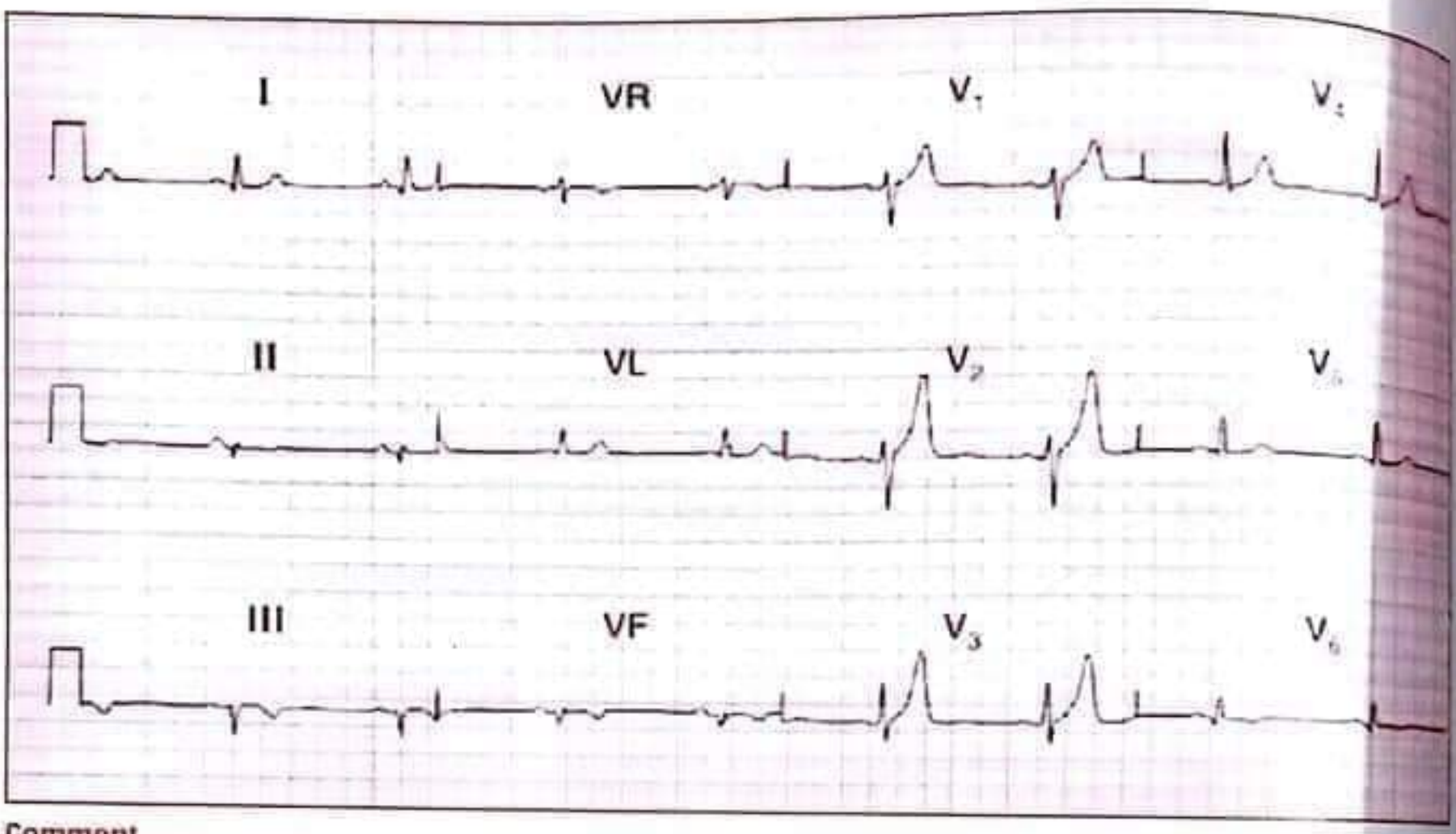
- The extrasystoles are fairly frequent but the ECG is otherwise normal.
- Ventricular extrasystoles are very common in pregnancy, and systolic murmurs are almost universal.
- Her heart is almost certainly normal.

What to do ?

- Remember that anaemia is a common cause of a systolic murmur.
- Doubts about the significance of the murmur can be resolved by echocardiography, but this need not be performed in every pregnant woman
- it is best reserved for the investigation of apparently important murmurs that persist after delivery.
- The patient should be reassured and the extrasystoles left untreated

Ex : 2

A 60-year-old man was seen as an out-patient, complaining of rather vague central chest pain on exertion. He had never had pain at rest.
What does this ECG show and what would you do next ?



Comment

- **Rhythm :** regular
- **Rate :** about 50 bpm
- **Axis :** left
- **P wave :** normal
- **P-R interval :** normal
- **QRS complex :** small Q waves in LII , LIII and aVF
- **ST segment :** normal
- **T wave :** Markedly peaked T waves in leads V1 to V5 ,
  Biphasic T waves in leads II, V6.
  inverted T waves in leads III, VF.

Diagnosis :

Old inferior myocardial ction.

Clinical interpretation

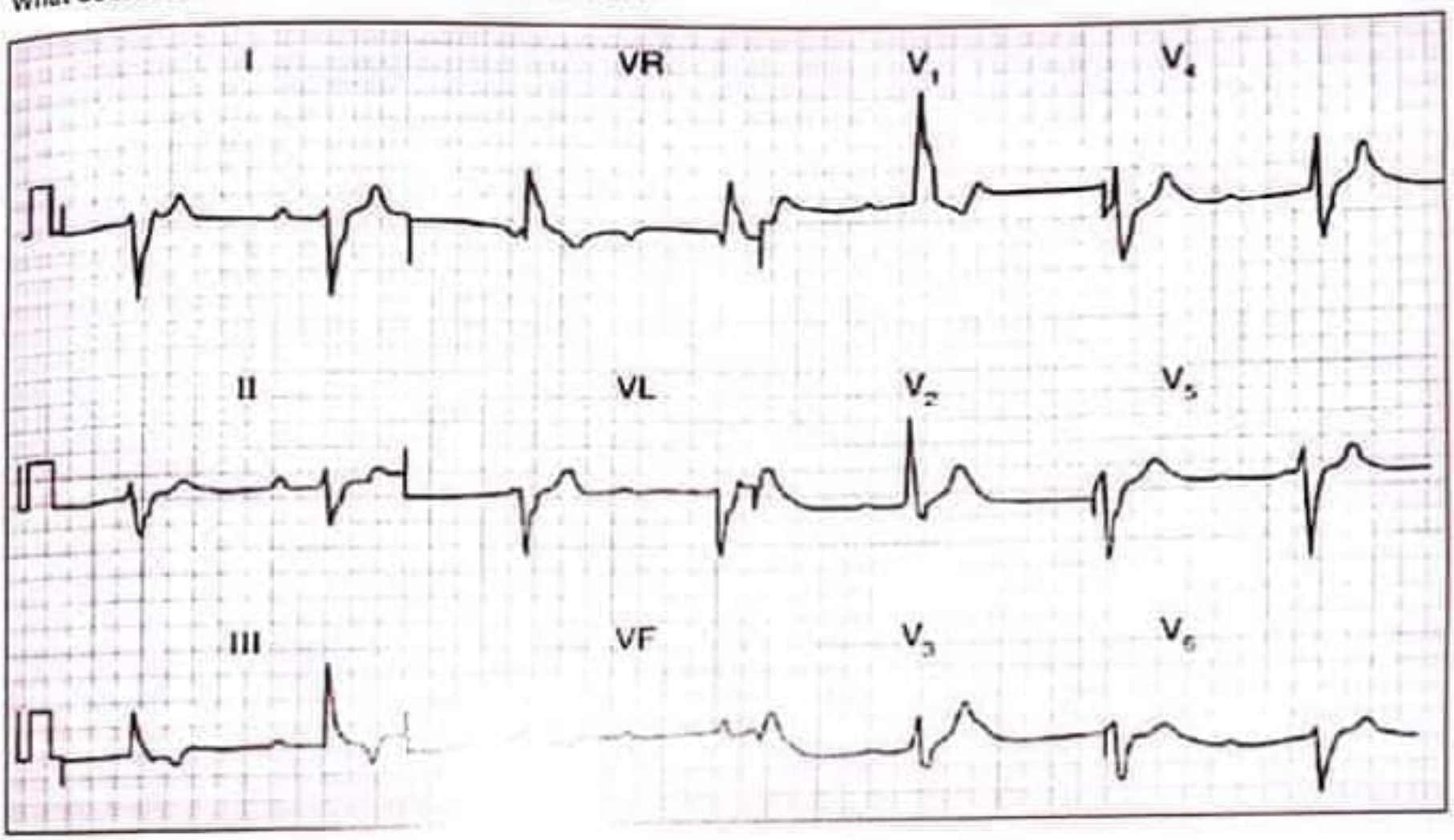
The Q waves in the inferior leads, together with inverted T waves, point to an old inferior myocardial in rction. While symmetrically peaked T waves in the anterior leads can be due to hyperkalaemia, or to ischaemia , but they are frequently a normal variant

