Electrocardiogram

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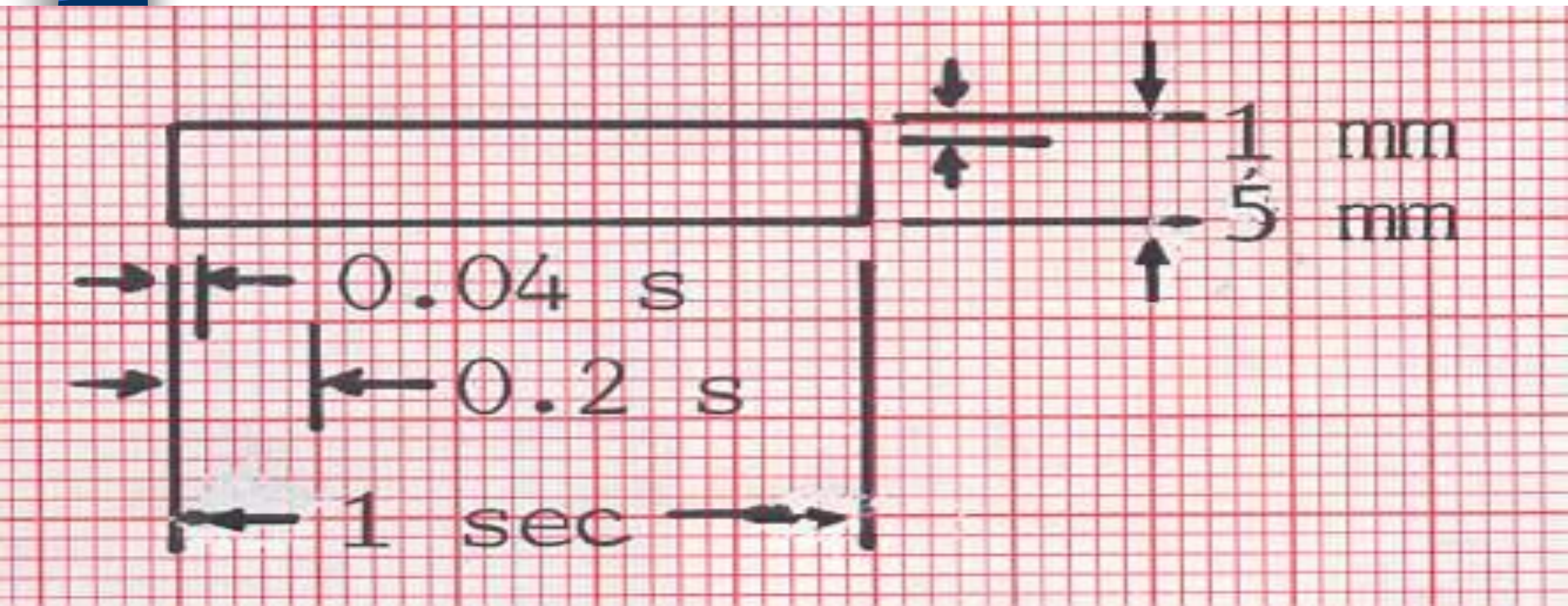
(1) RATE

Heart rate = 300 divided by numbers of large boxed in RR interval



Normal ECG intervals:-

p (=atrial depolarization)	< 3 small squares
PR interval (=atrioventricular conduction)	0.12- 0.2 second (3-5 small squares)
Q	duration < 0.04 second (1 small square) and deep (< ¼ that of R)
QRS (=ventricular depolarization)	< 0.12 second (3 small squares)
QT interval	2 large squares (prolong QT if > half of RR interval). Causes = drugs, electrolyte imbalance, stroke, coma, seizure, myocardial ischemia

(2) RHYTHM

- If p not upright in lead II → not sinus rhythm (exception: dextrocardia, lead misplacement)
- Leads II and V1 → best to observe p
- Leads V1 and V2 → best to observe bundle branch block

1. ***Sinus arrhythmia:***

beat-to-beat change in RR interval

The escape beat : comes “late”

eg. atrial escape

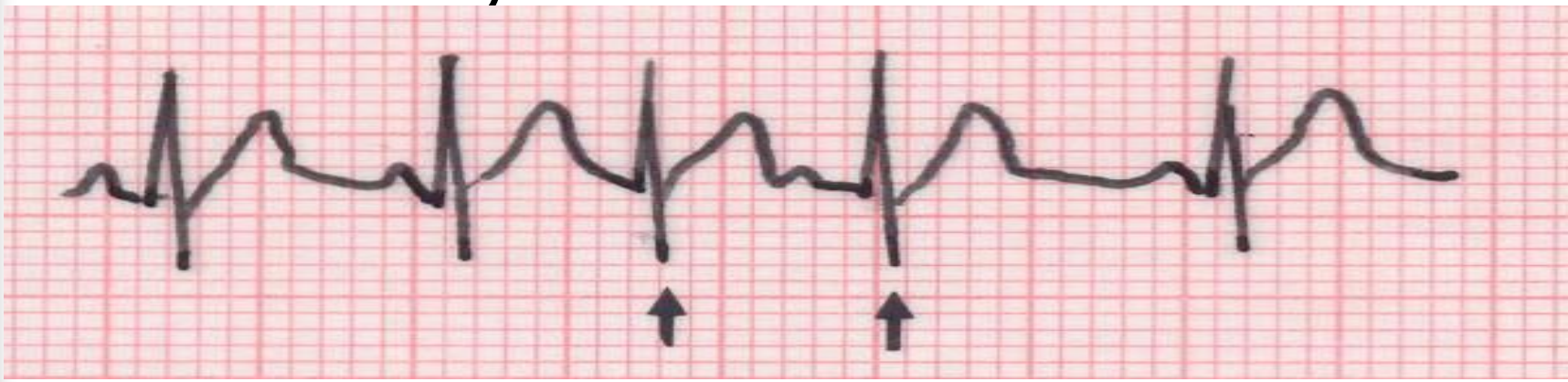
nodal escape (no p in junctional beats)

