



核心課程編號：B46

# 心電圖判讀

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109年03月15日 第三版



## PGY

### 知識

1. 心電圖之基本原理
2. 正常心電圖的波形及正常值
3. 心律不整及傳導系統異常的判讀
4. 心房擴大及心室肥大的心電圖表現
5. 心肌缺氧及梗塞之判讀
6. 肺栓塞的心電圖變化
7. 毛地黃藥物效果在心電圖之表現
8. 高低血鉀之心電圖變化
9. 急性心包膜炎的心電圖判讀

## UGY

### 知識

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### 技能

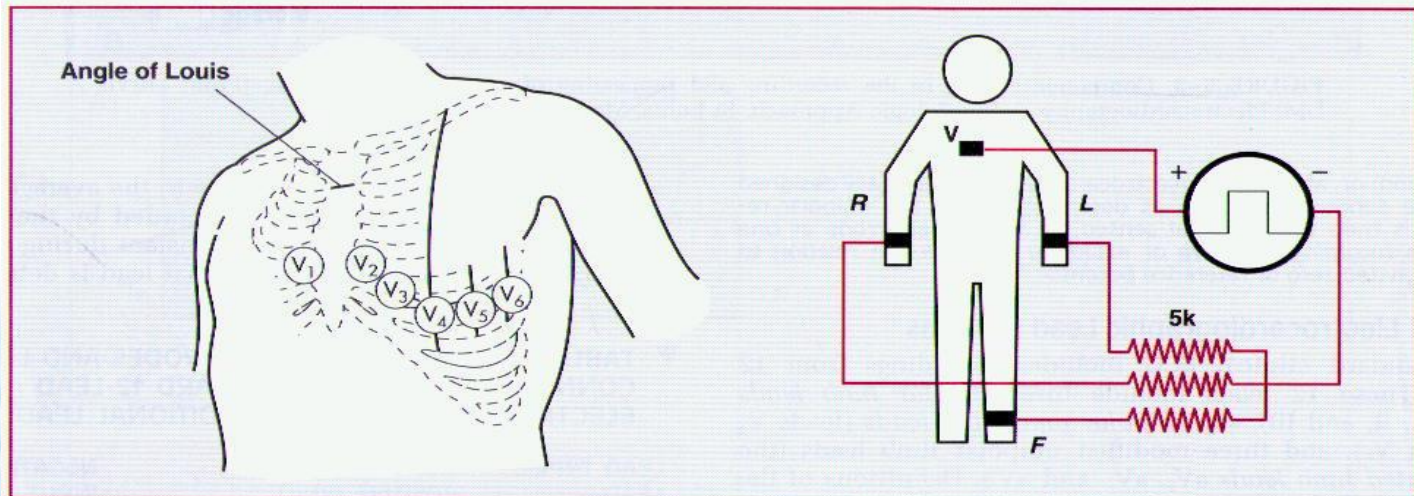
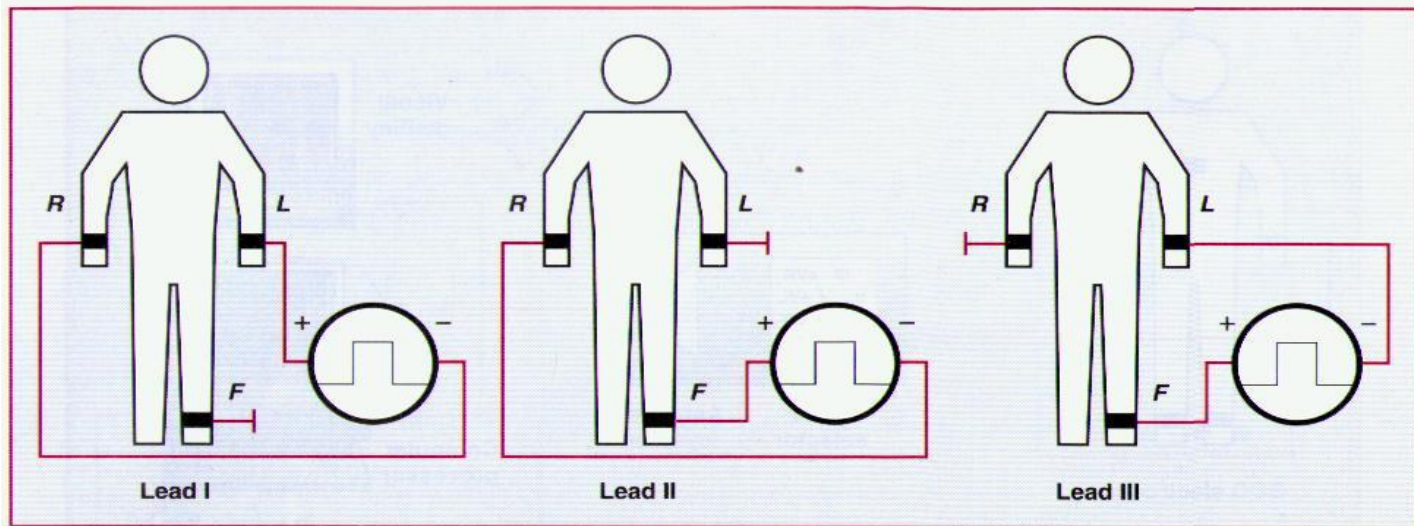
1. 操作心電圖機器



# Basic knowledge of ECG

• Electrocardiography (ECG or EKG)

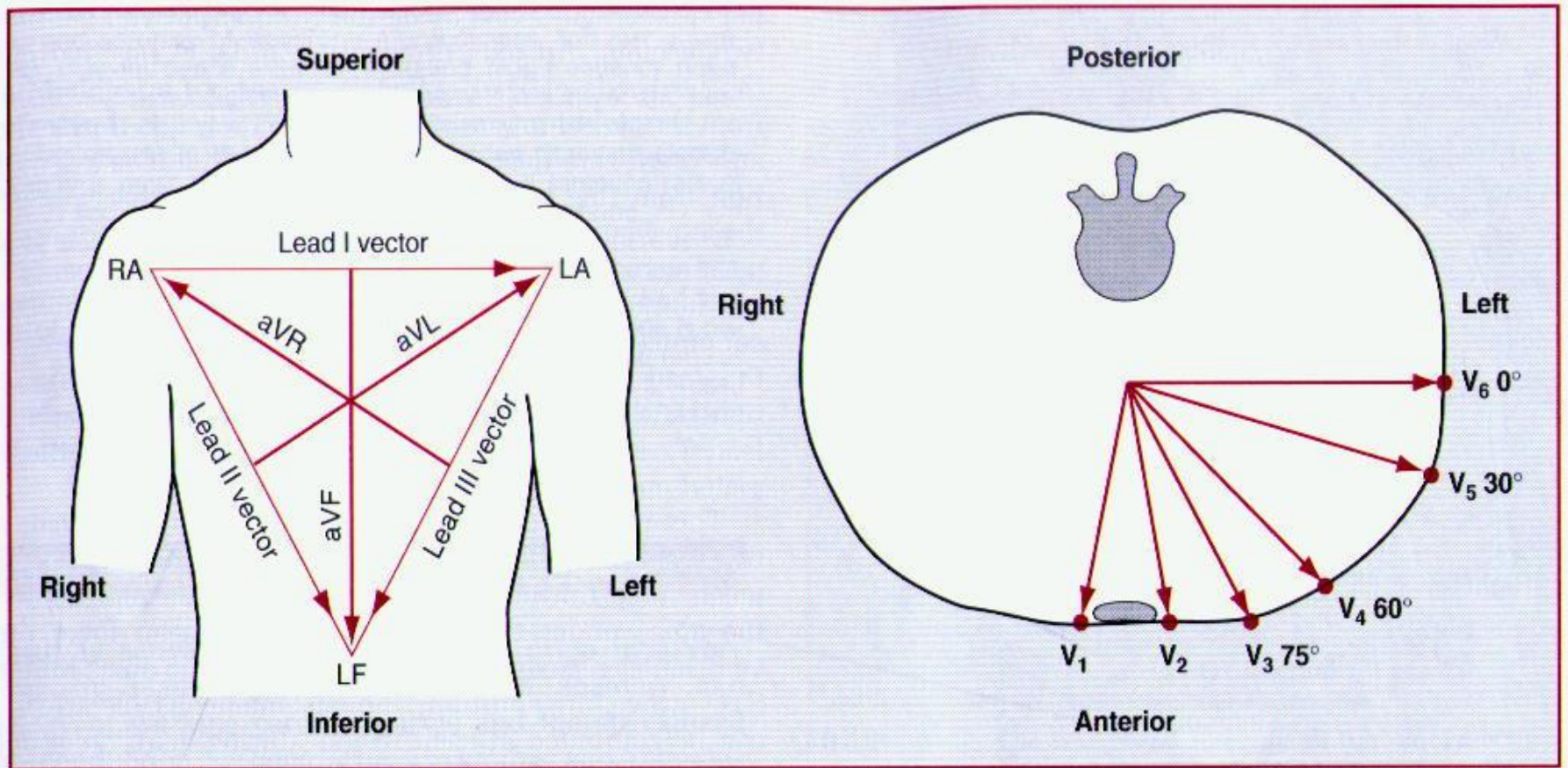
心電圖即是心臟電氣活動的記錄





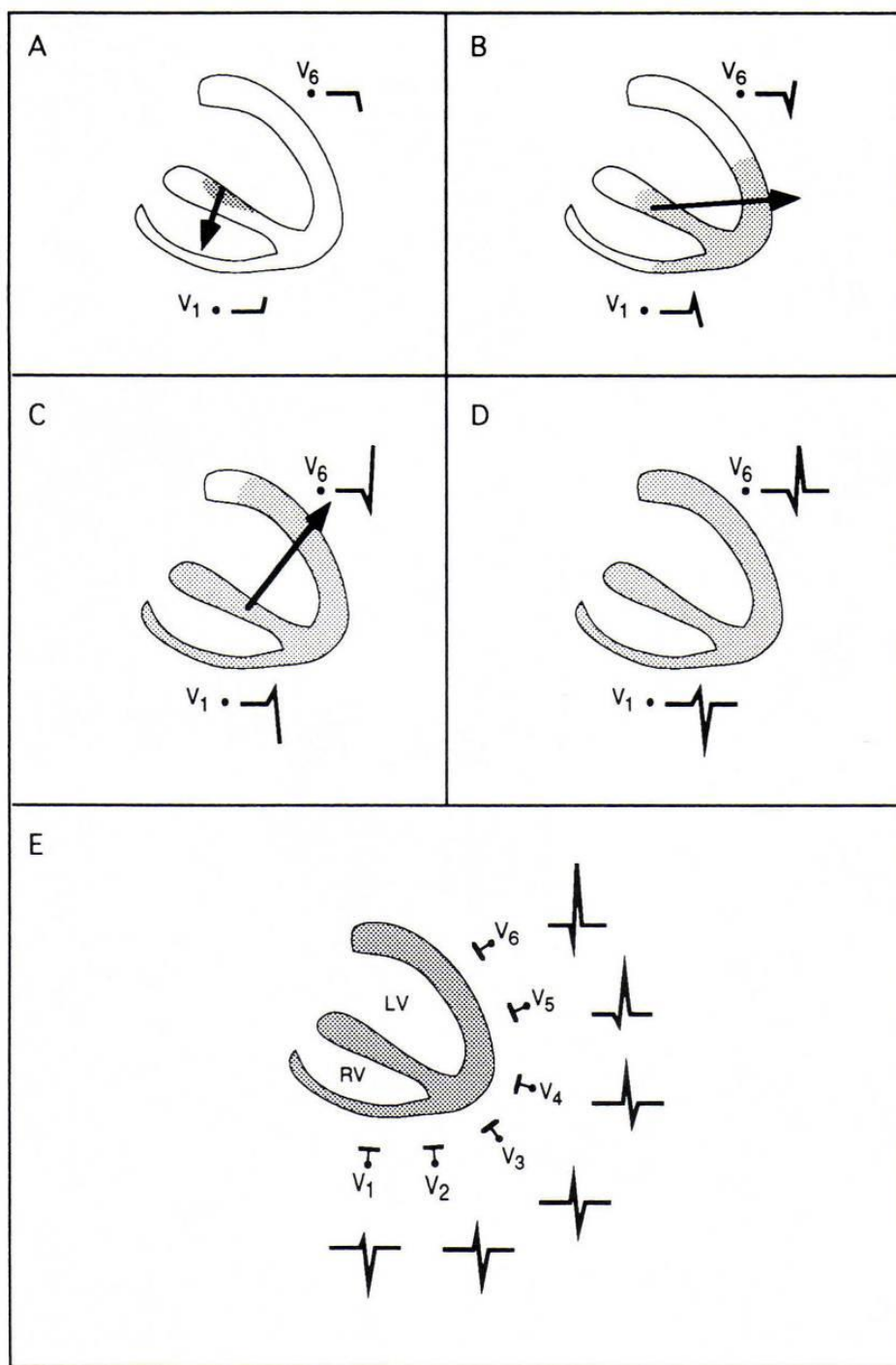
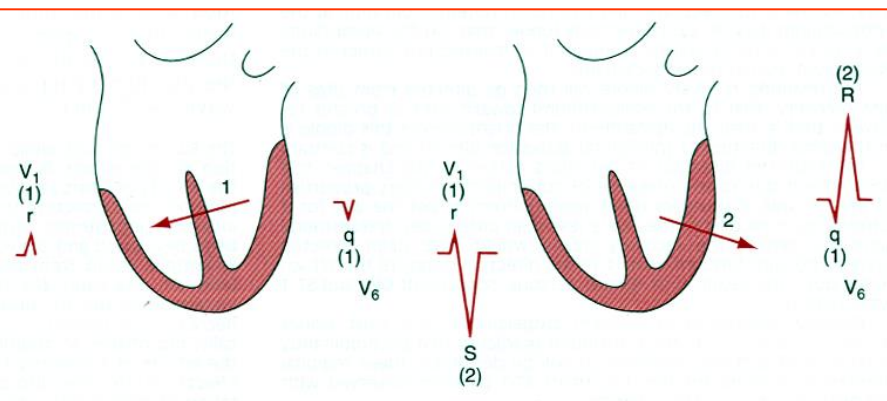