What to do ?

- The patient seems to have had a myocardial infarction at some point in the past, and by implication his vague chest pain may be due to cardiac ischaemia.
- Attention must be paid to risk factors (smoking, blood pressure, plasma cholesterol), and he probably needs long-term treatment with aspirin and a statin.
- An exercise test will be the best way of deciding whether he has coronary disease that merits angiography.

Ex : 3

An 80-year-old woman, who had previously had a few attacks of dizziness, fell and broke her hip.
Sh found to have a slow pulse, and this is her ECG.
The surgeons want to operate as soon as possible but the anaestheist is unhappy.
What does the ECG show and what should be done?



Comment

- **Rhythm :** regular
- **Rate :** about 40 bpm
- **Axis :** Right axis deviation.
- **P wave :** multiple , independant of QRS.
- **P-R interval :** greatly variable
- **QRS complex :** wide
- **ST segment :** normal
- **T wave :** normal

Diagnosis :

3rd degree heart block.

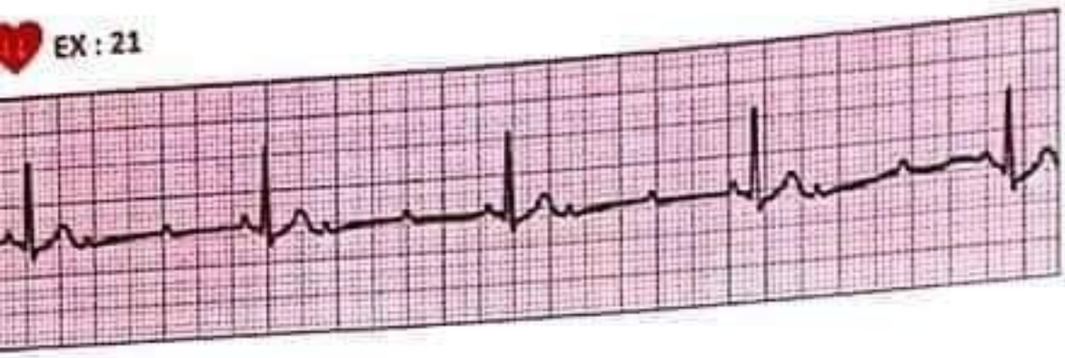
Clinical interpretation

In complete heart block there is no relationship between the P waves (here with a rate of 70/min) and the QRS complexes.
The ventricular 'escape' rhythm has wide QRS complexes and abnormal T waves.
No further interpretation of the ECG is possible.

What to do ?

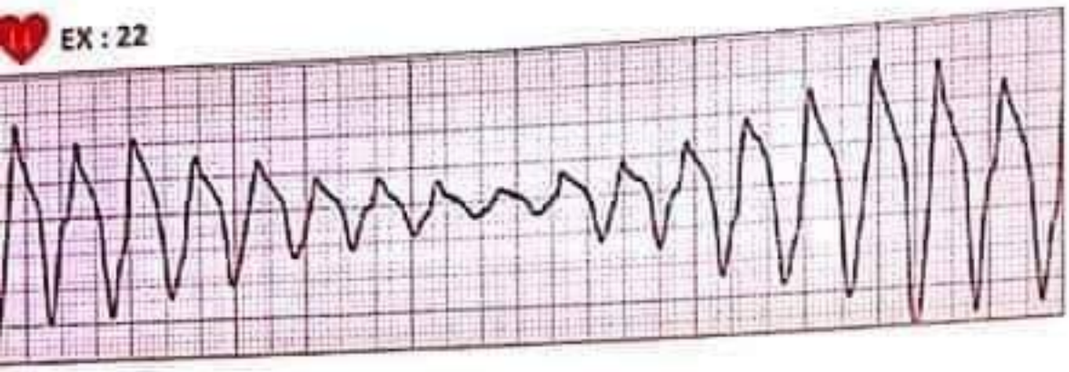
- In the absence of a history suggesting an MI , this woman almost certainly has chronic heart block.
- the fall may or may not have been due to a Stokes-Adams attack.
- She needs a permanent pacemaker, ideally immediately to save the morbidity of first temporary, and then permanent, pacemaker insertion.
- If permanent pacing is not possible immediately, a temporary pacemaker will be needed preoperatively.

EX : 21



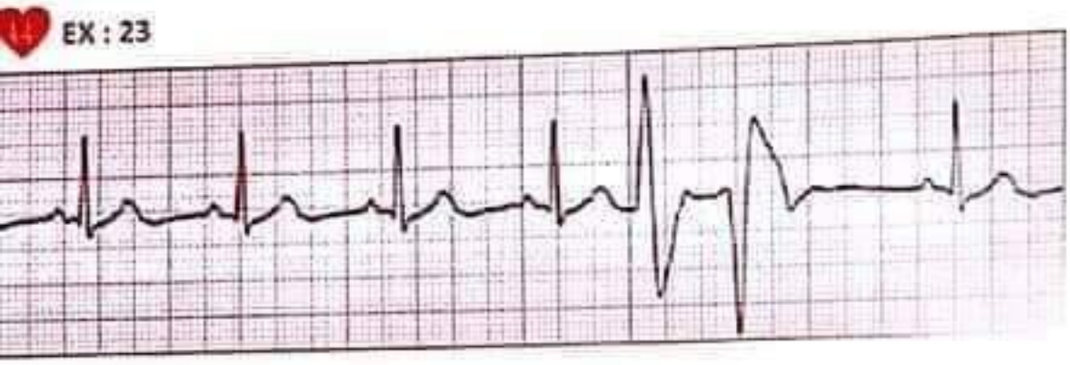
Rate: 45 bpm
Rhythm: Regular
P Waves: Normal
PR Interval: 0.16 sec
QRS: 0.10 sec
Interpretation: Second-degree AV block Type II with 3:1 conduction.