ventricular escape

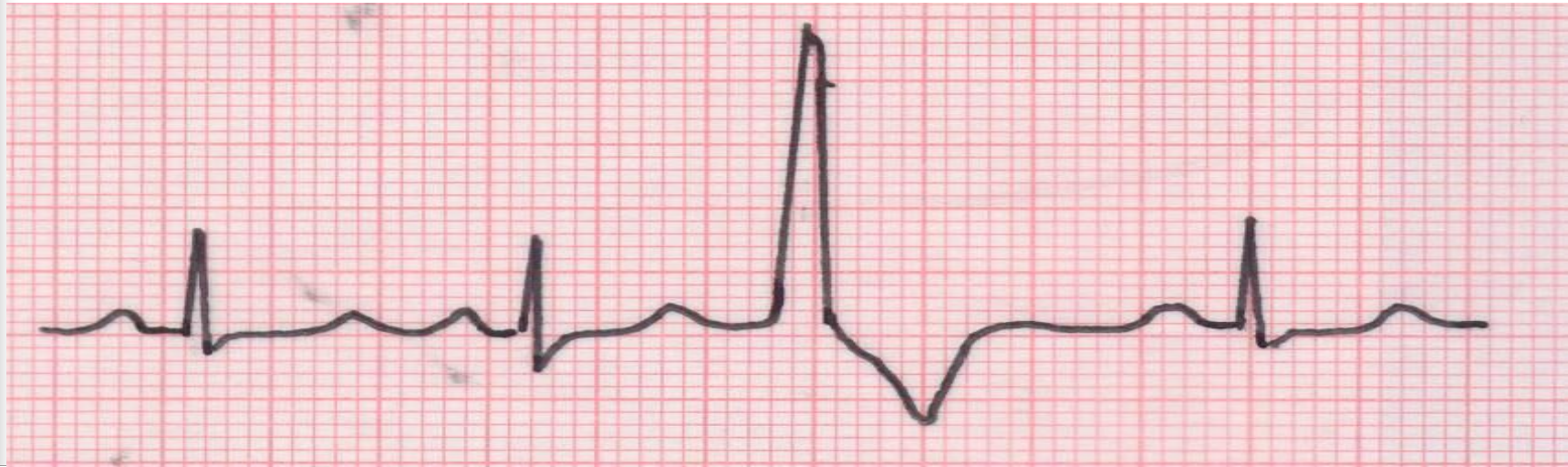
accelerated idioventricular rhythm

- ***The extrasystoles:*** come “early”

  eg. atrial and junctional (nodal) extrasystoles

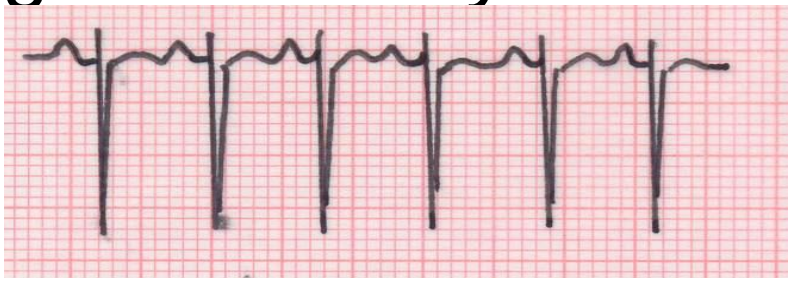


ventricular extrasystole

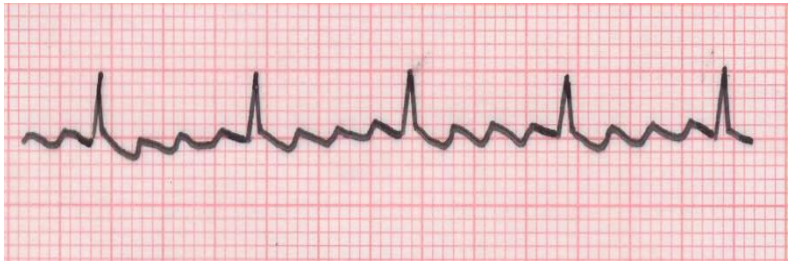


- ***Supraventricular and ventricular tachyarrhythmias:-***

eg. atrial tachycardia

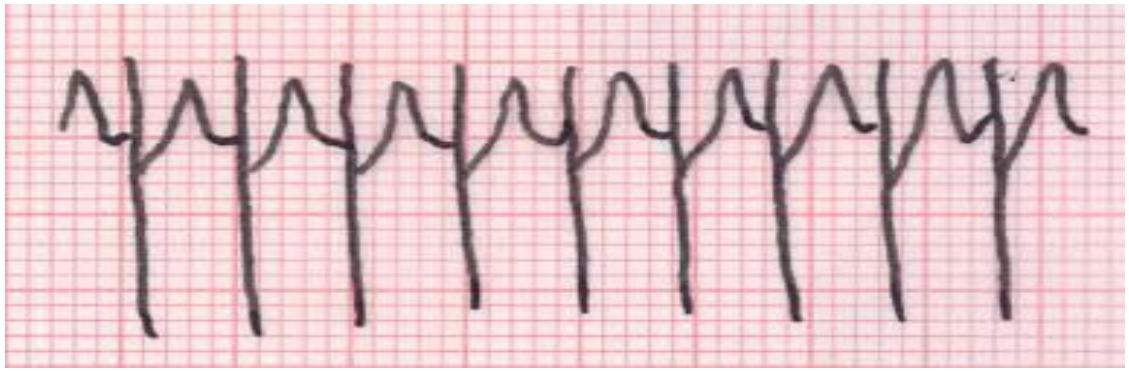


atrial flutter (sawtooth pattern)