# Basic knowledge of ECG





# V1&V6的QRS波 是如何形成的







# 心電圖波形：EKG WAVEFORMS

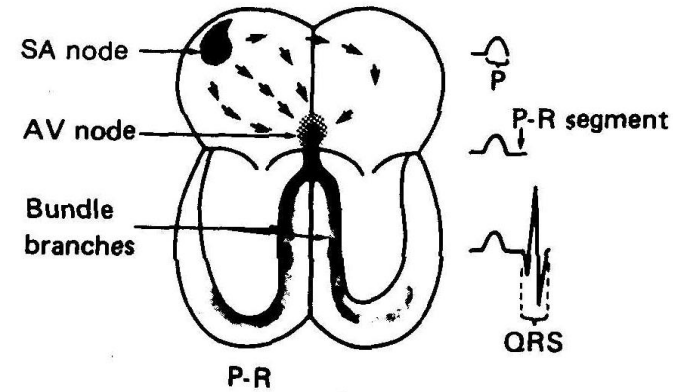
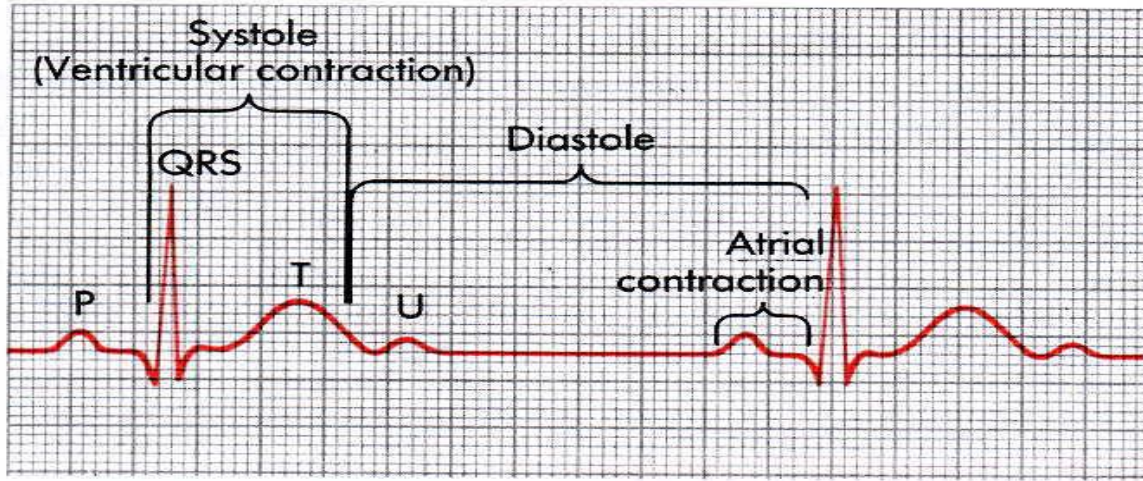
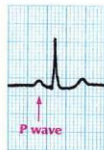
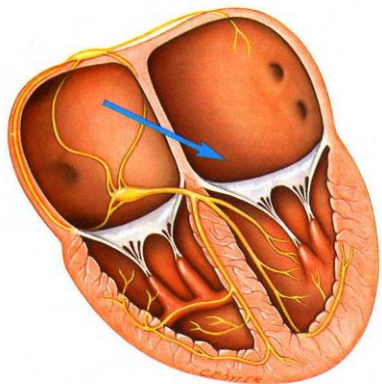
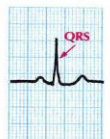
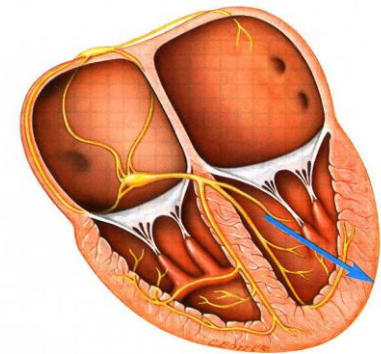


圖 1-3 ECG波型以及相對應的時間長短(Timing)



- P wave: 心房去極化
- QRS wave: 心室去極化
- T wave: 心室再極化







# 心電圖波形：EKG WAVEFORMS

## ❖ QRS complex 的命名：

- 第一個向下的波：Q wave
- 第一個向上的波：R wave
- 第二個向下的波：S wave

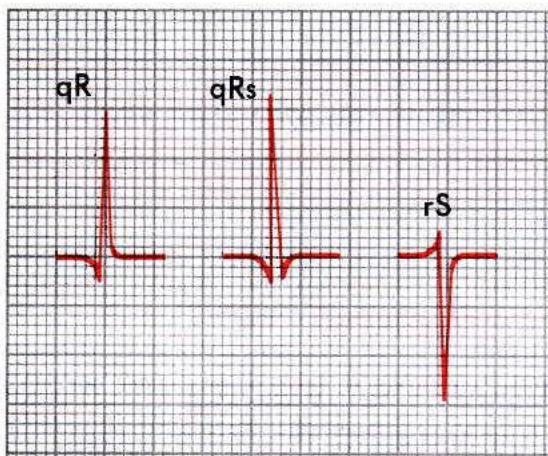
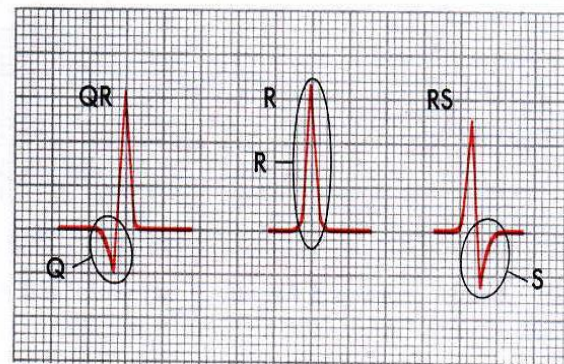


圖1-8 qR, qRs, rS complexes · 偏折量較小者用小寫表

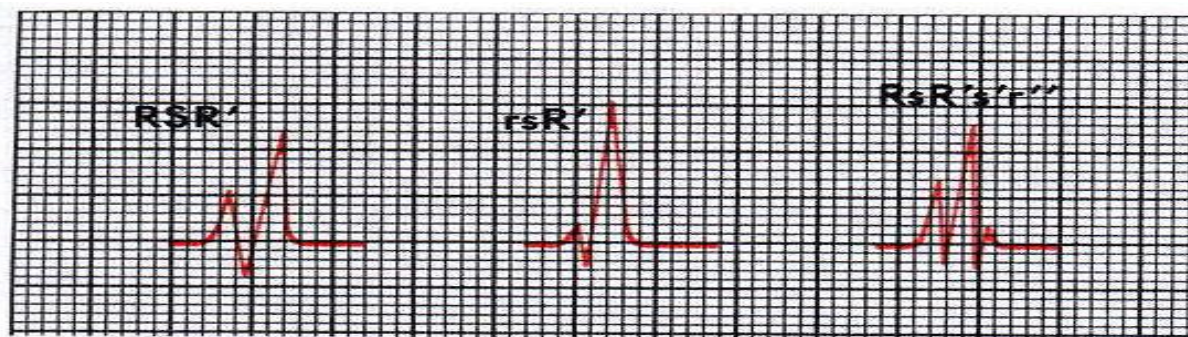
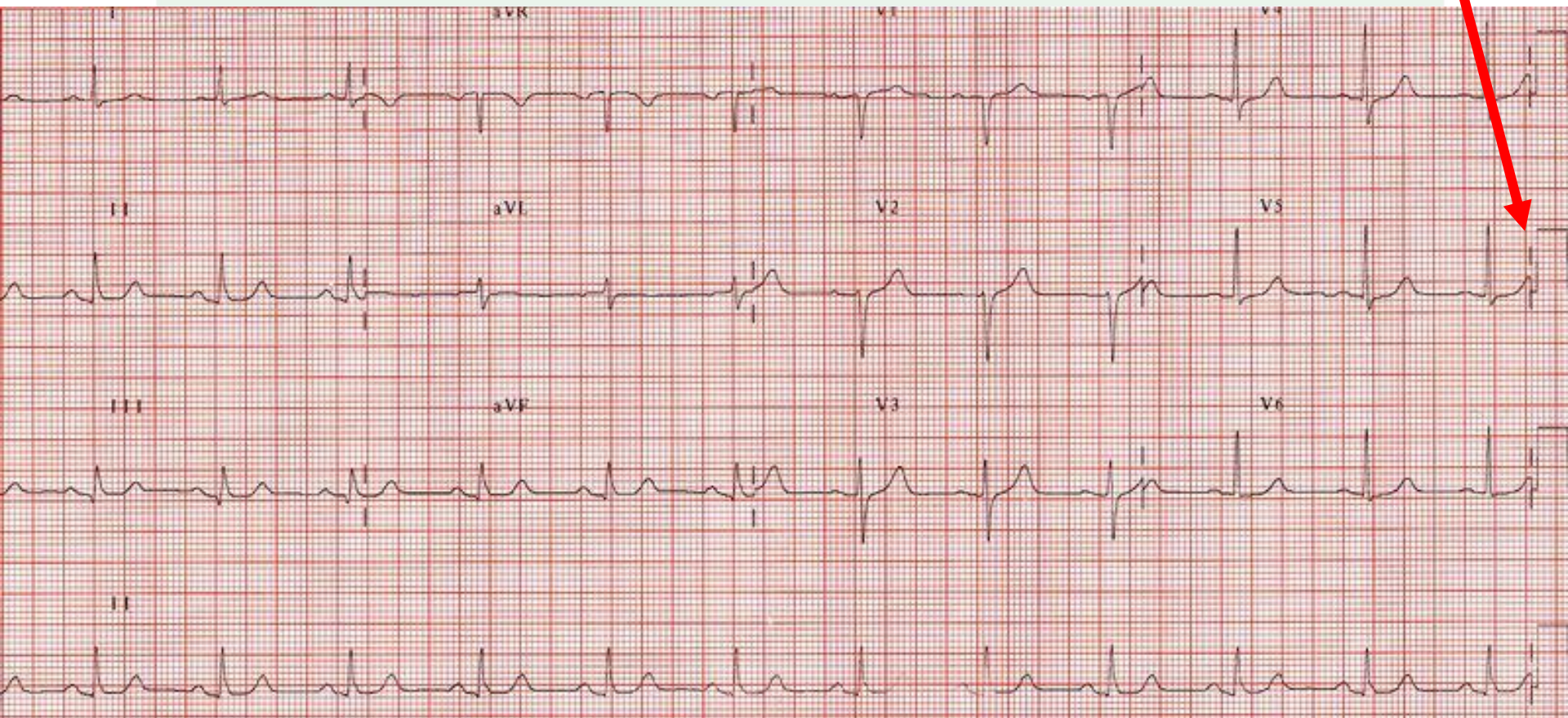


圖1-10 QS complex由於沒有正偏折(R波)，所以無法分辨此為Qwave或QS wave





# Standard: normal, half or double



25 mm/s 10 mm/mV K & D. Hz 40 Hz W HP798 14810  
PRINTED IN U.S.A.