EX : 22



Rate: 200–250 bpm
Rhythm: Irregular
P Waves: None
PR Interval: None
QRS: Wide (>0.12 sec), bizarre
Interpretation: VT—torsade de pointes

EX : 23



Rate: Basic rate 68 bpm
Rhythm: Irregular
P Waves: Normal
PR Interval: normal
QRS: 0.10 sec
Interpretation: Sinus rhythm with multiform PVCs

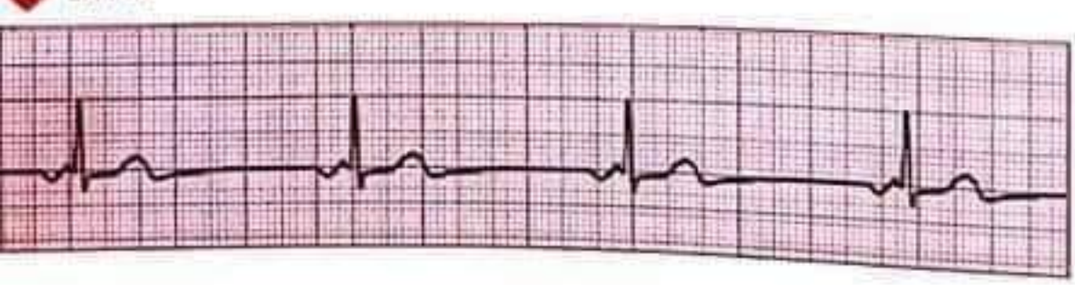
EX : 24

Rate: 68 bpm
Rhythm: Regular
P Waves: Upright with pacing spikes
PR Interval: 0.16 sec
QRS: 0.10 sec
Interpretation: Atrial pacemaker

EX : 25

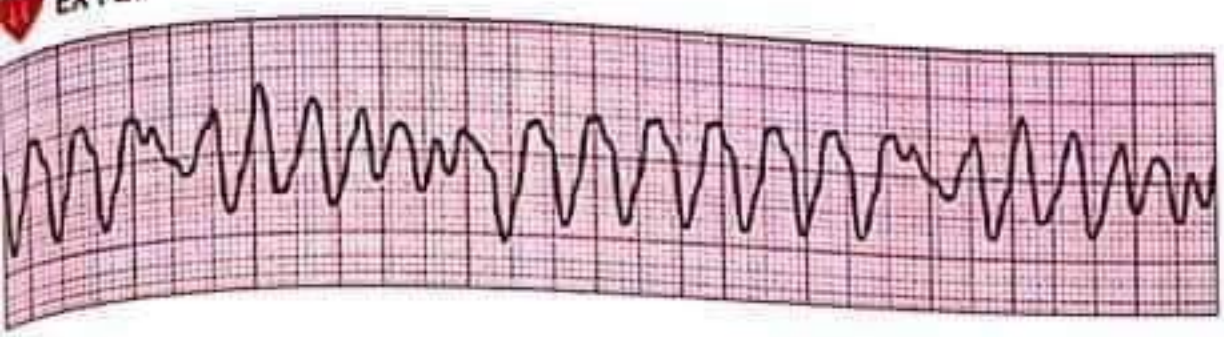
Rate: 48 bpm
Rhythm: Regular
P Waves: Normal, superimposed on QRS and T waves
PR Interval: Varies
QRS: 0.16 sec
Interpretation: Third-degree AV block

EX : 26



Rate: 48 bpm
Rhythm: Regular
P Waves: Inverted
PR Interval: 0.12 sec
QRS: 0.08 sec
Interpretation: Junctional rhythm

EX : 27



Rate: 250 bpm
Rhythm: Irregular
P Waves: None
PR Interval: None
QRS: Wide (>0.12 sec), bizarre
Interpretation: VT—polymorphic

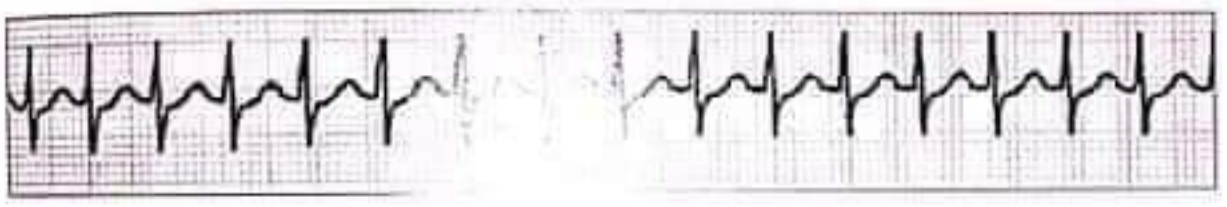
EX : 28

Rate: Atrial ≥350 bpm, ventricular up to 150 bpm
Rhythm: Irregular
P Waves: None
PR Interval: None
QRS: normal
Interpretation: A-fib

EX : 29

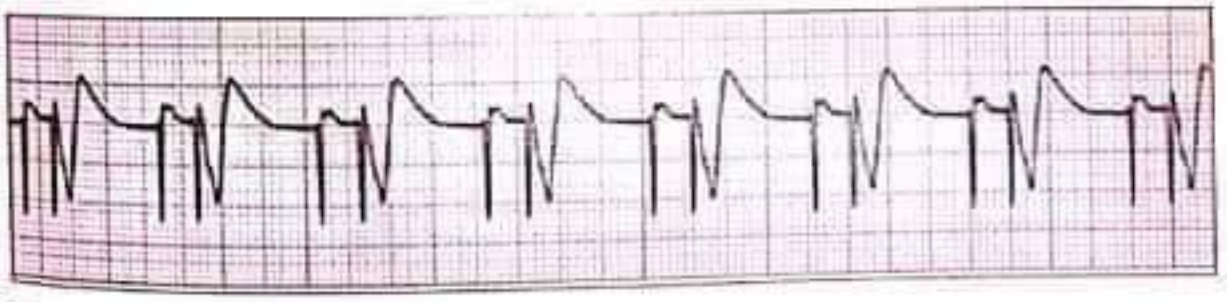
Rate: Basic rate 79 bpm
Rhythm: Irregular
P Waves: Normal
PR Interval: 0.20 sec
QRS: normal
Interpretation: Sinus rhythm with ventricular trigeminy

EX : 30



Rate: about 150 bpm
Rhythm: Regular
P Waves: absent
PR Interval : ?
QRS: normal
Interpretation: PSVT