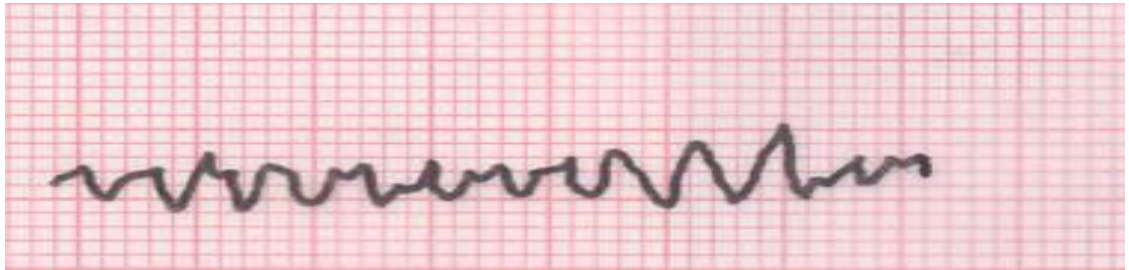
atrial fibrillation

junctional (nodal) tachycardia



ventricular tachycardia

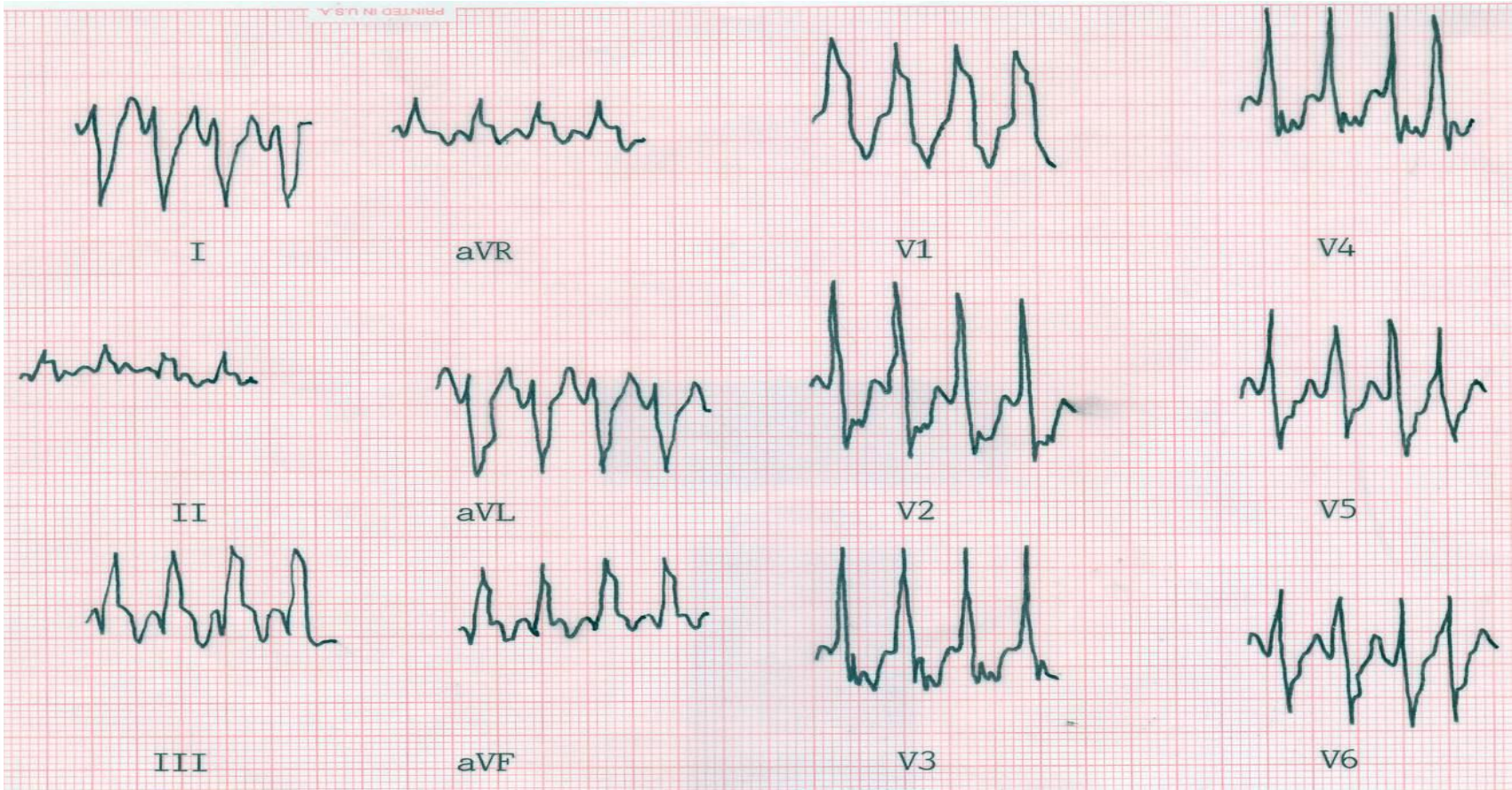
ventricular fibrillation



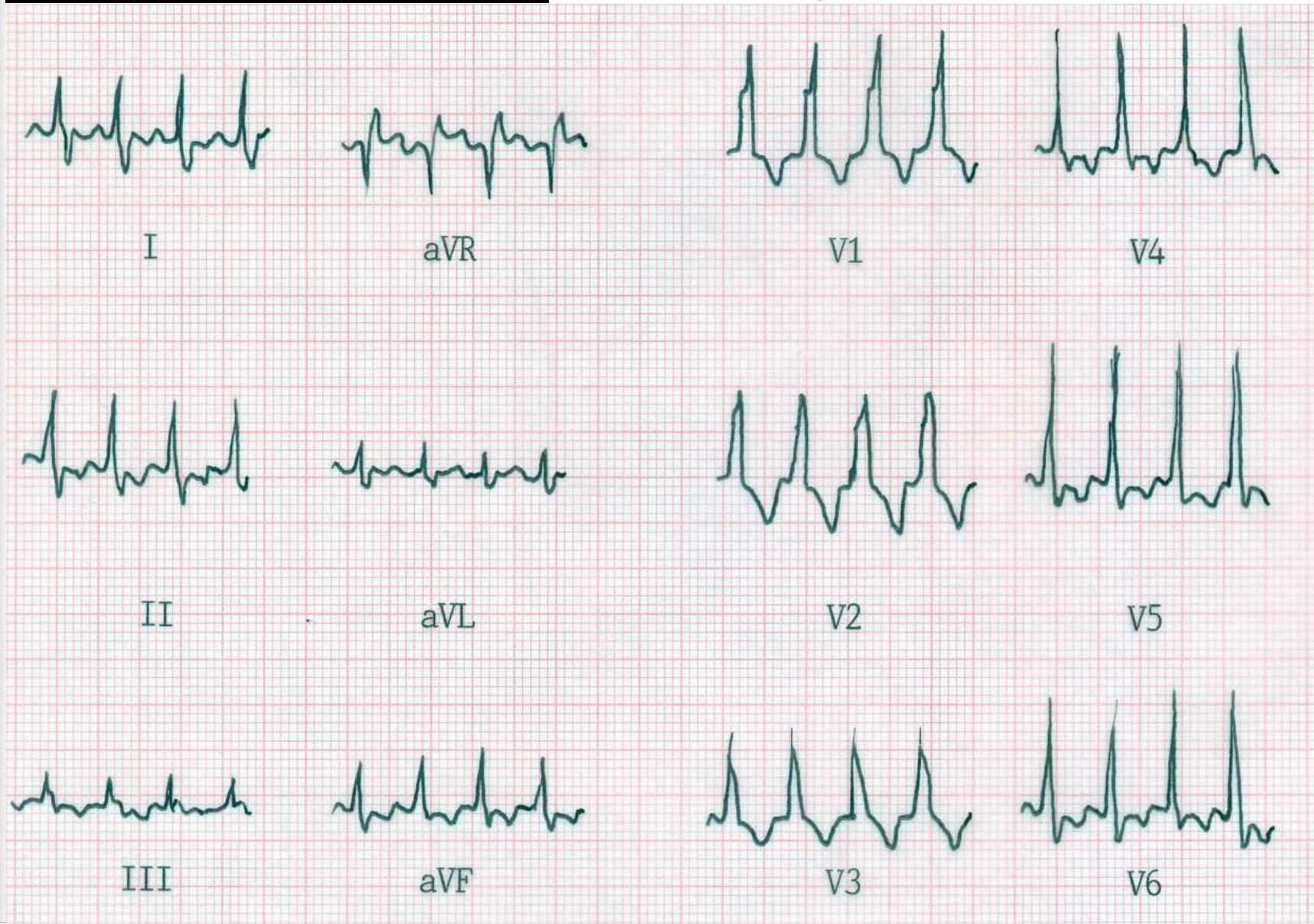
- ***To distinguish supraventricular and ventricular tachycardia, favor VT if :-***

1. wide QRS
2. marked axis deviation (especially left)
3. concordance of QRS complex (ie. QRS predominantly upright or downward)
4. fusion beat, capture beat present
5. In V1, taller left rabbit ear R wave (Rsr’ pattern)
6. V6 predominantly negative
7. uglier tracing (less organized pattern)