# Intervals

## Normal Intervals

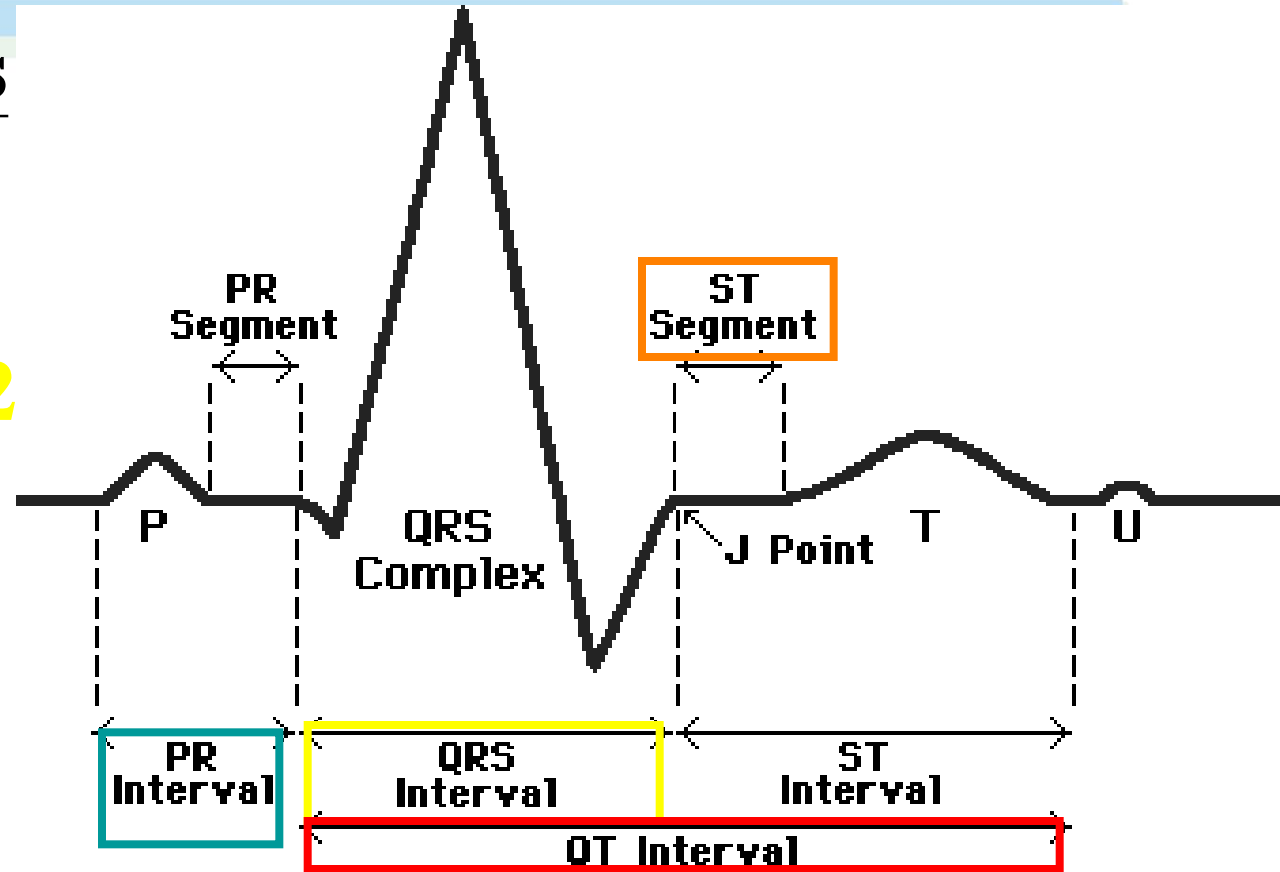
**PR: 0.12 to 0.20**

**QRS: 0.04 to 0.12**

**QT: < 0.45**

**(varies)**

**ST: isoelectric**





# Rate

❖  $60 / \text{RR interval in sec}$

❖  $300 / \text{大格數}$

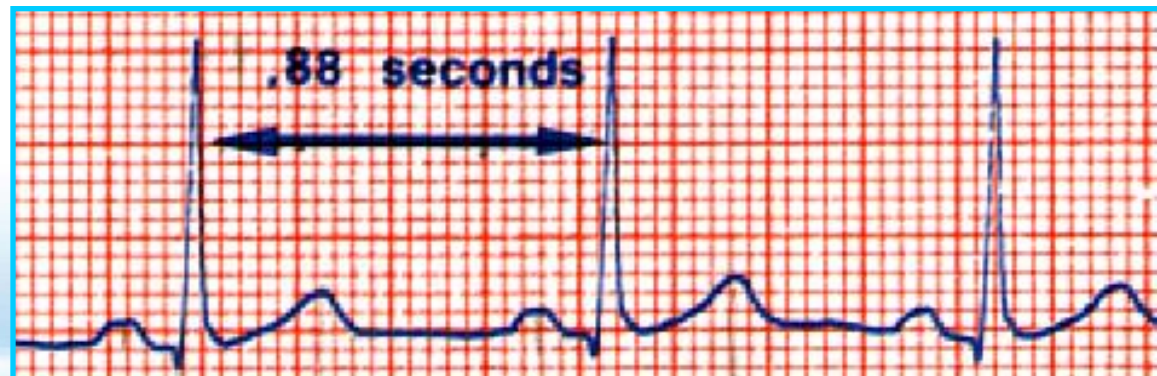
1大格 = 300      4大格 = 75

2大格 = 150      5大格 = 60

3大格 = 100      6大格 = 50

❖ Long lead II R wave x 6

$$60 / 0.88 \text{ sec} = 68 / \text{min}$$

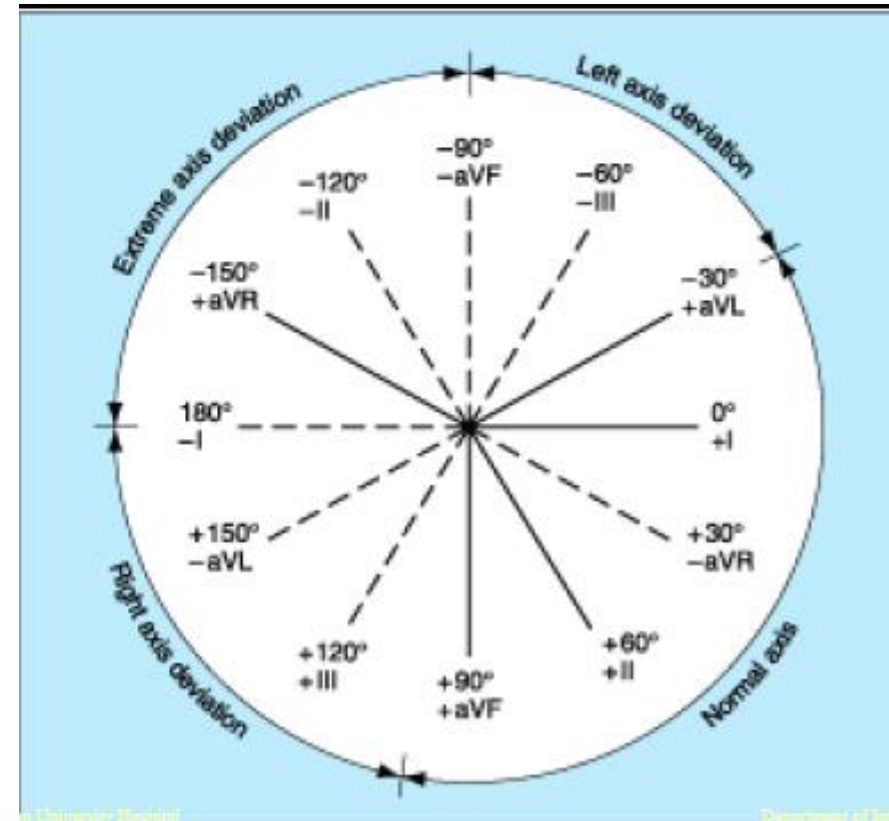




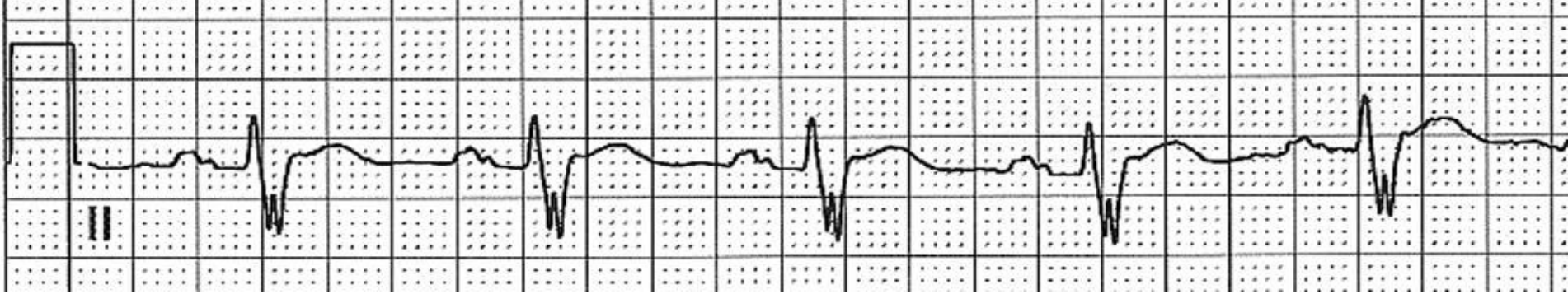


# Axis

- ❖ Normal axis:  $0 \sim 90^\circ$   
(lead I, AVF more positive)
- ❖ LAD:  $< -30^\circ$  (lead II more negative)
- ❖ RAD:  $> 90^\circ$  (lead I more negative)
- ❖ Superior Axis deviation (North-west direction)



• Normal Limits of QRS Axis  
in Adults:  $-30^\circ$  to  $+90^\circ$ .



# Rhythm

- Heart rate ?
- Identify P wave ?
- QRS (wide or narrow QRS) ?
- Regularity ?
- P & QRS 相關性 ?





## ❖ Normal sinus rhythm

- Normal P wave axis and morphology
- P wave morphology: positive in inferior leads, negative in aVR
- P waves precede QRS complexes
- Rate 60-100 bpm

## ❖ Sinus tachycardia

- Normal P wave axis and morphology
- P waves precede QRS complexes
- Rate > 100 bpm

## ❖ Sinus bradycardia

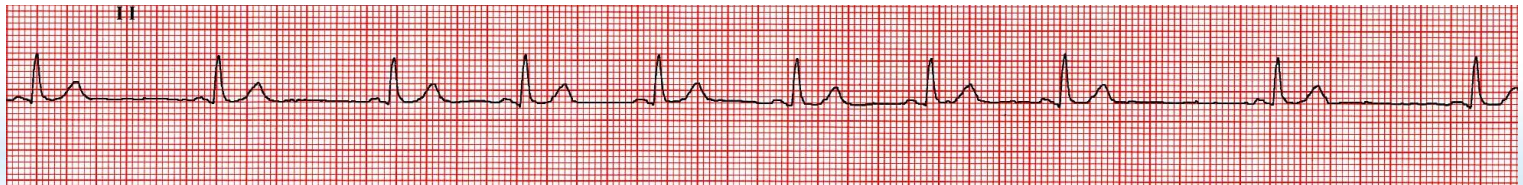
- Normal P wave axis and morphology
- P waves precede QRS complexes
- Rate < 60 bpm



# Sinus Arrhythmia

## (竇性心律不整)

- ❖ Normal P wave axis and morphology
- ❖ Variation in the P-P interval
- ❖ Longest and shortest PP intervals vary by  $> 0.16$  sec or 10%





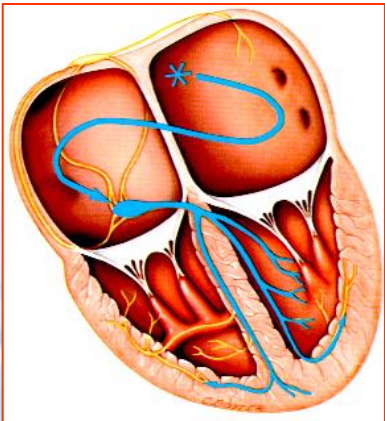


# 心律不整 (Cardiac Arrhythmia)



# Atrial premature contraction (APC)

- ❖ P wave is abnormal in configuration
- ❖ P wave is premature relative to the normal pp interval
- ❖ Narrow QRS complex
- ❖ A non-compensatory pause followed by a premature beat

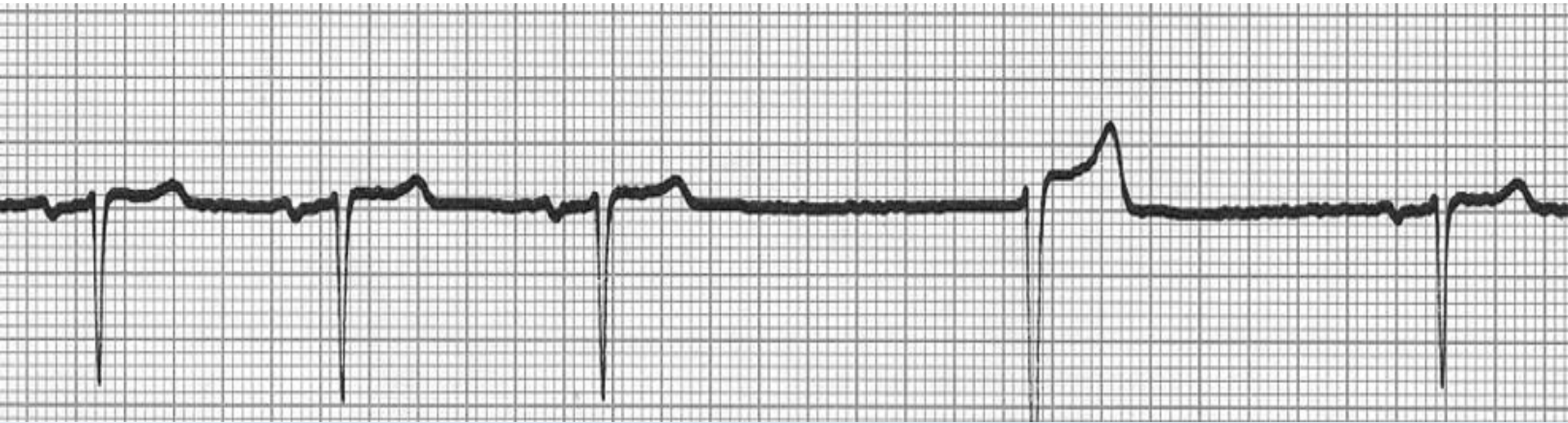






# Junctional Escape Rhythm

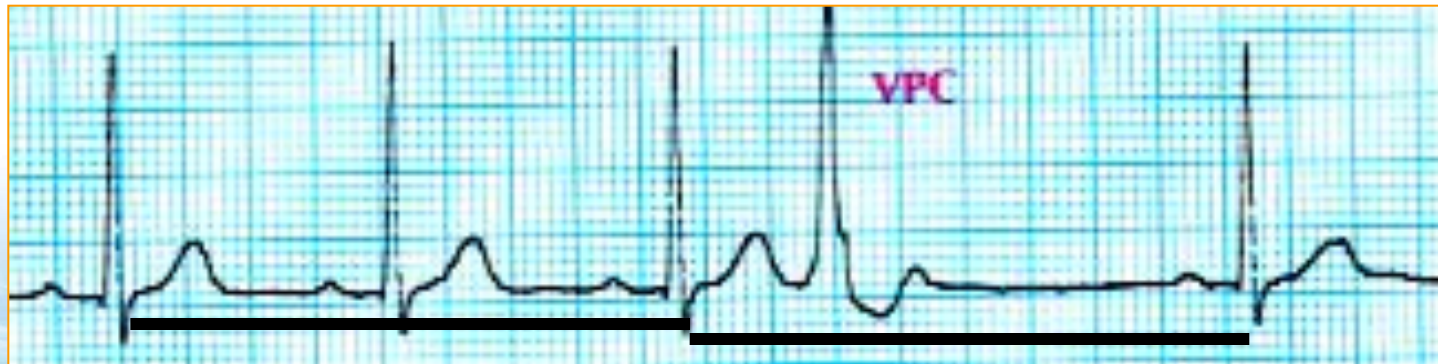
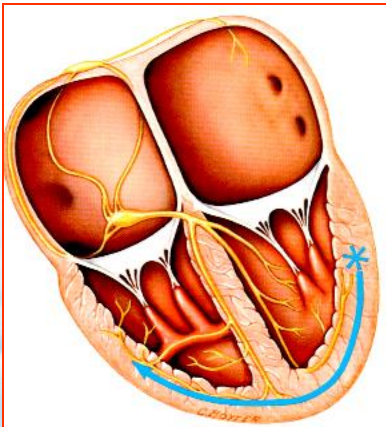
- ✦ absent P wave
- ✦ normal (narrow) QRS complexes
- ✦ rate 40-60 bpm





# Ventricular premature contraction (VPC)

- ❖ Wide QRS complex
- ❖ No preceding P wave; AV dissociation is present
- ❖ The premature beat is followed by a full compensatory pause







**Bigeminal VPCs**



**Multifocal VPCs**

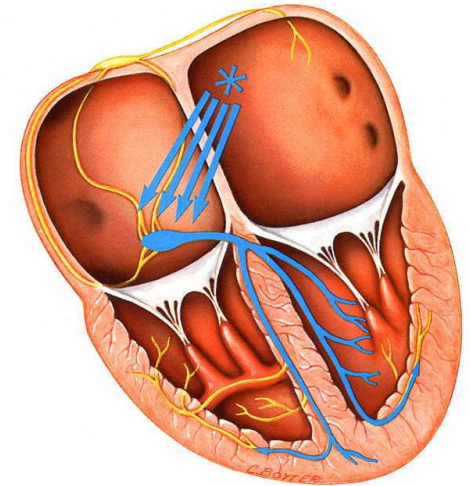
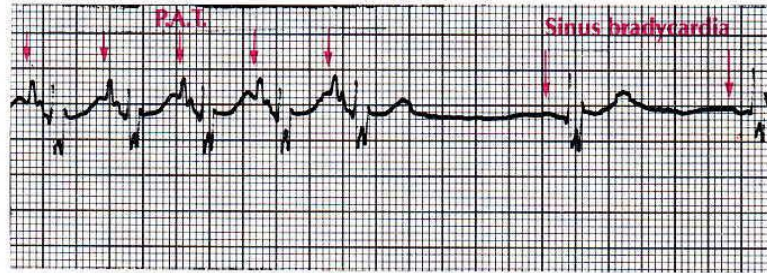