EX : 31

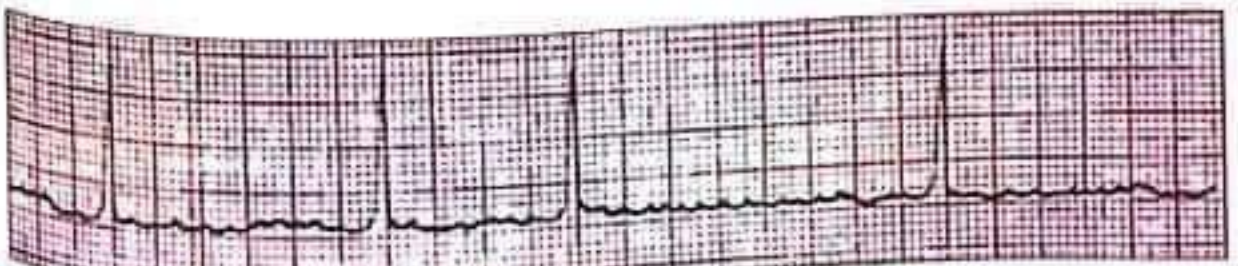


Rate: 75 bpm
Rhythm: Regular
P Waves: Upright with pacing spike
PR Interval: 0.20 sec
QRS: 0.16 sec
Interpretation: Atrial-ventricular pacemaker

EX : 32

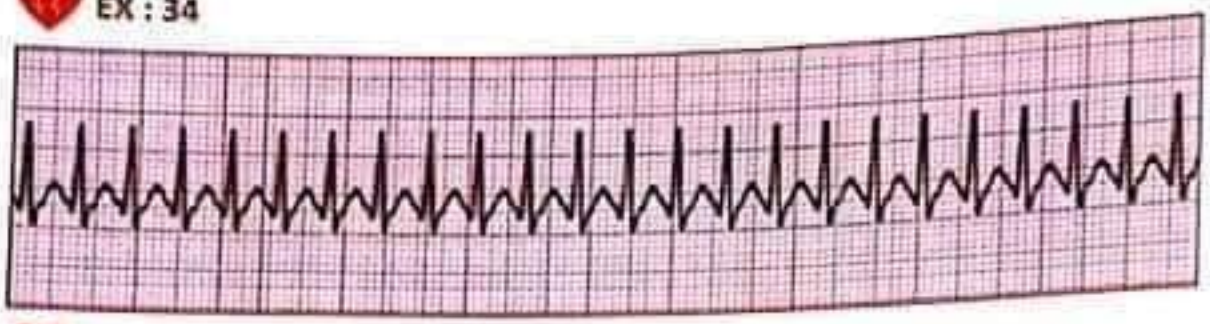
Rate: 68 bpm
Rhythm: Irregular
P Waves: Normal
PR Interval: 0.16 sec
QRS: 0.10 sec
Interpretation: Sinus rhythm with two premature atrial contractions (beats 2 and 7)

EX : 33



Rate: 50 bpm
Rhythm: irregular
P Waves: fibrillatory waves
PR Interval:
QRS: normal.
Interpretation: Slow AF

EX : 34

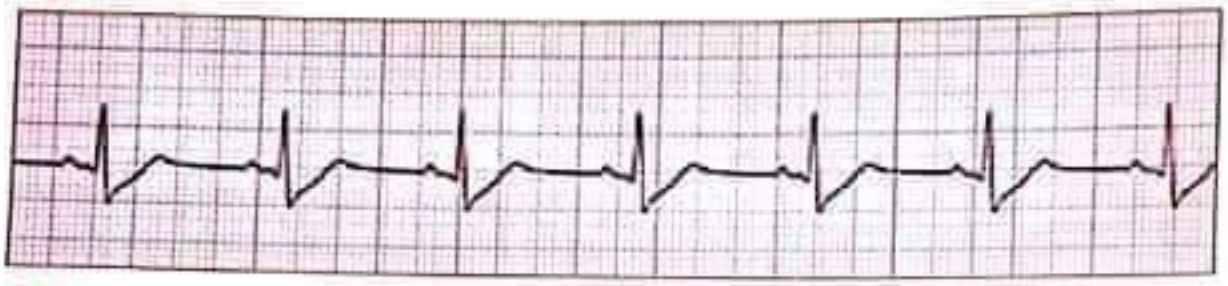


Rate: 250 bpm
Rhythm: Regular
P Waves: Buried in T waves
PR Interval: Not measurable
QRS: 0.08 sec
Interpretation: SVT

EX : 35

Rate: 136 bpm
Rhythm: Regular
P Waves: Not visible
PR Interval: Not measurable
QRS: normal
Interpretation: Sinus tachycardia with muscle artifact

EX : 36

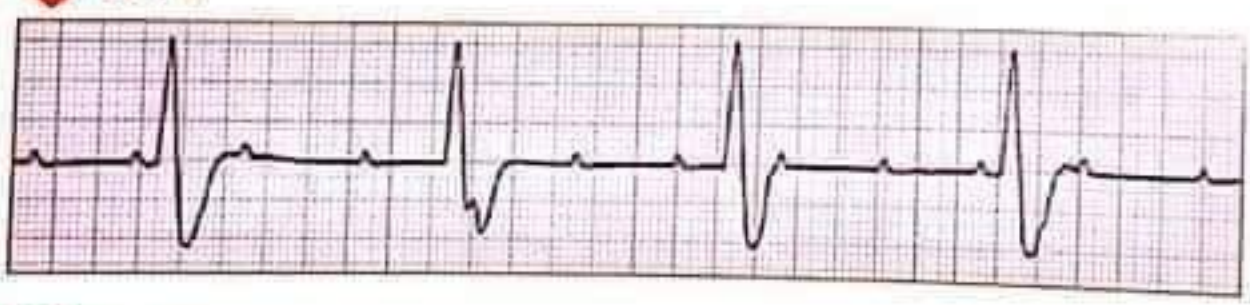


Rate: 71 bpm
Rhythm: Regular
P Waves: Normal
PR Interval: 0.16 sec
QRS: 0.10 sec
Interpretation: Sinus rhythm with ST segment depression.

EX : 37

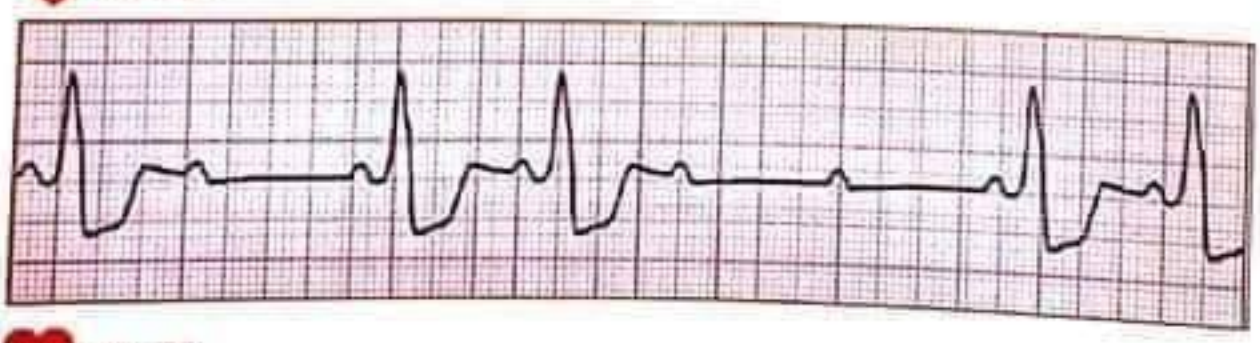
This **pattern is due to**
Loose electrodes