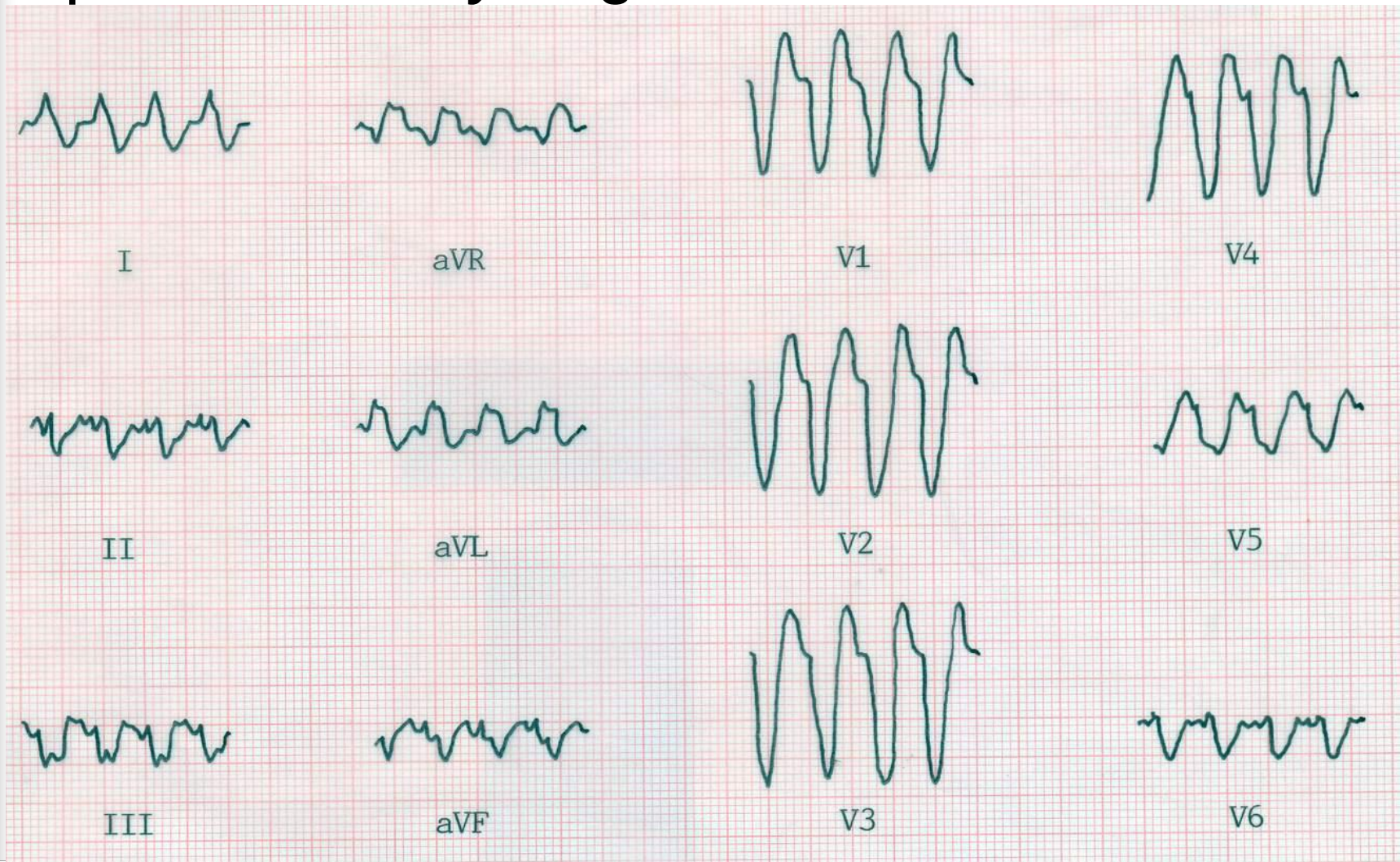
It is VT because: wide QRS, marked right axis deviation, uglier tracing (less organized pattern), V1 left rabbit ear Rsr' pattern



It's SVT because: narrow QRS, normal axis



It's VT because: wide QRS, marked left axis deviation, uglier tracing, QRS in V6 predominantly negative.



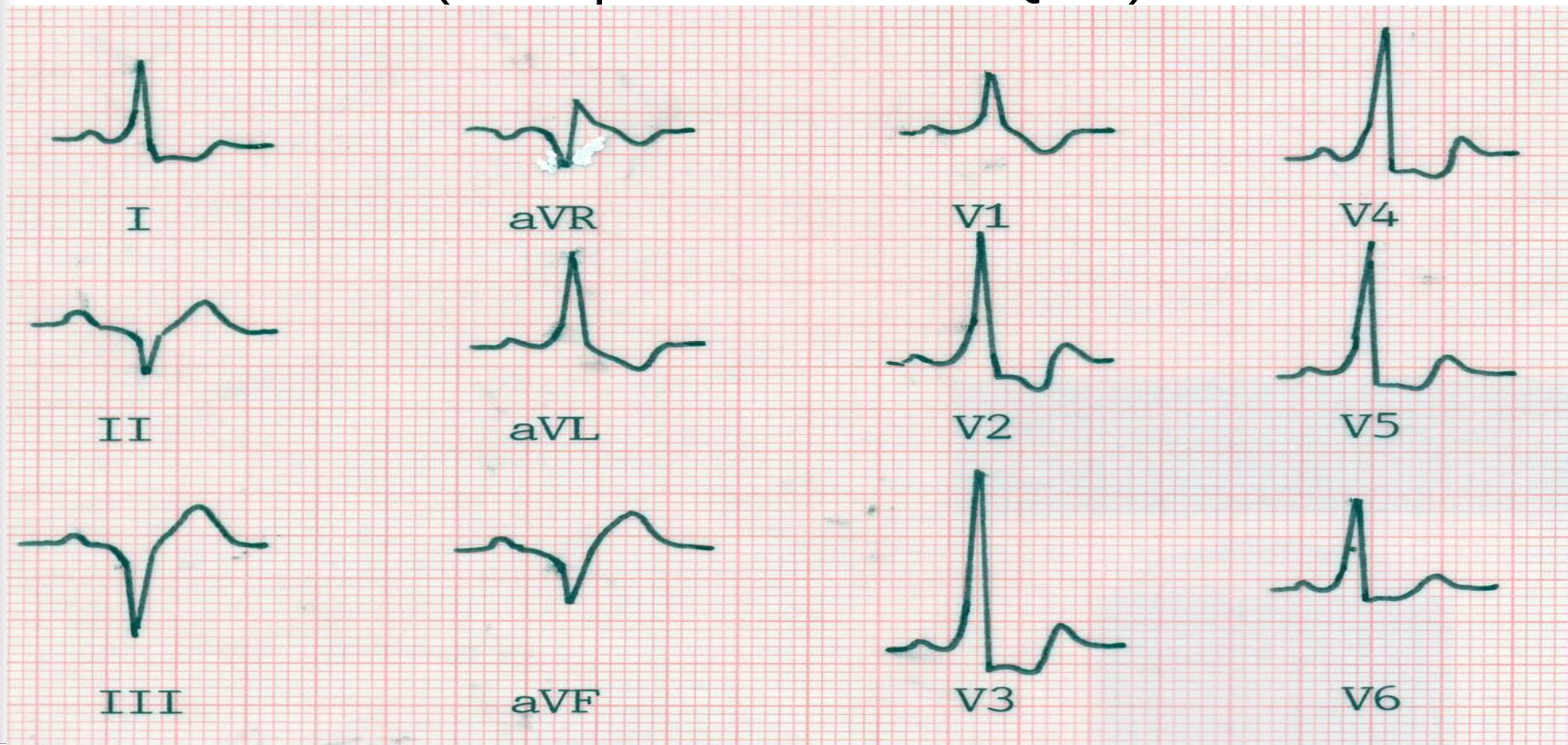
Preexcitation Syndromes

(1) Wolff-Parkinson-White (WPW syndrome):