**Short run VT**



# 陣發性心房心博過速

## Paroxysmal Atrial Tachycardia



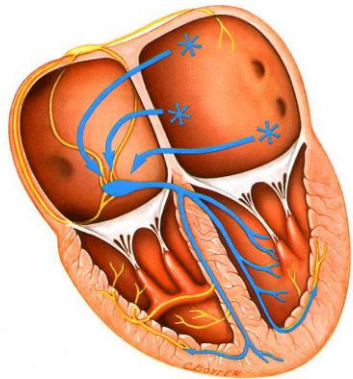
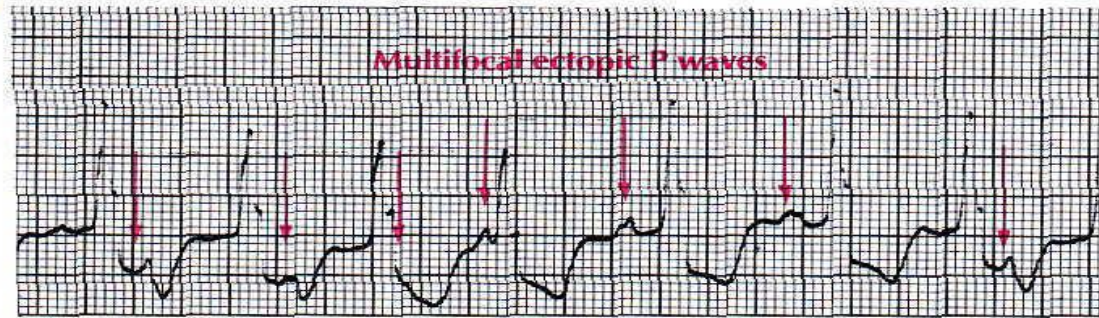
心跳: 140-220/min





# 多焦點性心房心博過速

## Multifocal Atrial Tachycardia



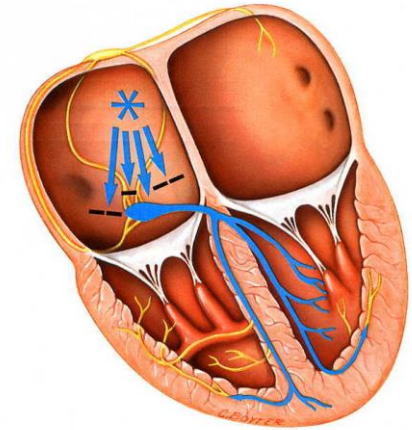
4-6 multifocal APCs in a row  
with an irregular P-P cycle,  
varying PR intervals, rate  
100-200/min



# 心房撲動(atrial flutter)

- sawtooth waveform in inferior leads
- Usually 2:1(150BPM), 3:1(75BPM), 4:1 conduction etc.
- Usually narrow QRS complex
- **One ectopic focus** in atria, rate 220-350/min

## Atrial Flutter



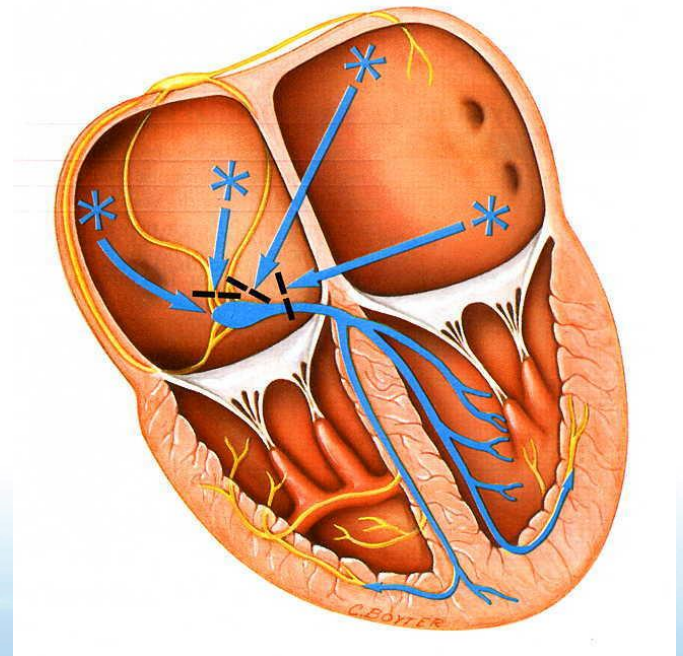
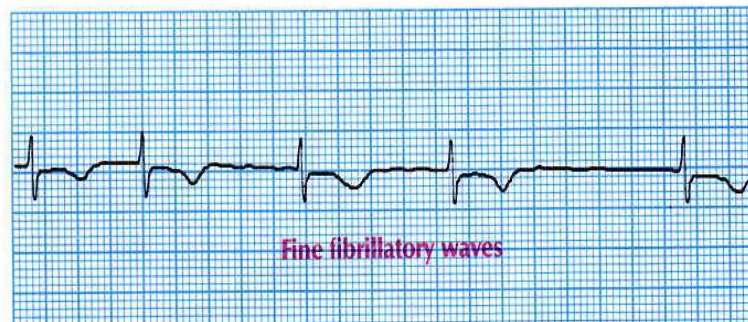
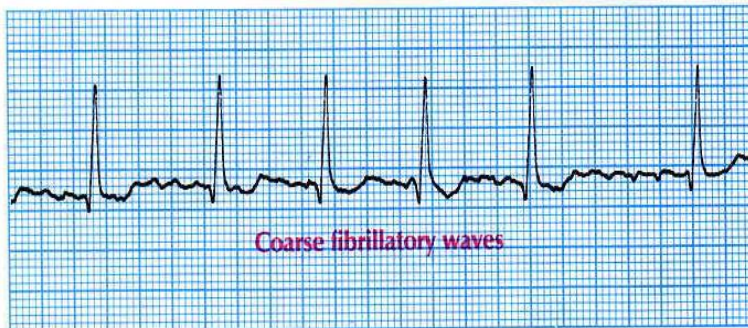




# 心房顫動 (atrial fibrillation)

- Multifocal ectopic foci in the atria, rate 350-650/min
- fibrillatory waves; No p waves
- RR intervals are **irregularly irregular**
- If ventricular rate  $> 100$  bpm  $\rightarrow$  Af with rapid ventricular response (Af with RVR)

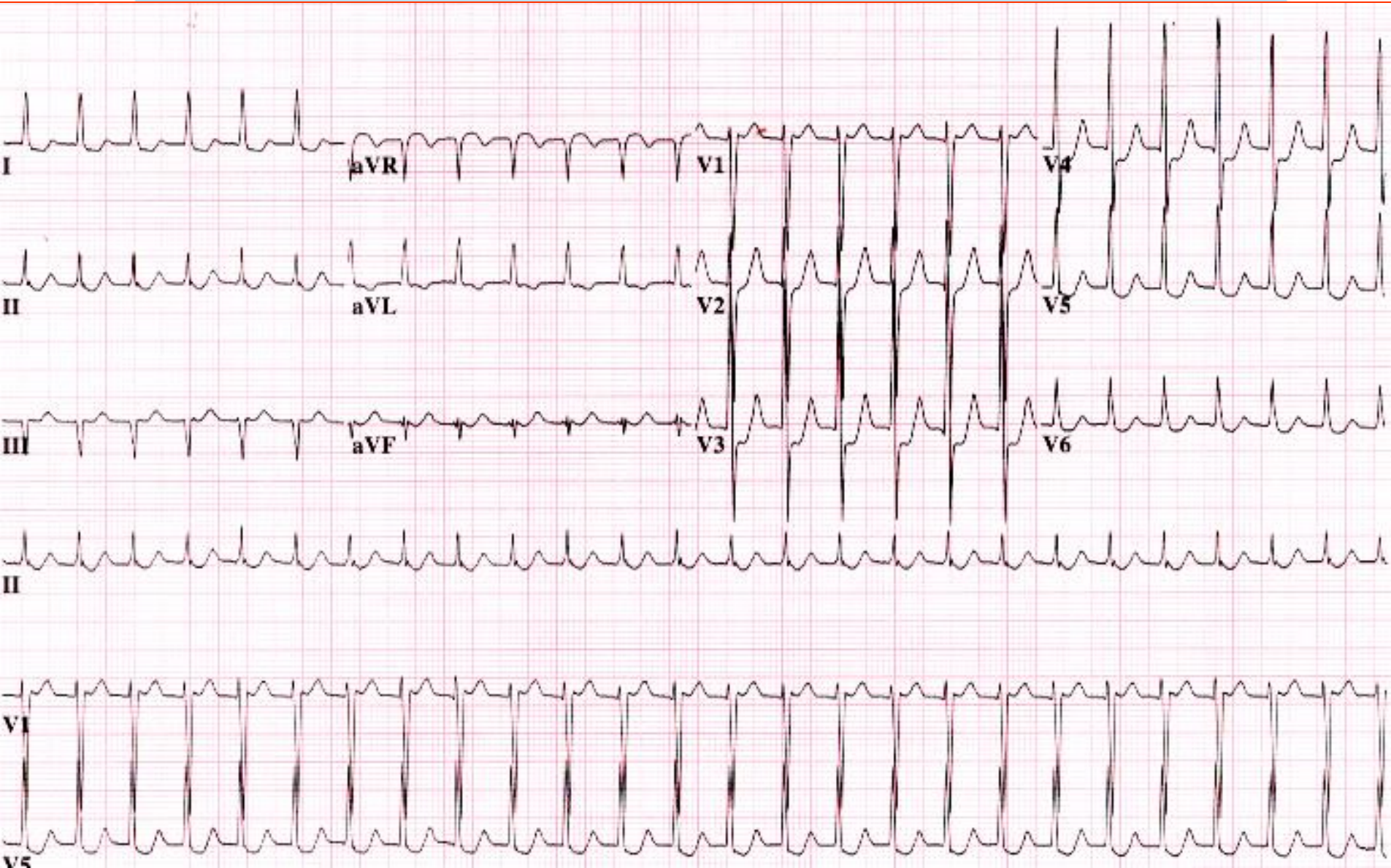
## Atrial Fibrillation







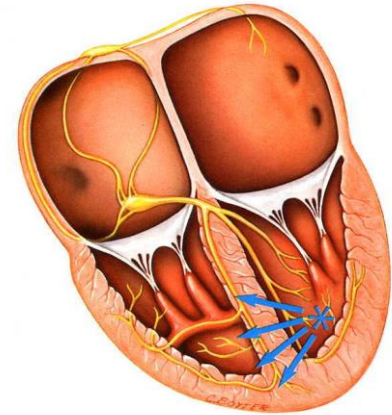
# A 71-year-old male with previous episodes of tachycardia: Paroxysmal supraventricular tachycardia





# 心室心博過速

- ↘  $\geq 3$  consecutive VPCs at a rate  $> 100$  bpm
- ↘ Wide QRS complex
- ↘ RR is usually regular



**Ventricular Tachycardia**

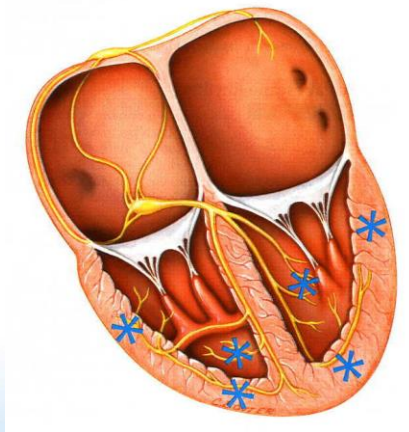
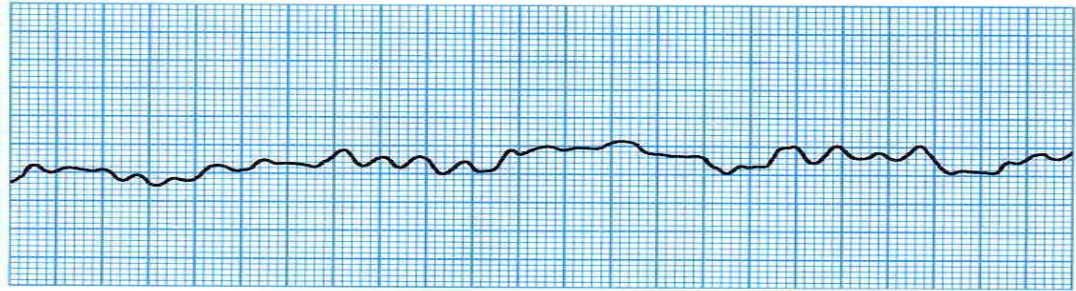