EX : 38



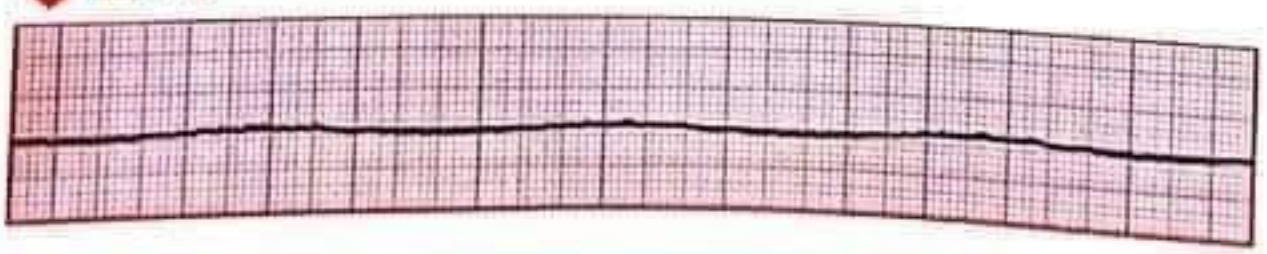
Rate : 40 bpm
Rhythm: regular
P Waves: Normal shape but multiple and come any time (AV-dissociation)
PR Interval: variable
QRS: wide
Interpretation: complete heart block

EX : 39



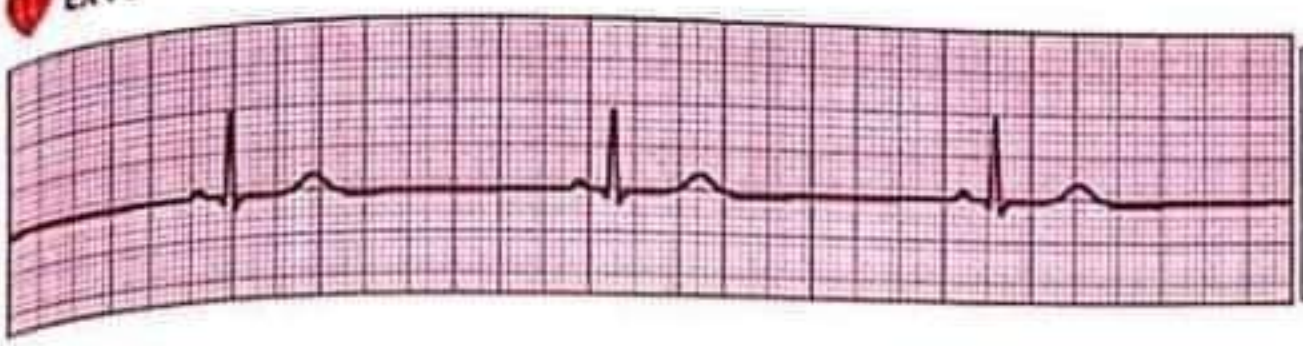
Rate : bpm
Rhythm: irregular
P Waves: Normal shape but multiple and some are not conducted.
PR Interval: normal in conducted beats
QRS: wide
Interpretation: 2nd° HB mobitz 2.

EX : 40



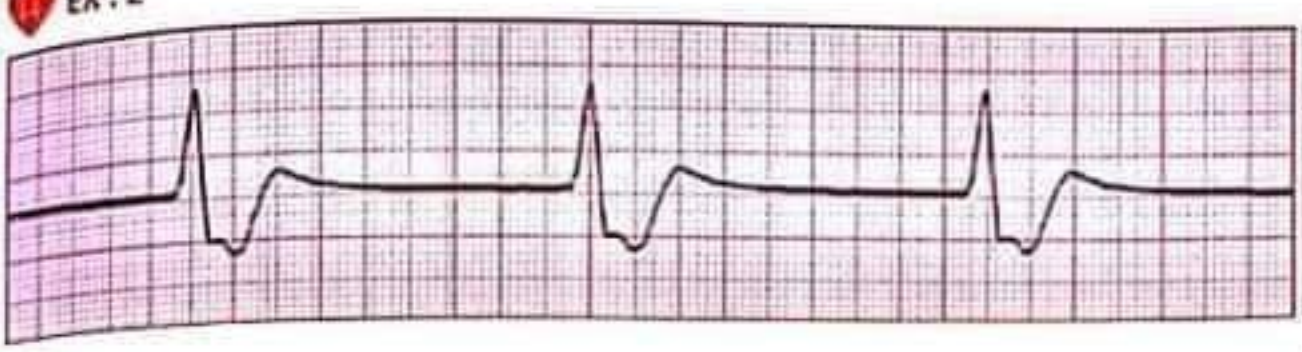
This shape is called Asystole

EX : 1



Rate: 35 bpm
Rhythm: Regular
P Waves: Normal
PR Interval: 0.16 sec
QRS: normal
Interpretation: Sinus bradycardia

EX : 2

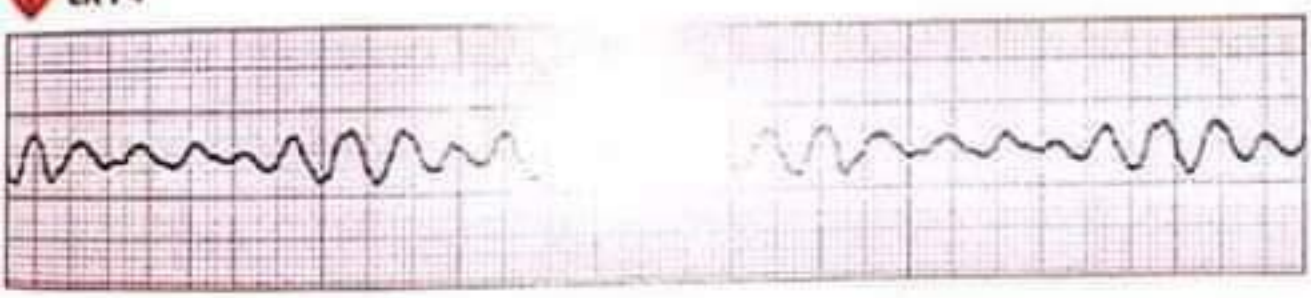


Rate: 34 bpm
Rhythm: Regular
P Waves: None
PR Interval: None
QRS: wide (0.20 sec)
Interpretation: Idioventricular rhythm