accessory pathway = bundle of Kent

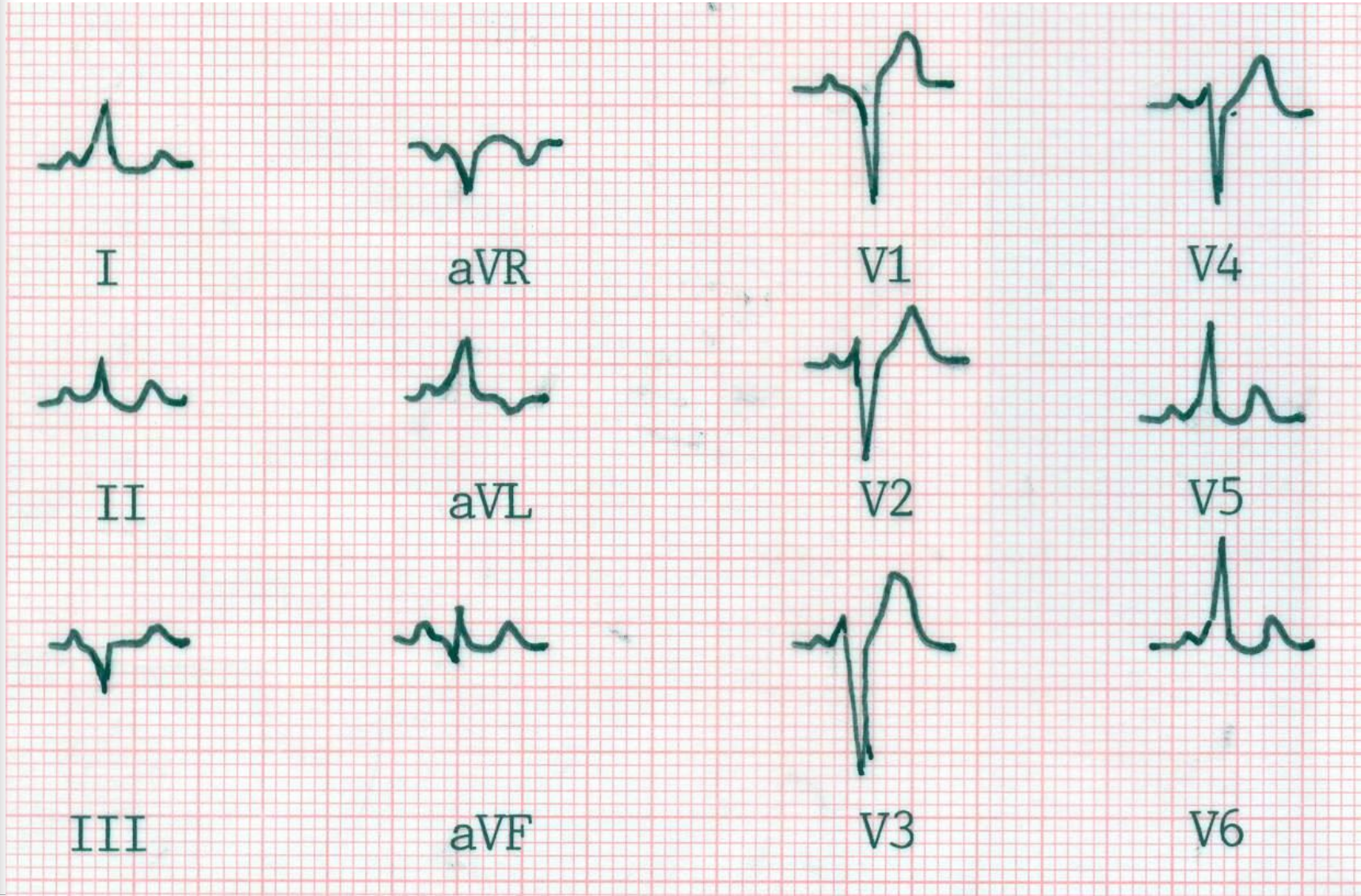
short PR interval

delta wave (slur upstroke of wide QRS)



b) right-side accessory pathway:

no dominant R in V1



(2) Lown-Ganong-Levine (LGL syndrome):

accessory pathway = James fiber

short PR interval (only!)

no delta wave and QRS not wide

- ***Conduction disturbances:***

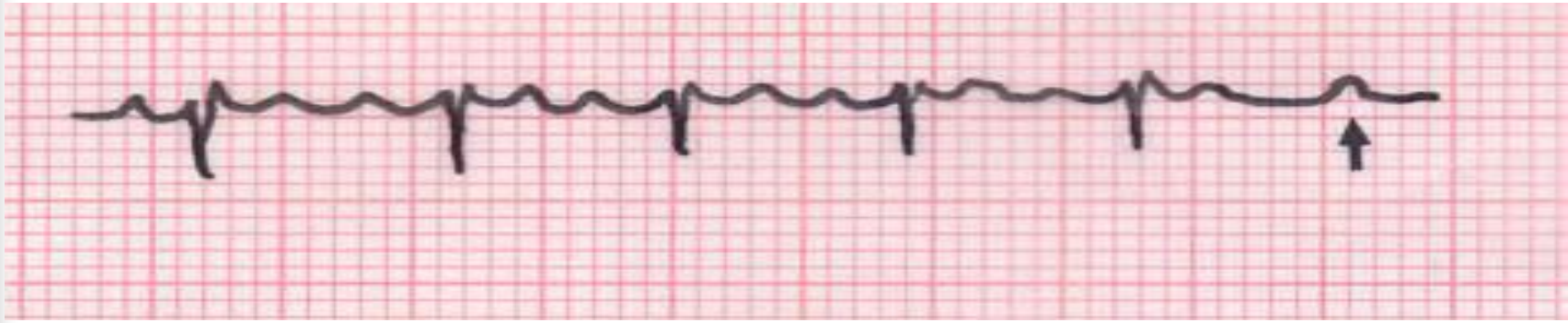
  first degree atrioventricular block:

  prolong PR interval

  second degree atrioventricular block (Mobitz I or Wenckebach):

  progressive lengthened PR then block

Mobitz II: constant PR then block



third degree atrioventricular block (complete heart block):