# 心室顫動

## Ventricular Fibrillation



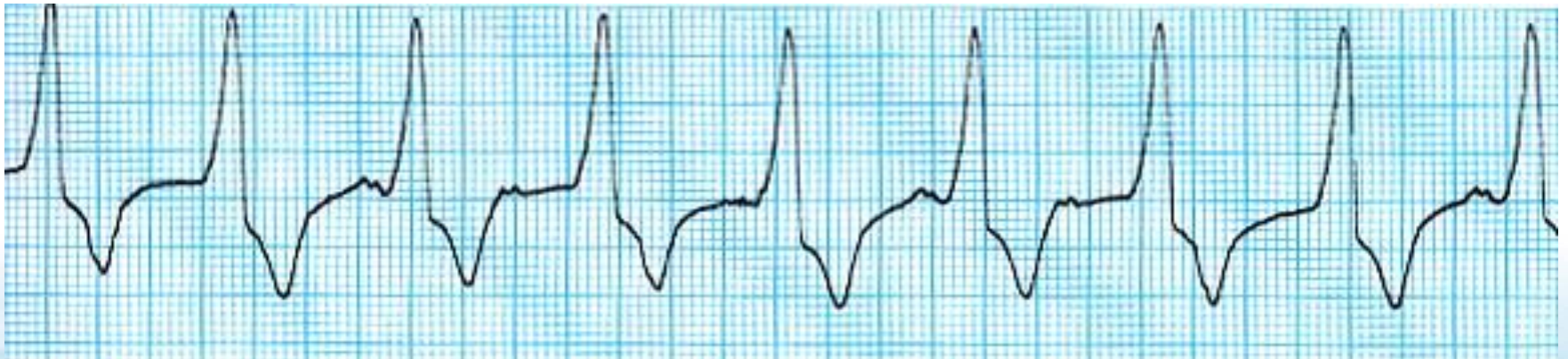
無心房活動或QRS complex





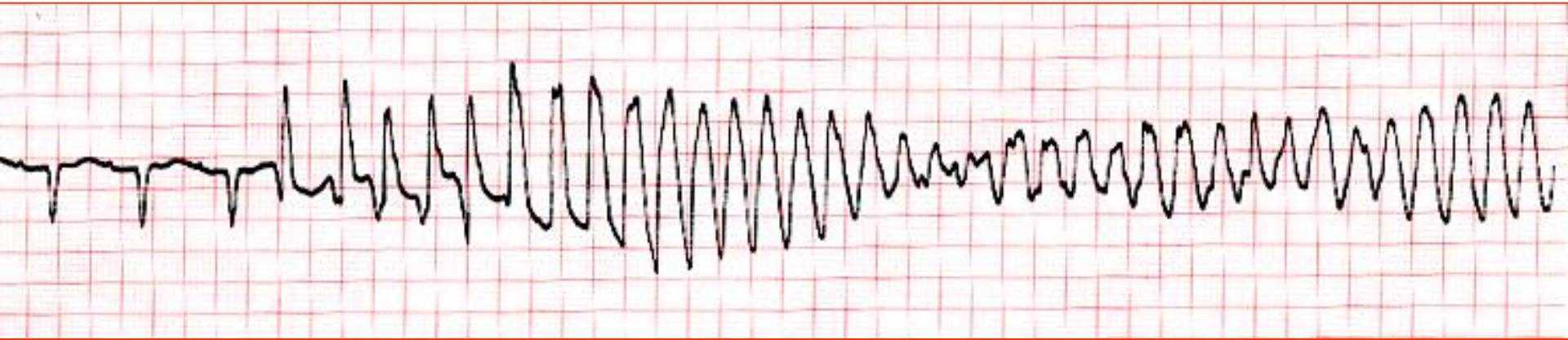
# Accelerated idioventricular rhythm (AIVR)

- ❖ Wide QRS complex, HR 60-100 bpm (faster than sinus rate)
- ❖ Usually seen in association with an AMI
- ❖ It is considered to be a reperfusion arrhythmia





# Torsades de Points



## ◆ *Definition:*

A ventricular tachycardia characterized by QRS complexes progressively changing amplitude and contour that seem to revolve around the isoelectric line and create the typical twisting about a point appearance





# First Degree AV block

- ❖ PR interval  $>0.20$  sec
- ❖ All P waves conducted

## First Degree AV Block

First degree AV block is the lengthening of conduction time from the AV node to the ventricles and is characterized by a PR interval greater than .20 second.



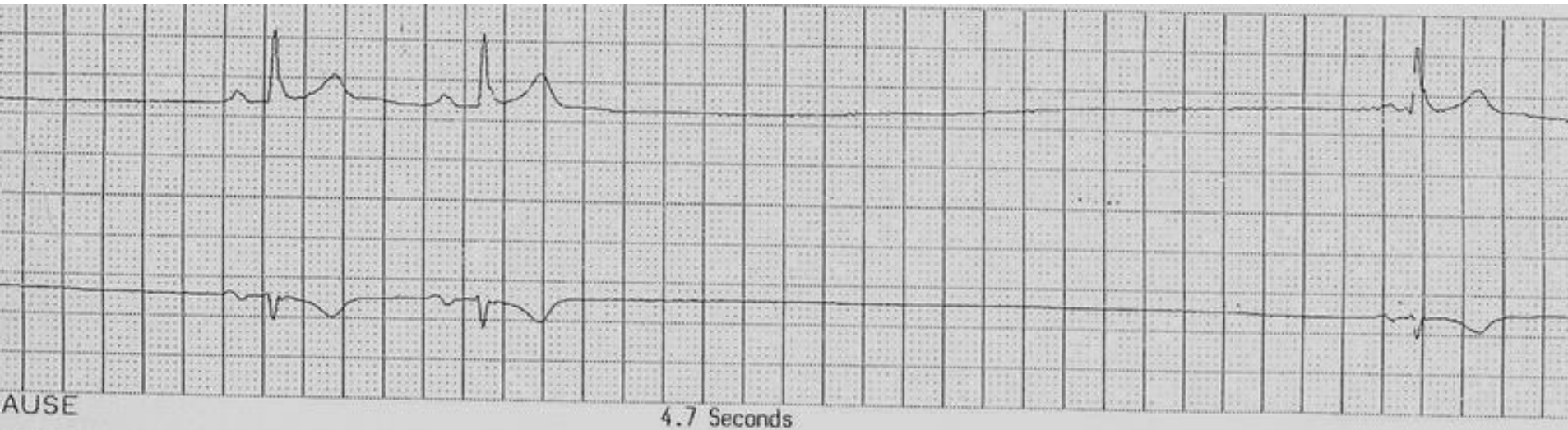
**Sinus rhythm with first degree AV block.**



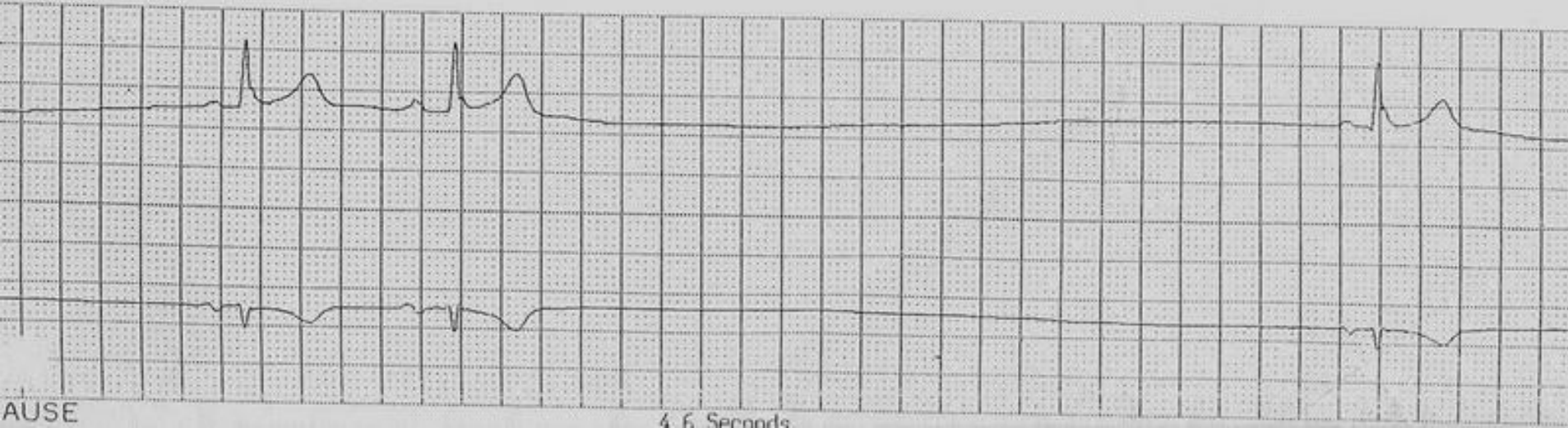


# Sick Sinus syndrome

◀ Sinus pauses and arrest (>3 sec)



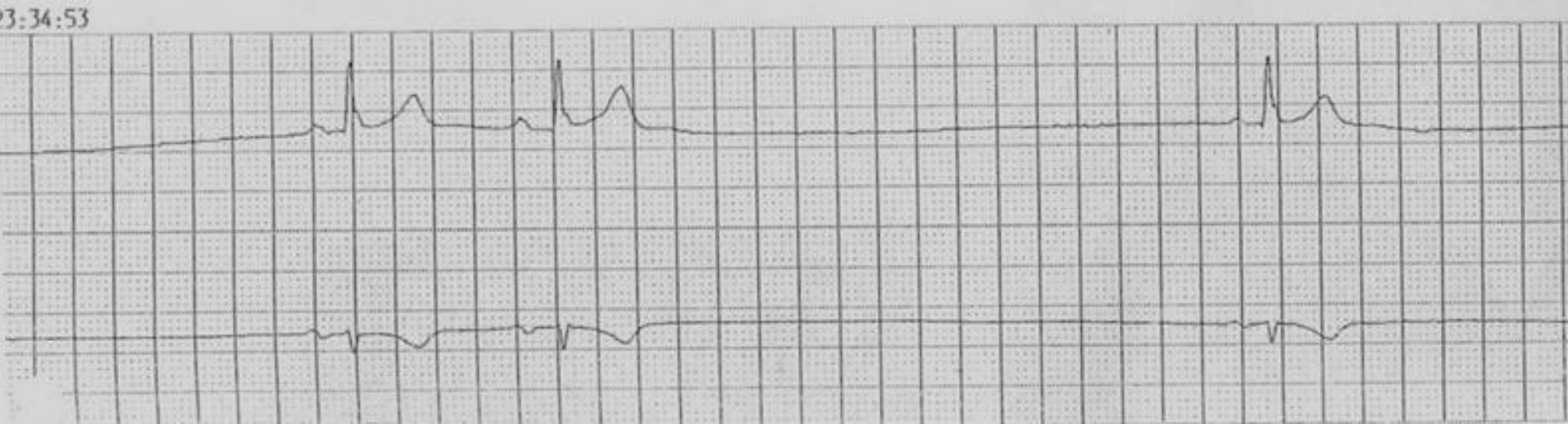
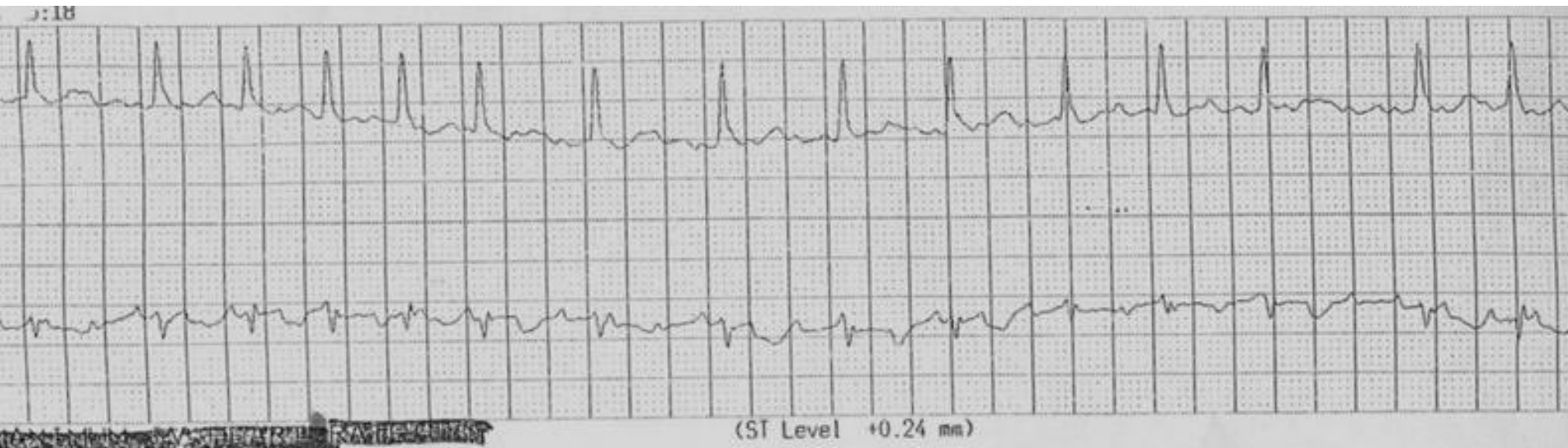
3:35:00