EX : 3

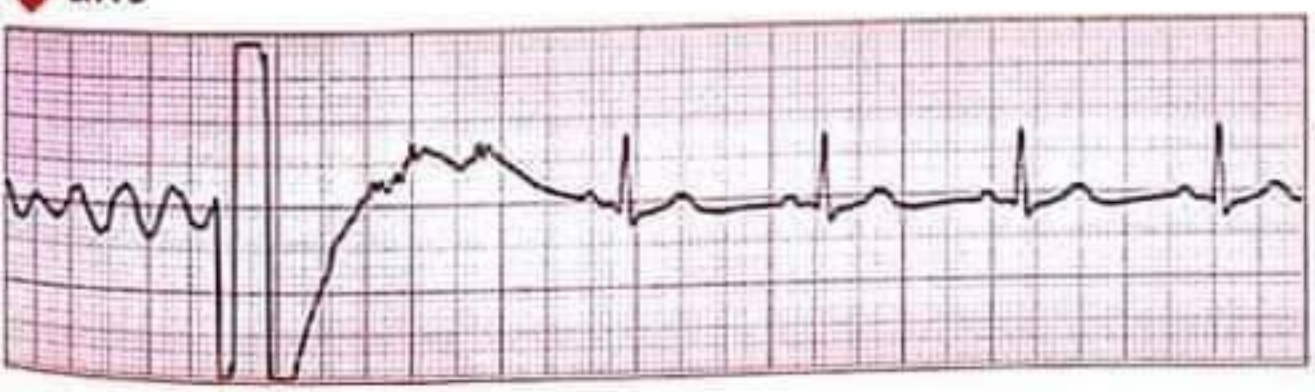
Rate : Ventricular 75 bpm, atrial 225 bpm
Rhythm : Regular
P Waves : Flutter waves
PR Interval : Variable
QRS : normal
Interpretation : Atrial flutter

EX : 4



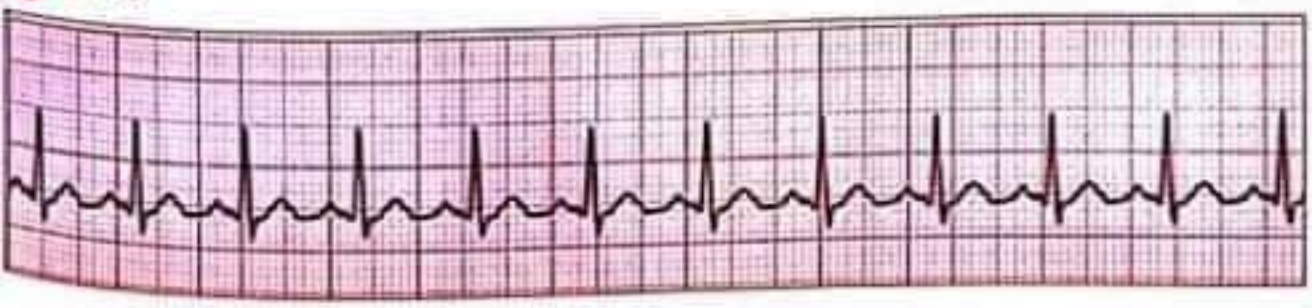
Rate : about 300 bpm
Rhythm :
P Waves : not seen
PR Interval : ??
QRS : 0.08 sec
Interpretation : Vent. fibrillation

EX : 5



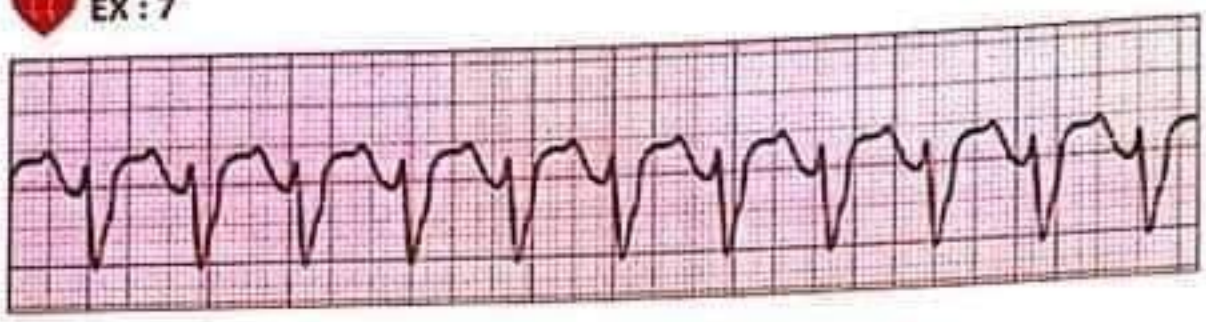
VF with defibrillation converted back to normal sinus rhythm.
Rate : 75 bpm.
rhythm : regular
PR int. & QRS : normal

EX : 6



Rate: 115 bpm
Rhythm: Regular
P Waves: Normal
PR Interval: 0.12 sec
QRS: normal
Interpretation: Sinus tachycardia

EX : 7

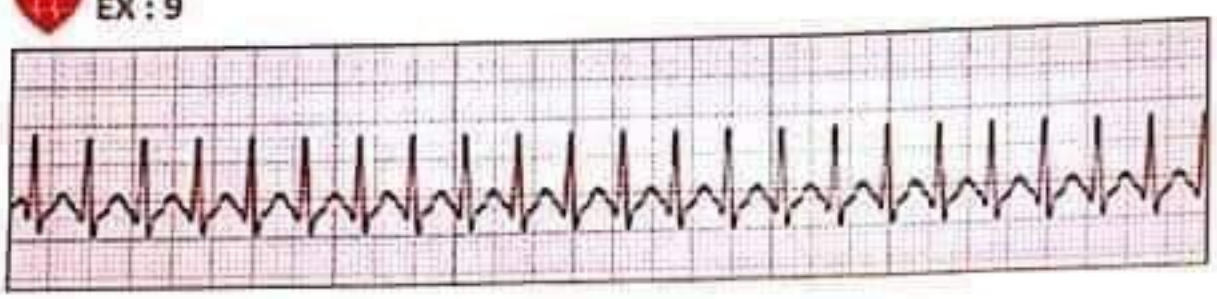


Rate : 115 bpm
Rhythm : Regular
P Waves : None
PR Interval : None
QRS : Wide (>0.12 sec), bizarre
Interpretation: Vent. tachycardia

EX : 8

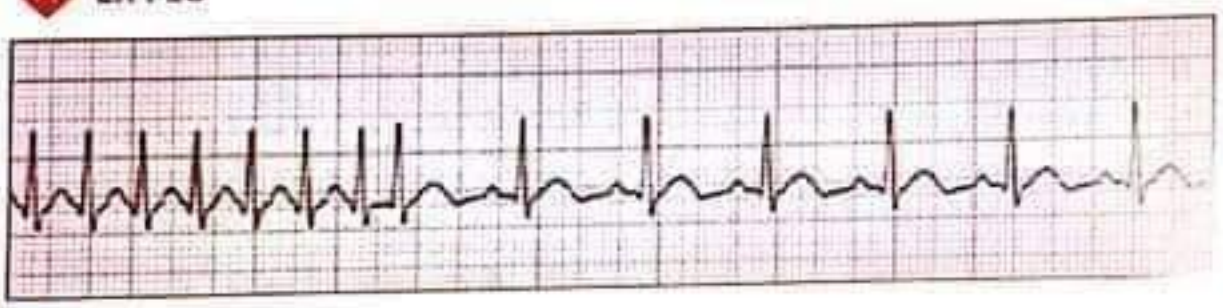
Paroxysmal supraventricular tachycardia
Initial junctional rhythm at 50 bpm converting to supraventricular tachycardia at 250 bpm.