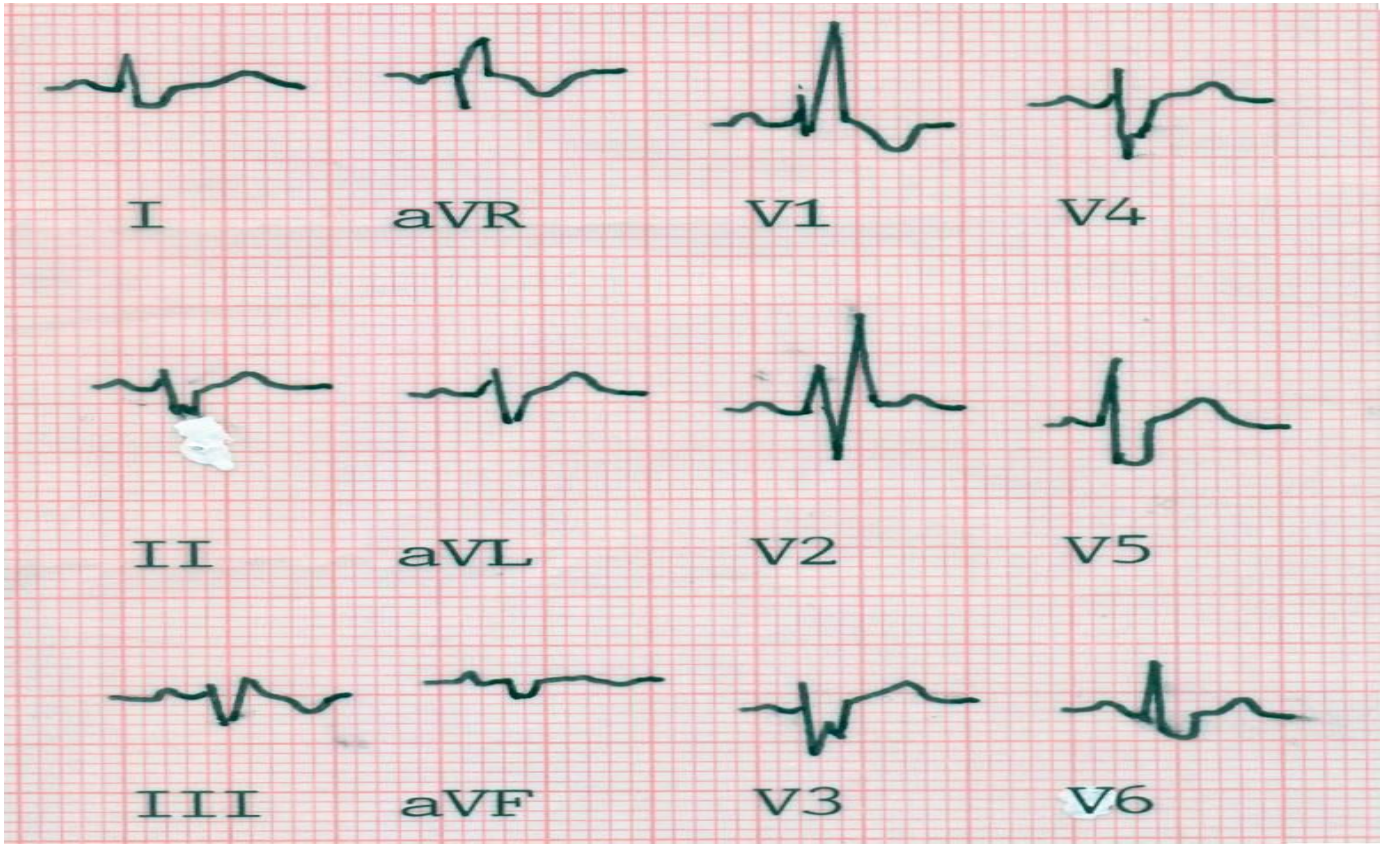
no conduction to ventricle, so ventricular response is regular (ie. RR interval constant). If irregular RR interval, intermittent AV conduction occurring and not complete heart block

- ***Right bundle branch block (RBBB):-***

  QRS duration ≥ 0.12 sec

  M-shaped complex (RSR') in V1

  slur S in leads V5, V6

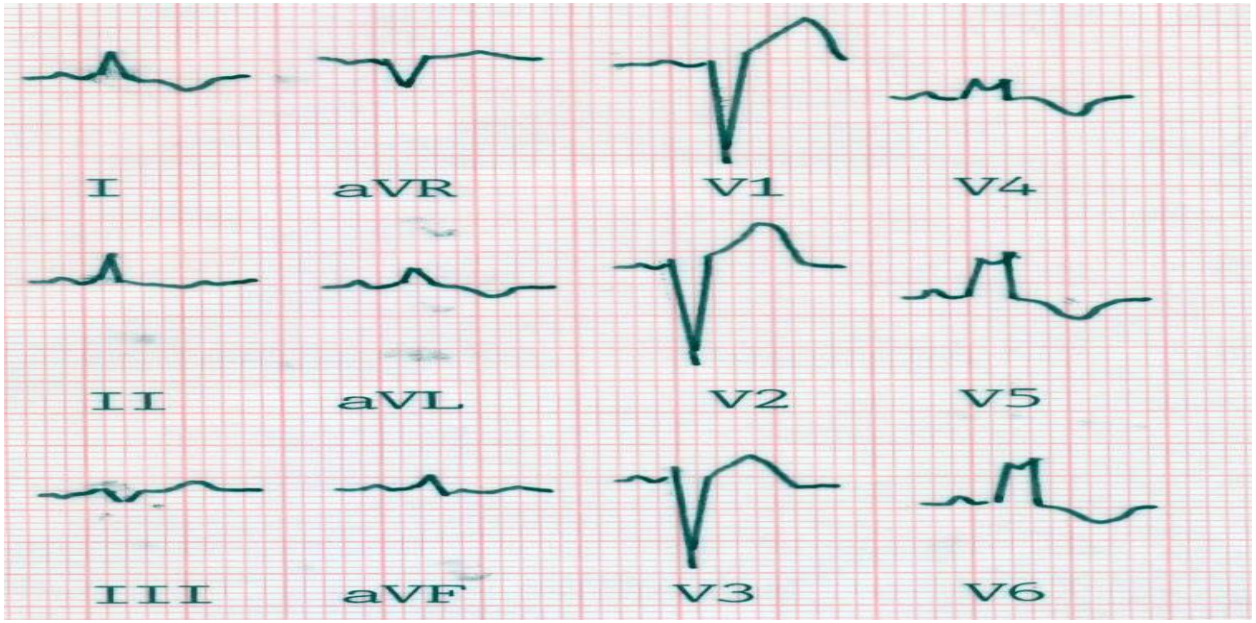


- ***Left bundle branch block (LBBB):-***

  QRS duration ≥ 0.12 sec

  small R or QS in leads V1 and V2

  notched R in leads V5, V6, I



(secondary STT changes in RBBB or LBBB is “opposite” to the QRS deflection, and is normal)