# Sick Sinus syndrome

◆ Tachycardia-bradycardia syndrome





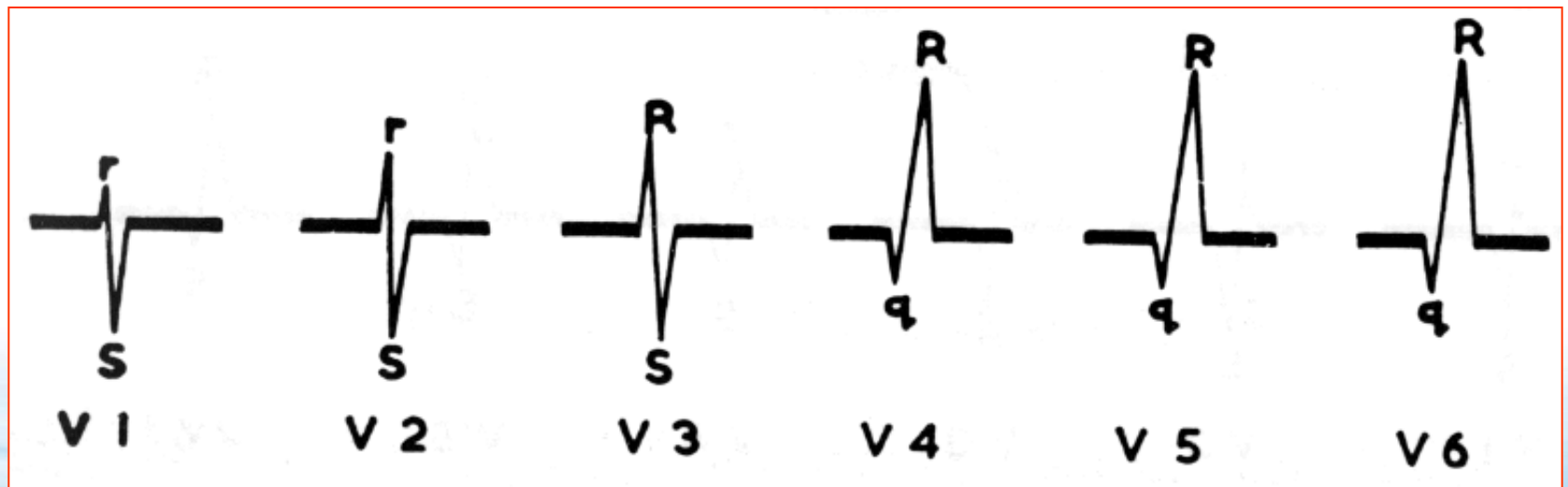
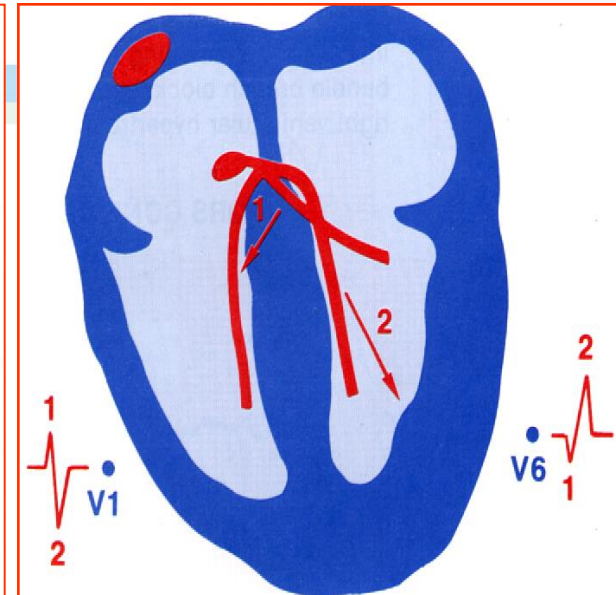
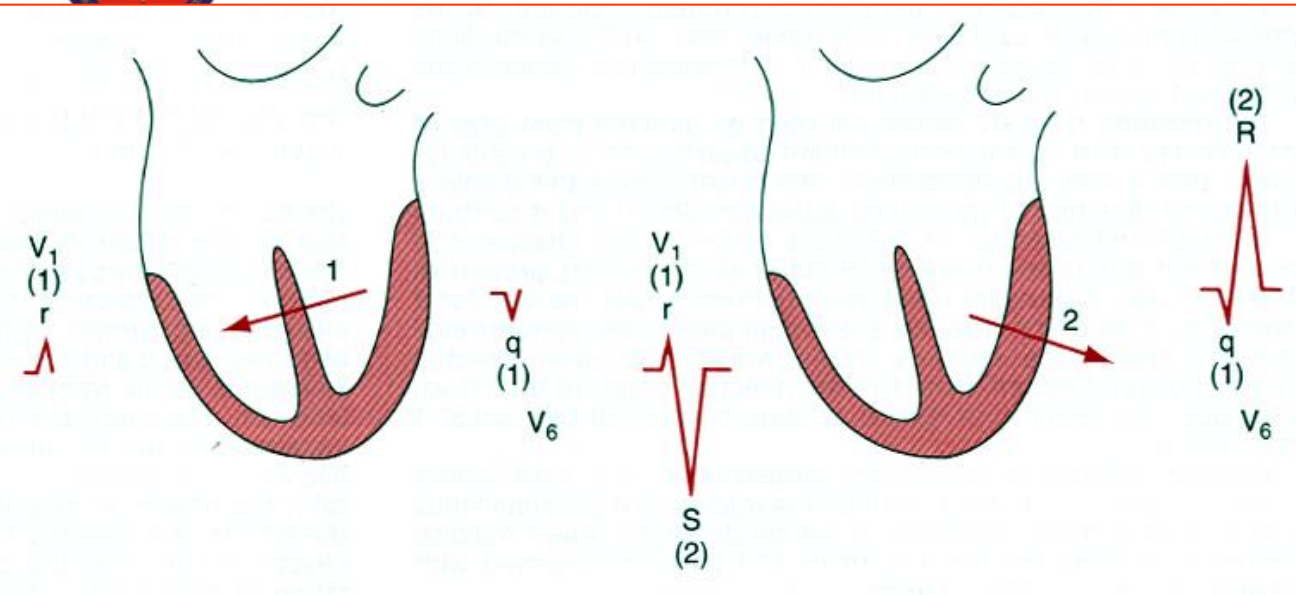


# IVCD(intraVentricular conduction delay)

- ❖ Right bundle branch block (RBBB)
- ❖ Left bundle branch block (LBBB)
- ❖ Left anterior fascicular hemiblock(LAHB)
- ❖ Left posterior fascicular hemiblock(LPHB)
- ❖ Non-specific intraventricular conduction delay



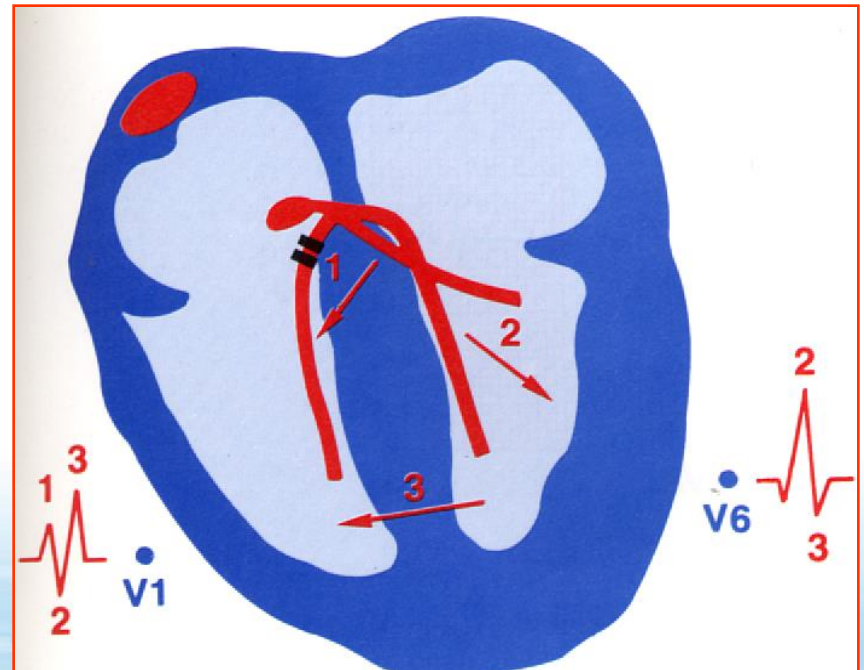
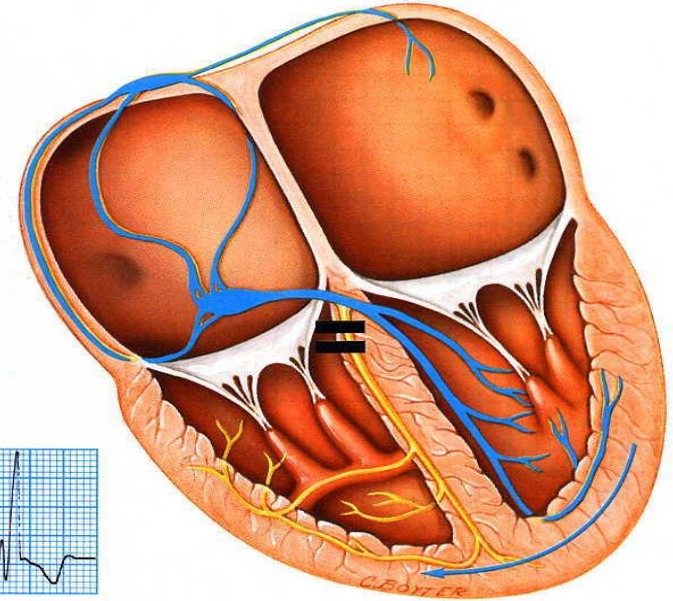
# normal conduction





# RBBB

- ❖ QRS > 0.12 sec
- ❖ rSR' in V1, V2
- ❖ Slurred S wave in V5, V6
- ❖ Incomplete RBBB: 0.10 ~ 0.12 sec

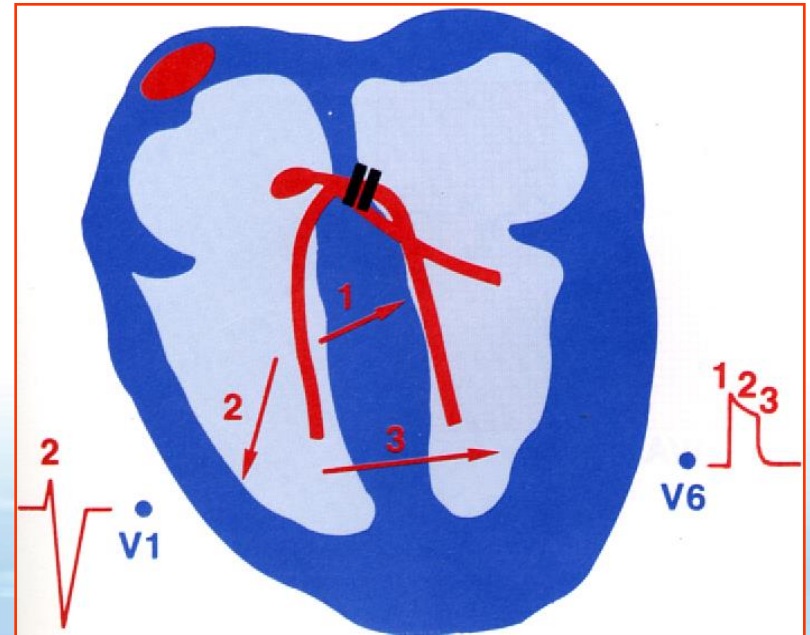
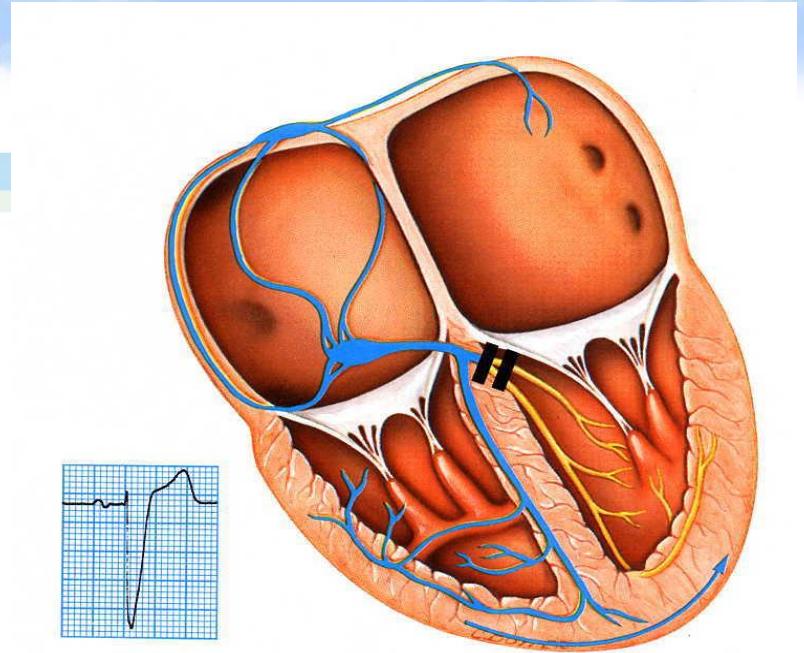






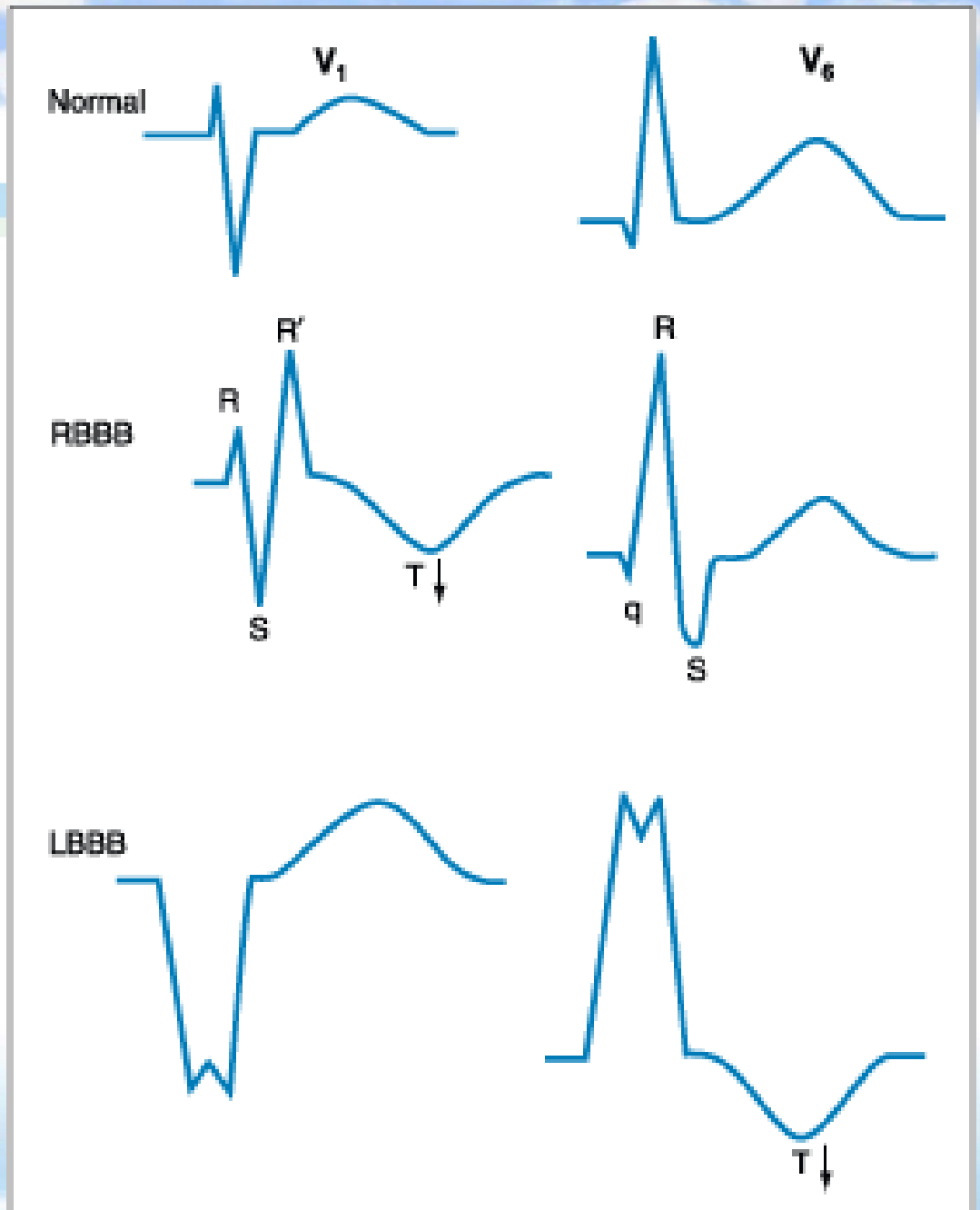
# LBBB

- ❖ QRS > 0.12 sec
- ❖ rSR' in V5, V6
- ❖ Slurred S wave in V1, V2
- ❖ Incomplete LBBB: 0.10 ~ 0.12 sec