EX : 9



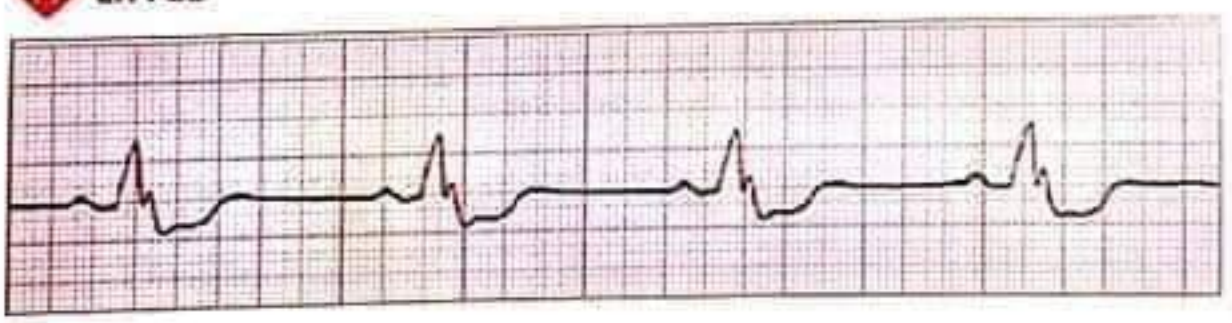
Rate : 250 bpm
Rhythm : Regular
P Waves : None
PR Interval : None
QRS : normal
Interpretation : SVT

EX : 10



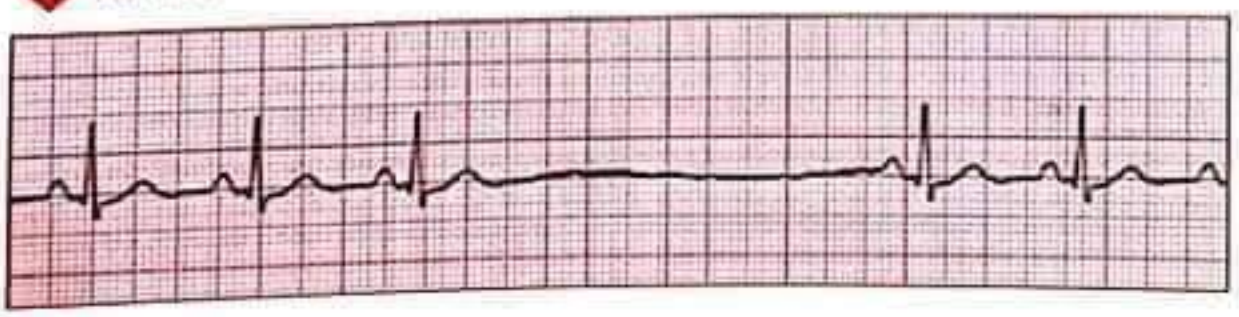
t 250 bpm converting to a sinus
n at 100 bpm

EX : 11



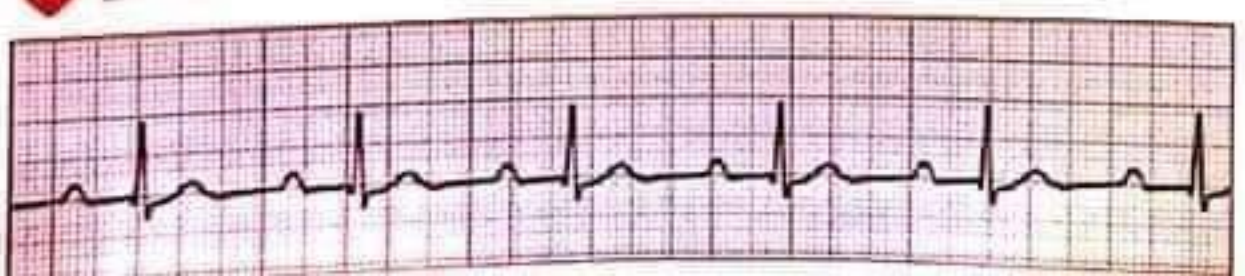
Rate: 41 bpm
Rhythm: Regular
P Waves: Normal
PR Interval: 0.20 sec
QRS: about 0.24 sec
Interpretation : Sinus bradycardia with a bundle branch block

EX : 12



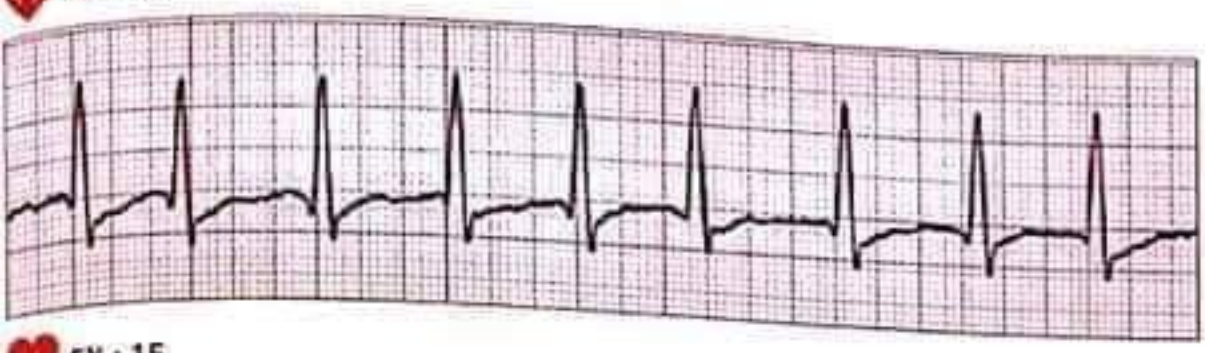
Rate: Basic rate 79 bpm
Rhythm: Irregular
P Waves: Normal
PR Interval: 0.16 sec
QRS: 0.08 sec
Interpretation: sinus pause/arrest

EX : 13



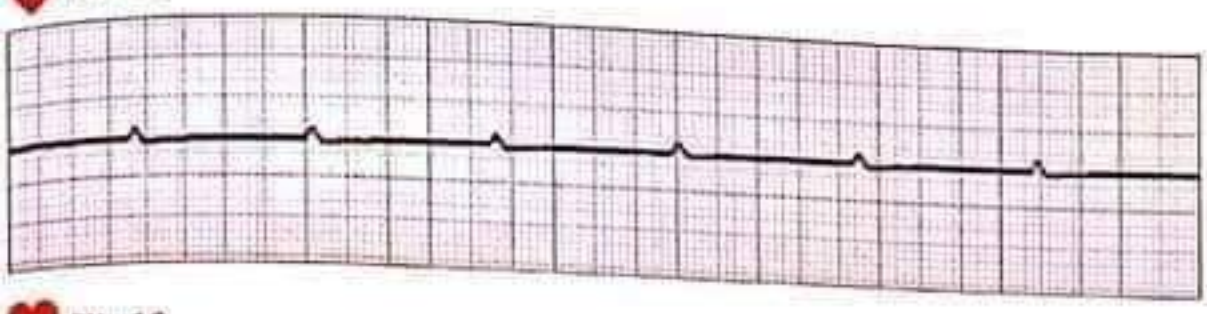
Rate: 58 bpm
Rhythm: Regular
P Waves: Normal
PR Interval: 0.32 sec
QRS: 0.08 sec
Interpretation: Sinus bradycardia with first-degree AV block