- ***Left anterior fascicular block (hemiblock):***

  left axis deviation

  small q in lead I

  small r in lead III

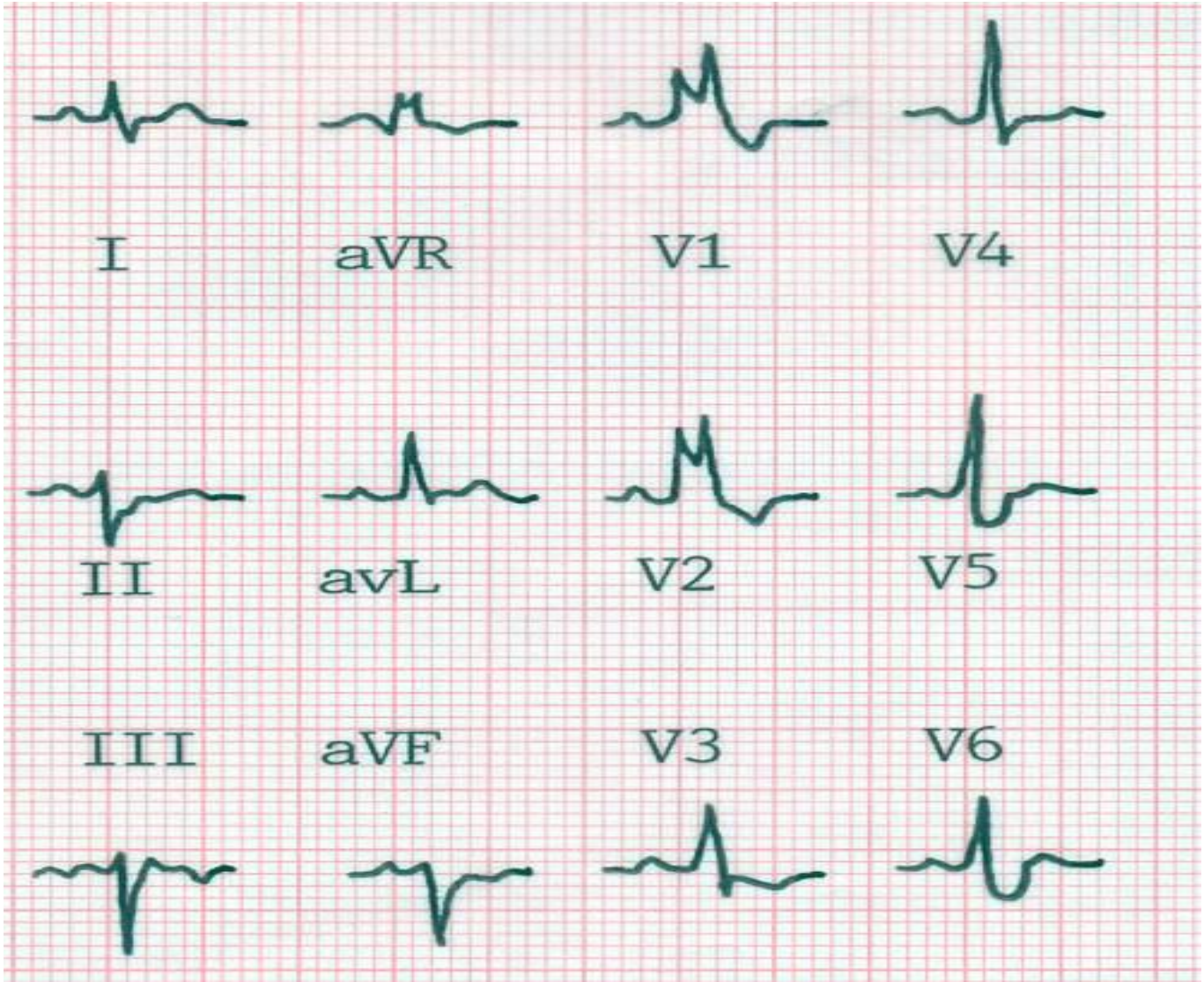
- ***Left posterior fascicular block (rare):***

  right axis deviation

  small q in lead III

  small r in lead I

- ***Bifascicular block:*** = RBBB + hemiblocks
  eg. RBBB + left axis deviation



- ***Common causes of narrow-QRS tachycardia:-***

  sinus tachycardia

  atrial flutter

  PSVT

- ***Common causes of wide-QRS tachycardia:-***

ventricular tachycardia

SVT with preexisting bundle branch block

SVT with aberrant conduction

(3) AXIS

= direction of main electrical vector
(= average direction of current flow)

- ***Normal axis:***
  I, II, III positive deflections
  or I and aVF positive

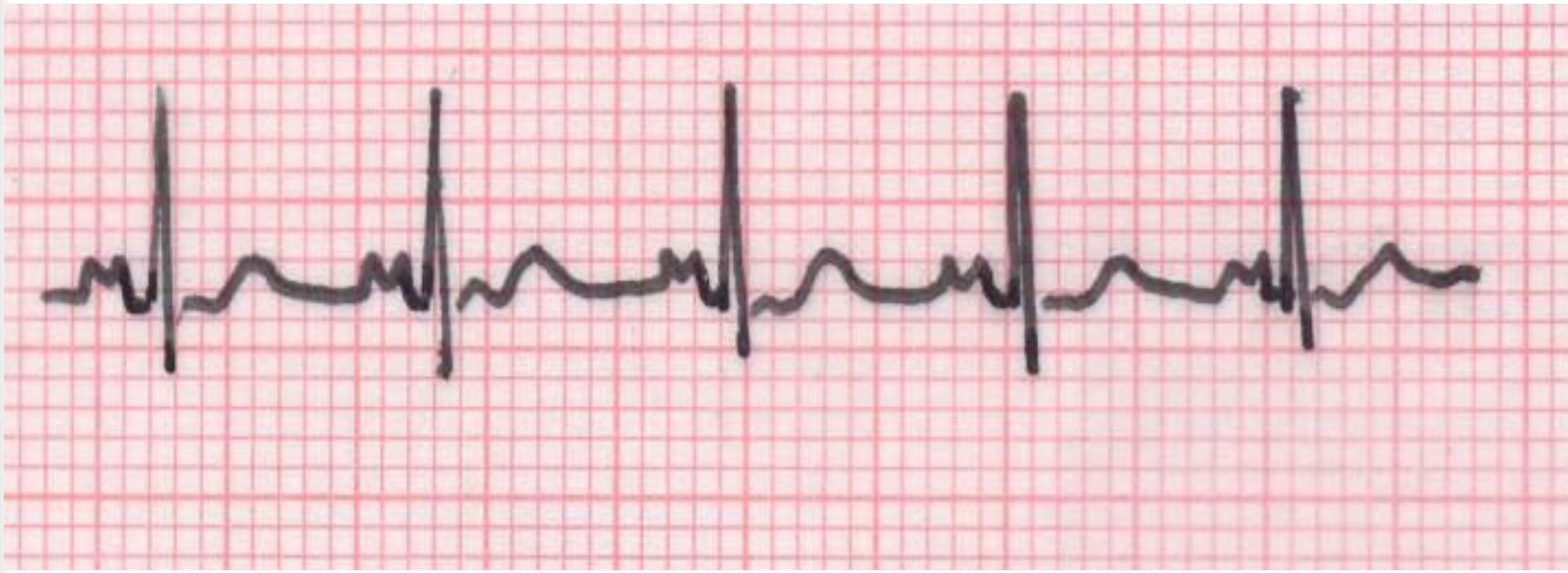
- ***Left axis deviation:***
  I positive but II,III negative deflections
  or I positive but aVF negative

- ***Right axis deviation:***
  I negative and II,III positive deflections
  or I negative but aVF positive
  causes: pulmonary disease, congenital heart disease etc.