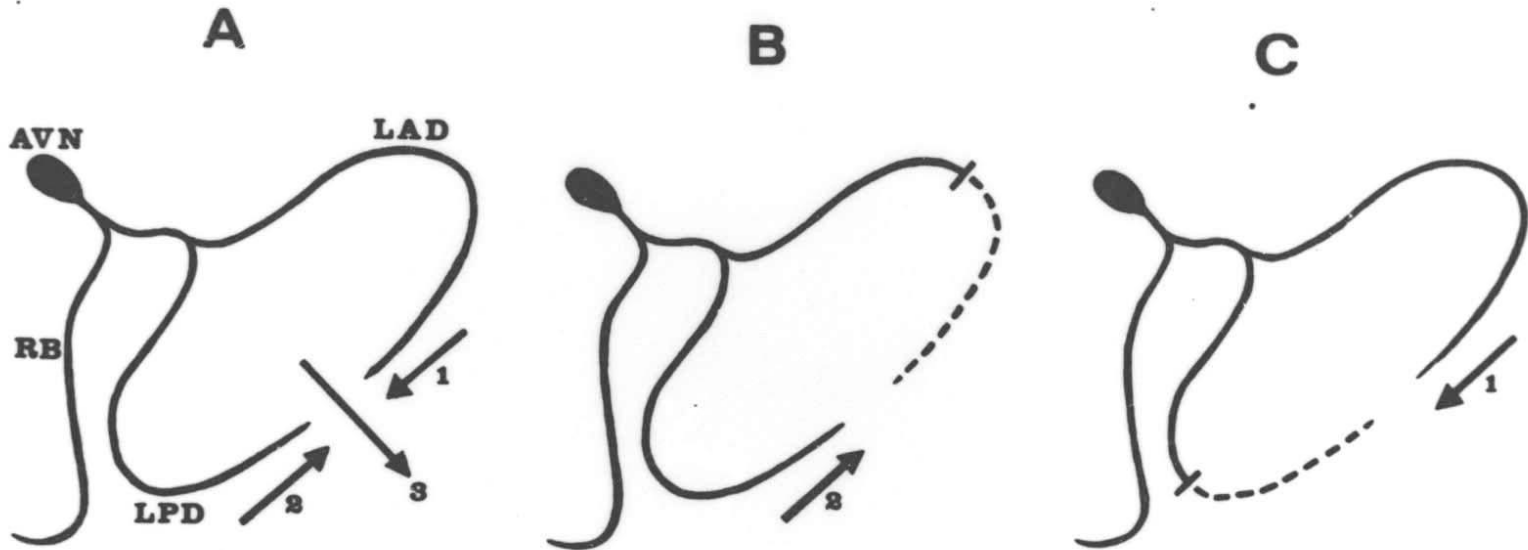
## ❖ Secondary ST-T changes







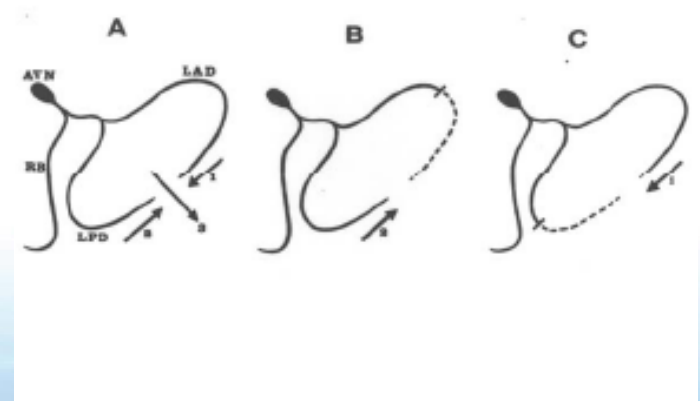
# Fascicular block





# LAFB

- ❖ LAD greater than  $-30^{\circ}$
- ❖ QRS interval normal or slightly prolonged
- ❖ gR pattern in leads I, aVL and rS in III, aVF

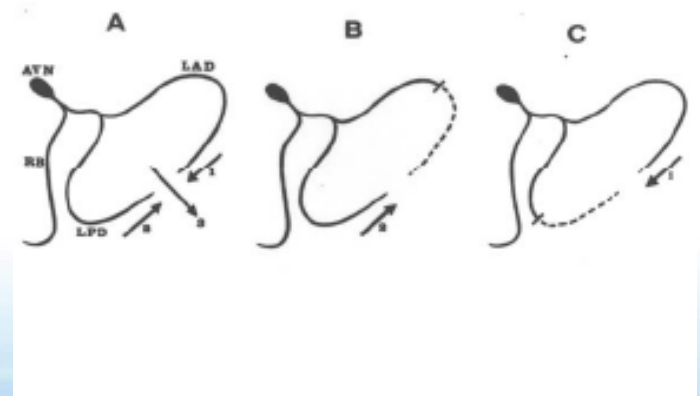






# LPHB

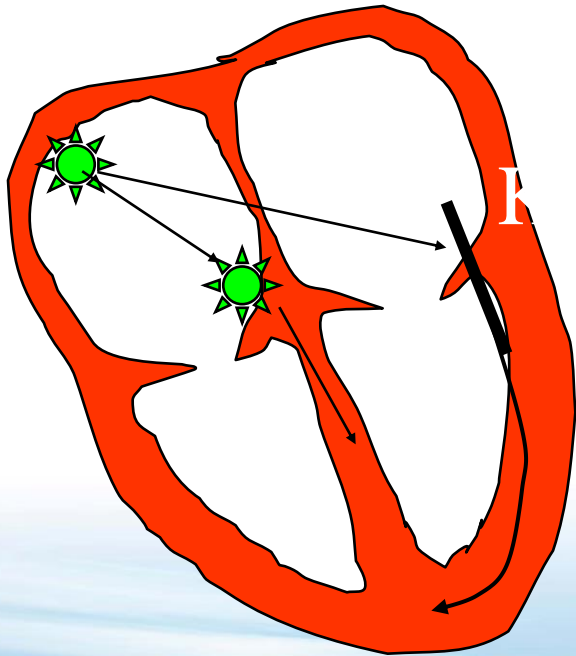
- ❖ RAD greater than  $120^\circ$
- ❖ QRS interval: Normal or slightly prolonged
- ❖ rS pattern in leads I, aVL gR pattern in leads III, aVF





# Wolff-Parkinson-White syndrome

- ❖ Short PR interval
- ❖ Delta waves
- ❖ Wide QRS







# Chamber enlargement

❖ LVH

❖ RVH

❖ LAE

❖ RAE

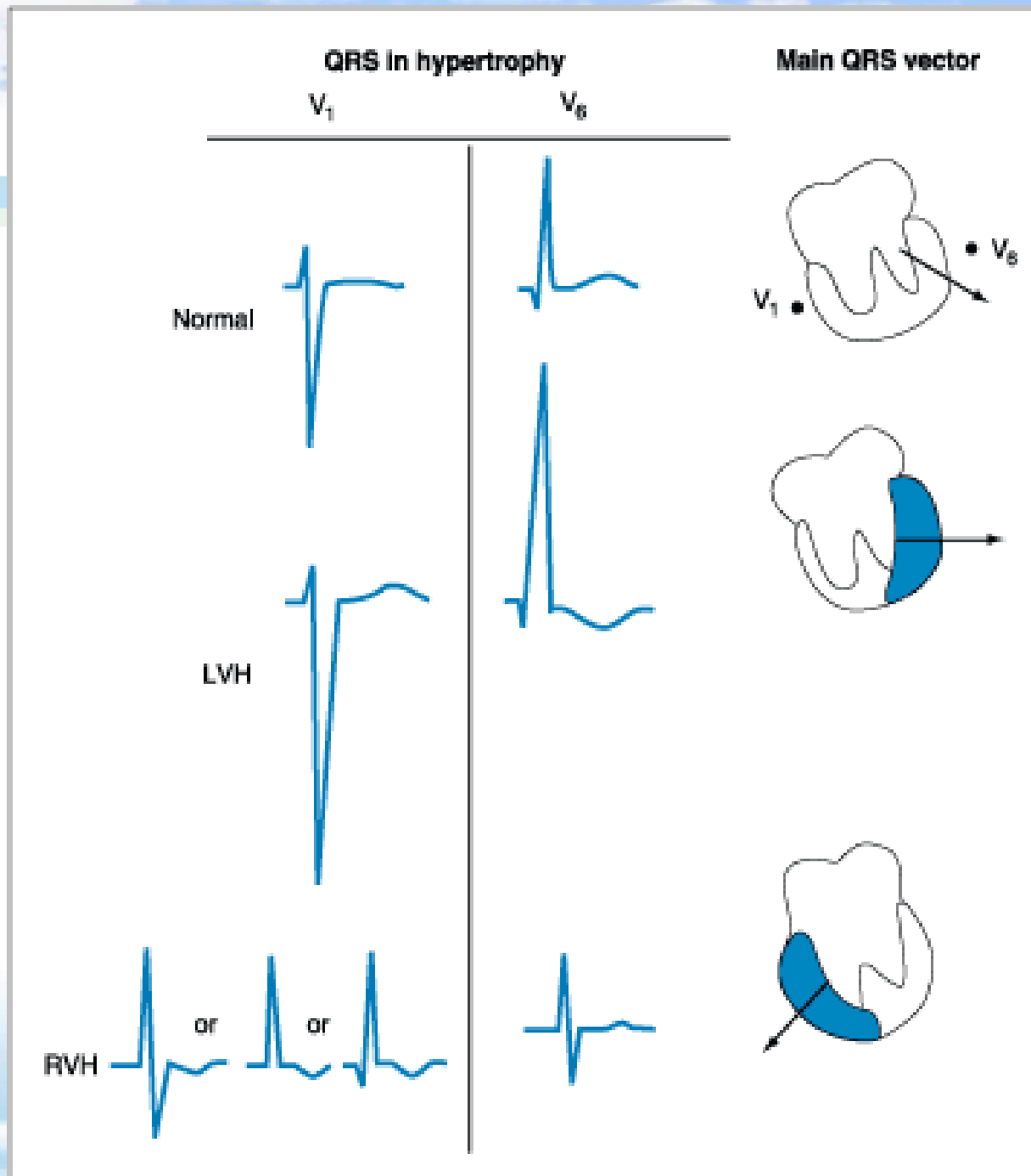


## LVH

- ➡ R wave in V5 or V6  $> 26$  mm
- ➡ R wave in V5 or V6 plus S wave in V1  $> 35$  mm

## RVH

- ➡ R/S ratio in V1  $> 1$

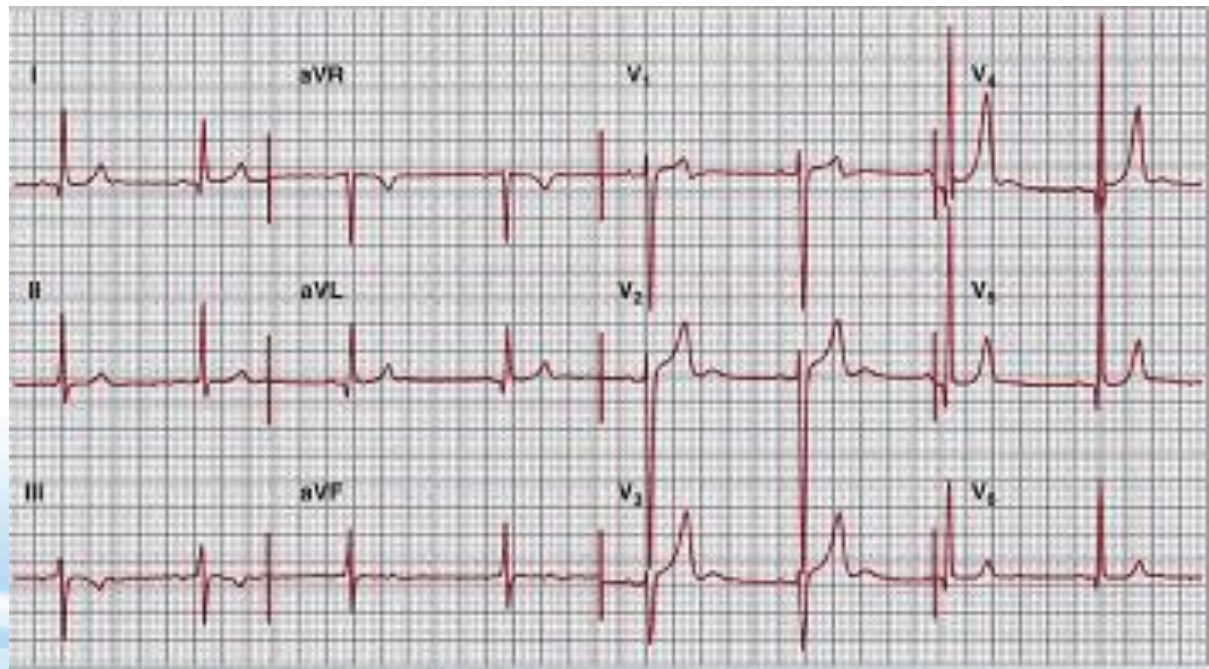
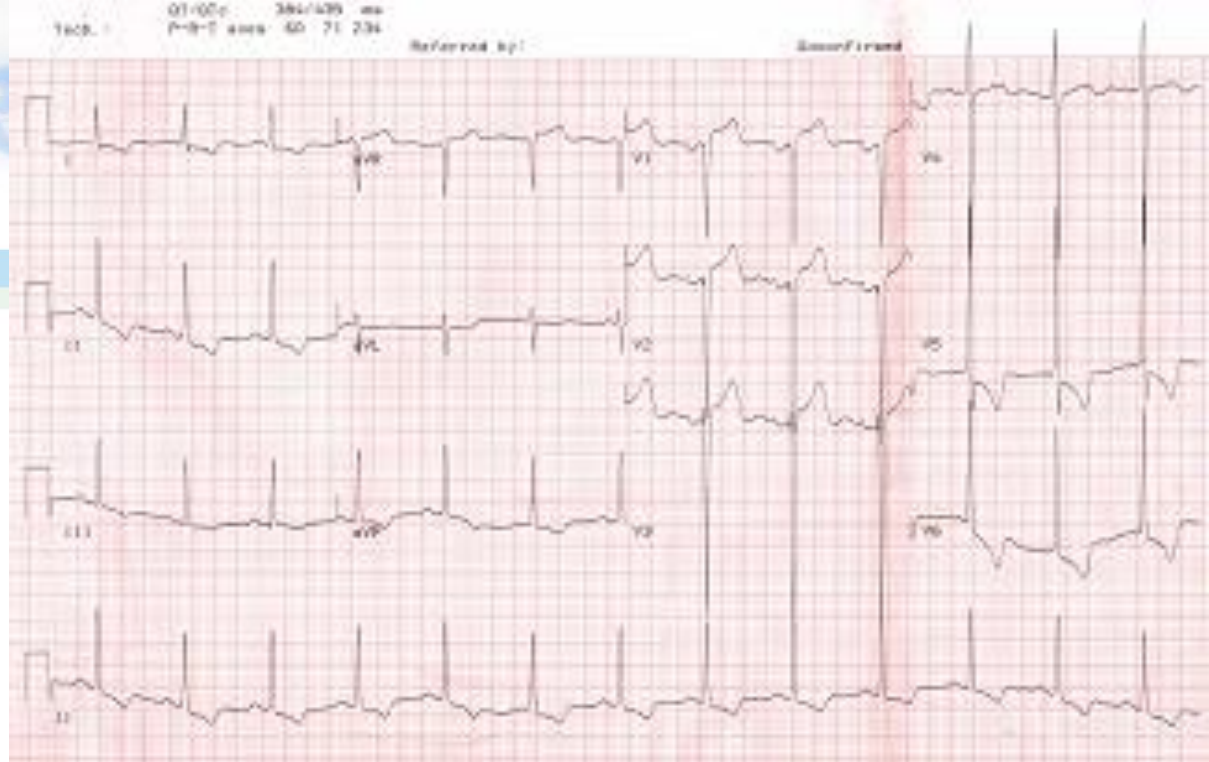