EX : 14



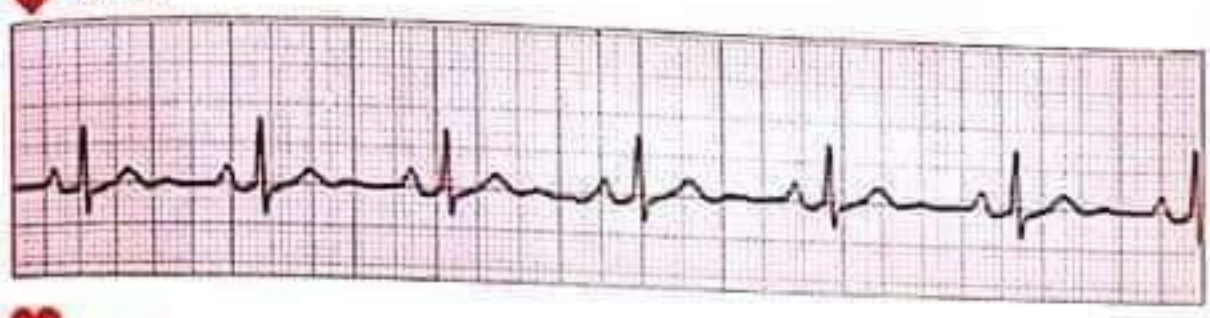
Rate: about 100 bpm
Rhythm: Irregular
P Waves: None
PR Interval: None
QRS: 0.12 sec
Interpretation: Atrial fibrillation

EX : 15



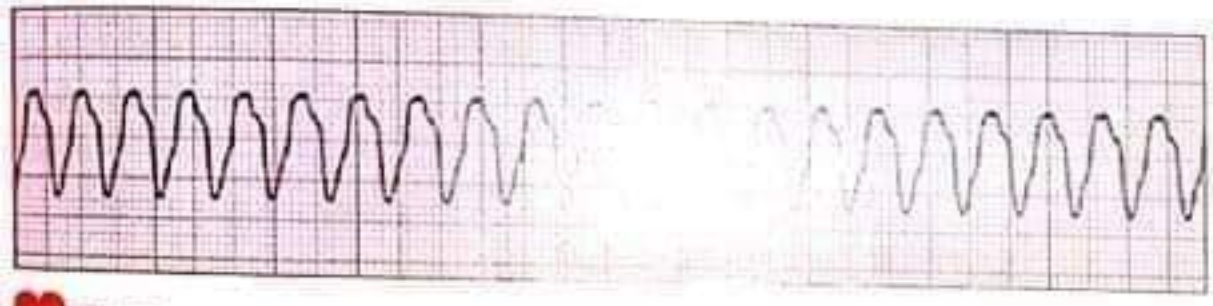
Rate: Atrial 60 bpm
Rhythm: Atrial regular
P Waves: Normal
PR Interval: None
QRS: None
Interpretation: P Wave asystole

EX : 16



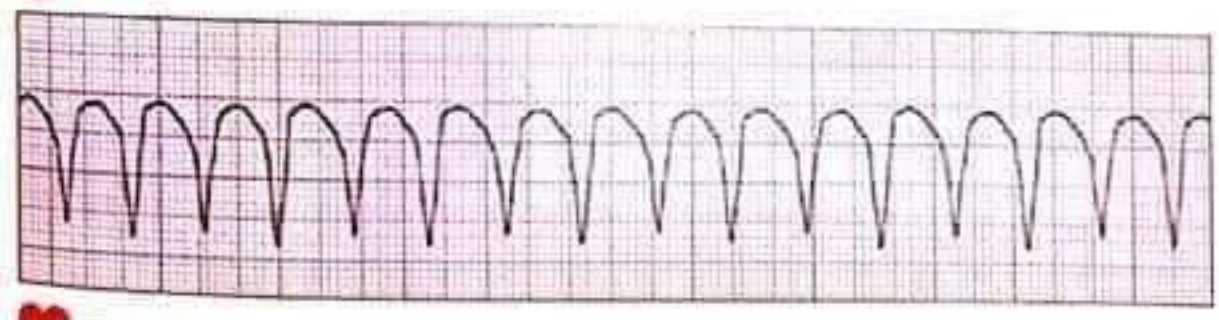
Rate: 65 bpm
Rhythm: Regular
P Waves: Normal
PR Interval: 0.20 sec
QRS: 0.08 sec
Interpretation: Normal sinus rhythm with U wave

EX : 17



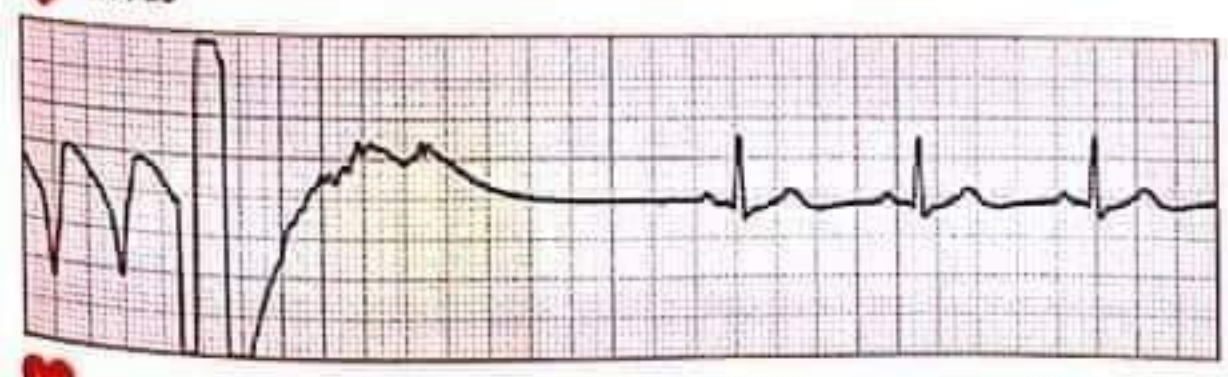
Rate: 214 bpm
Rhythm: Regular
P Waves: None
PR Interval: None
QRS: Wide (>0.12 sec), bizarre
Interpretation: V. Tachy

EX : 18



Rate: 214 bpm
Rhythm: Regular
P Waves: None
PR Interval: None
Interpretation: V. Tachy

EX : 19



ventricular Tachycardia
monomorphic with cardioversion converting to a sinus rhythm at 65 bpm

EX : 20

Rate: 50–75 bpm
Rhythm: Irregular
P Waves: Normal
PR Interval: 0.12–0.28 sec
QRS: 0.08 sec
Interpretation: Second-degree AV block Type I