(4) CHAMBER ENLARGEMENT

- ***Left atrial enlargement:***

  broad and bifid p wave



V1: negative p ≥ 1 small box (wide and deep)

- ***Right atrial enlargement:***

  peaked p > 2.5 mm in II,III or aVF

- ***Left ventricular hypertrophy:***

  S in V1 or V2 + R in V5 or V6 ≥ 35 mm

  S in V1 or V2 > 20

  R in V5 > 26

  R in V6 > 18

  R in aVL ≥ 13

- ***Right ventricular hypertrophy:***

  R in V1 ≥ 7 mm

  S in V5, V6 ≥ 7 mm

  R/S ratio in V1 ≥ 1

  R/S ratio in V5, V6 ≤ 1

(5) QRST CHANGES (INFARCT)

- ***Areas of heart and pattern of leads:-***

  inferior : II,III, aVF

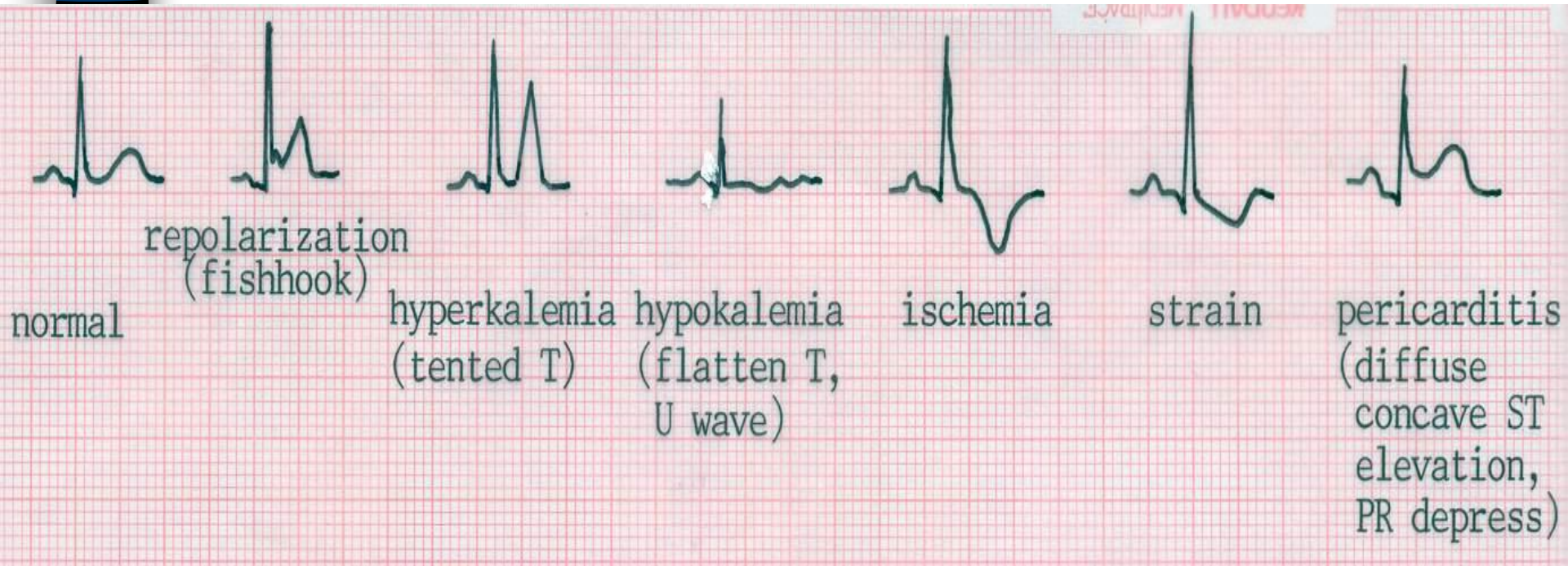
  septal : V1, 2

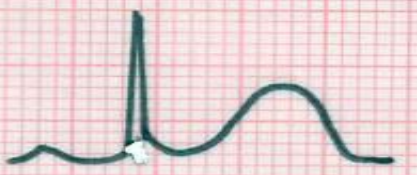
  anterior : V1 – 4

  lateral : V4 – 6

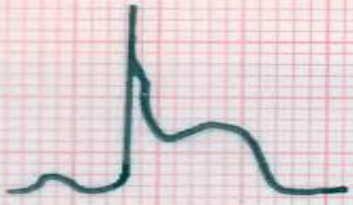
  I, aVL (high lateral)

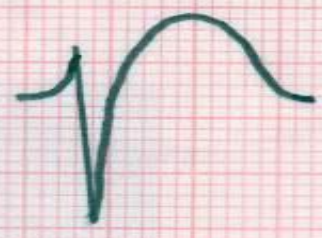
- ***ST segment changes:-***





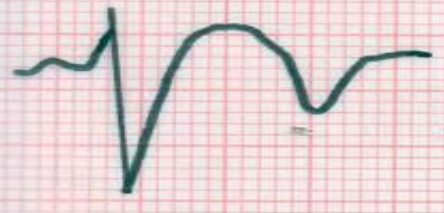
hyperacute T wave



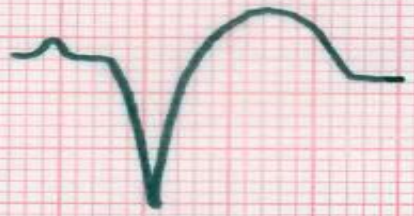


coved ST elevation

ST elevation (=injury)



T wave inversion (= ischemia)



Q wave (= infarct)

- Reciprocal ST segment depression = noninfarct area reflecting ongoing infarction
- Right ventricular infarction = V4R, V1
- Posterior infarction occurs in association with inferior or right infarction
- ST elevation ≥ 0.5 mm in aVR → suspect left main or 3 vessel disease

- ST elevation =
  - ≥ 1 mm elevation in ≥ 2 limb leads (II,III,aVF)
  - ≥ 2 mm elevation in ≥ 2 precordial leads (V1-6)
- ST depression = > 2 mm in > 2 leads

- ST segment coved (downward concavity) configuration → myocardial infarct
- Notching of j point (fish hook) → early repolarization
- Symmetrical inverted T wave → ischemia
- Asymmetric inverted T wave → strain

- ***Nonspecific ST changes*** = minor ST segment depression ≤ 1 mm. Causes = improper electrode contact, ischemia, electrolyte abnormalities, arrhythmia, myocarditis, cardiomyopathy, pulmonary embolism etc.

- ***Tall T wave*** > 5 mm in limb leads or > 10 mm in precordial leads. Causes = hyperacute T wave in acute myocardial infarction, hyperkalemia, left ventricular overload, stroke etc

- ***Low voltage QRS:***

  QRS in limb leads < 5 mm

  QRS in precordial leads < 10 mm

  causes = obesity, pericardial effusion, constrictive pericarditis, myxedema, pleural effusion, chronic lung disease etc.

- Wide QRS complex not RBBB or LBBB pattern → intraventricular conduction delay (IVCD)
- By age 10, electrocardiogram = adult pattern
- S1Q3T3 or S1S2S3 → pulmonary embolism
- Hyperkalemia → peaked T wave
- Hypokalemia → T wave flattening, U wave
- Hypercalcemia → prolong QT interval
- Hypocalcemia → shorten QT interval
- Hypo- and hypernatremia → no characteristic ECG changes
- Hypothermia → Osborn wave
- **Brugada syndrome : RBBB and ST elevation V1-3**