**Pressure  
overload**

**vs**

**Volume  
overload**

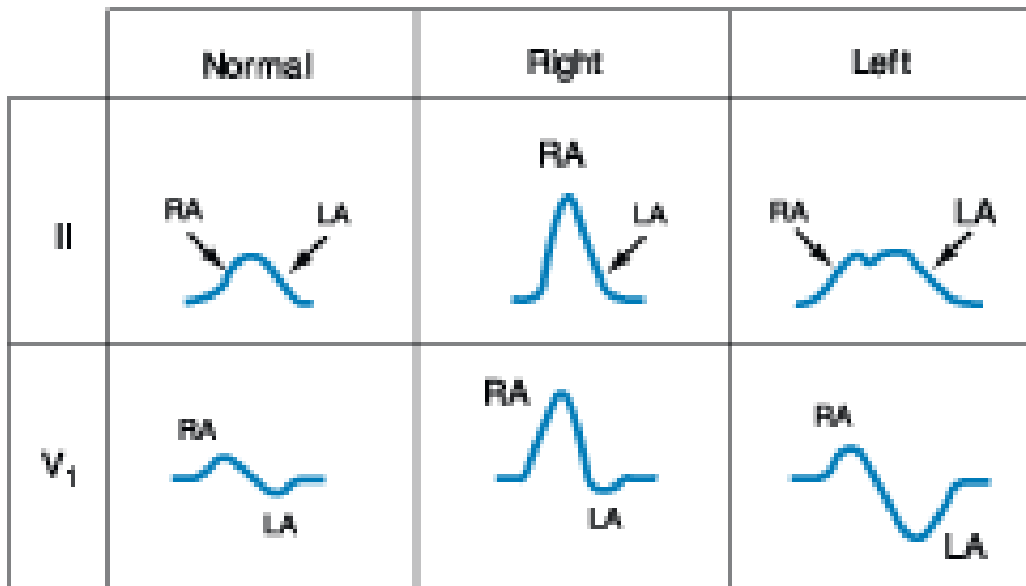






# LAE

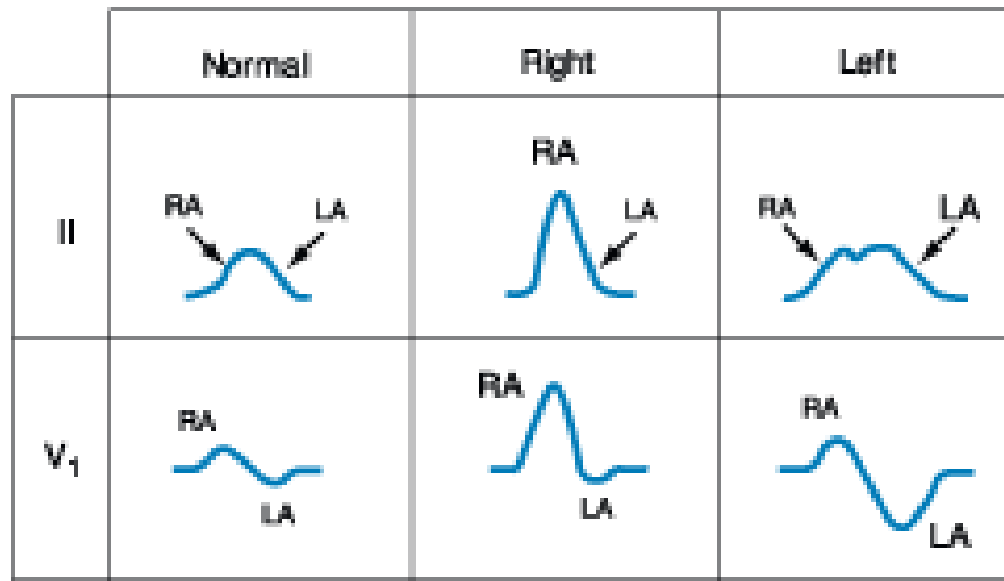
- ❖ The product of (time x voltage) in the P terminal force in **V1** is equal to, or more negative than **-0.04 mm-second** (1 small box wide, and 1 small box deep).
- ➔ **P wave** is **notched** and equal to, or **wider than 0.12 second** (P mitrale).





# RAE

- ❖ Tall and peaked P wave with a height of 2.5 mm or more in leads II, III, and aVF, with a normal duration (P pulmonale).
- ❖ Positive deflection of the P in lead V1 or V2 is greater than 1.5 mm.





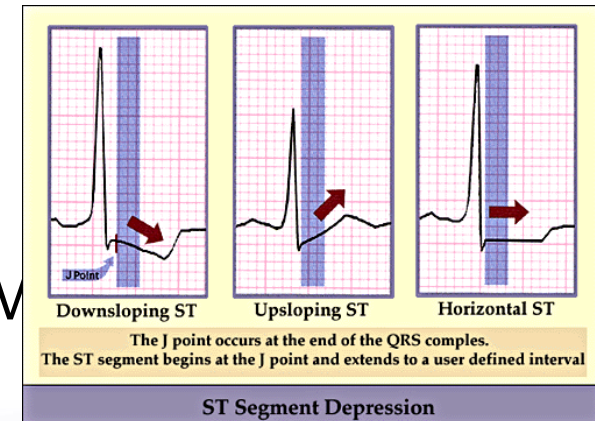
# Ischemic and infarction

## ❖ Ischemia: ST-T change

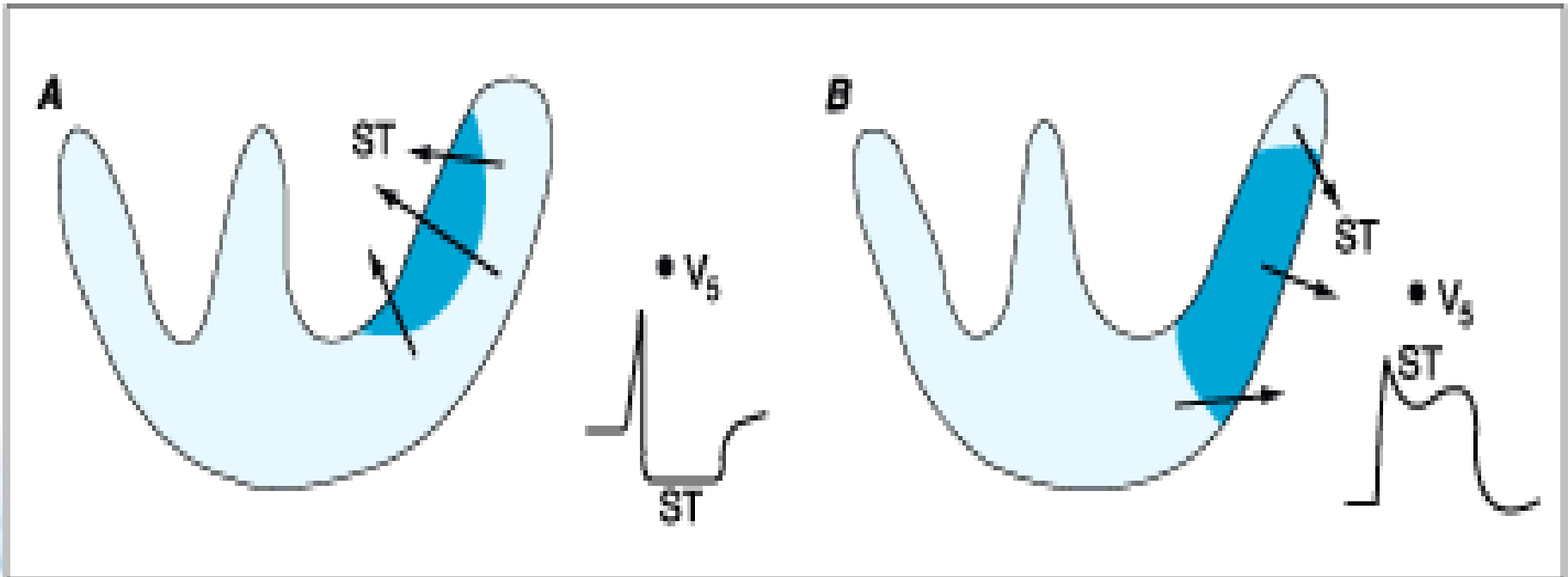
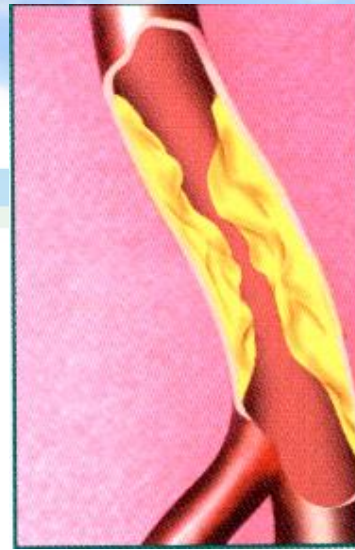
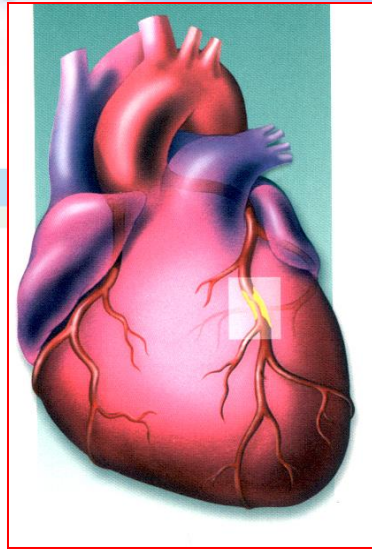
- J point
- ST segment: up slope, down slope, horizontal
- T wave: inverted, biphasic, upright

## ❖ Infarction

- acute or old
- evolutionary change
- ST elevation or non-ST elevation MI
- Q wave or non-Q wave MI

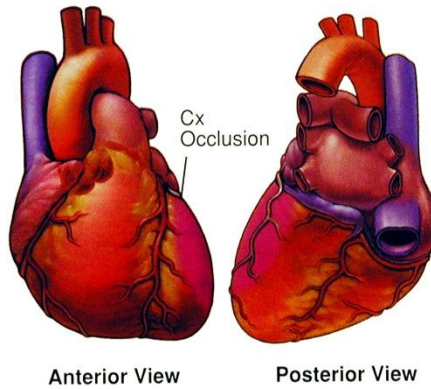




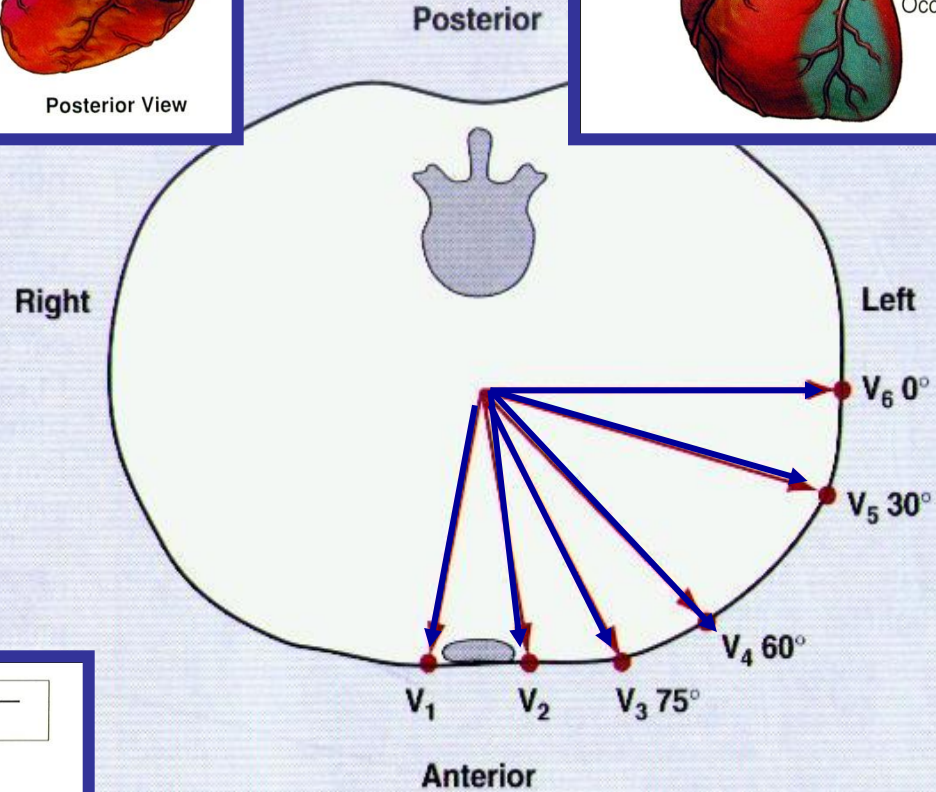
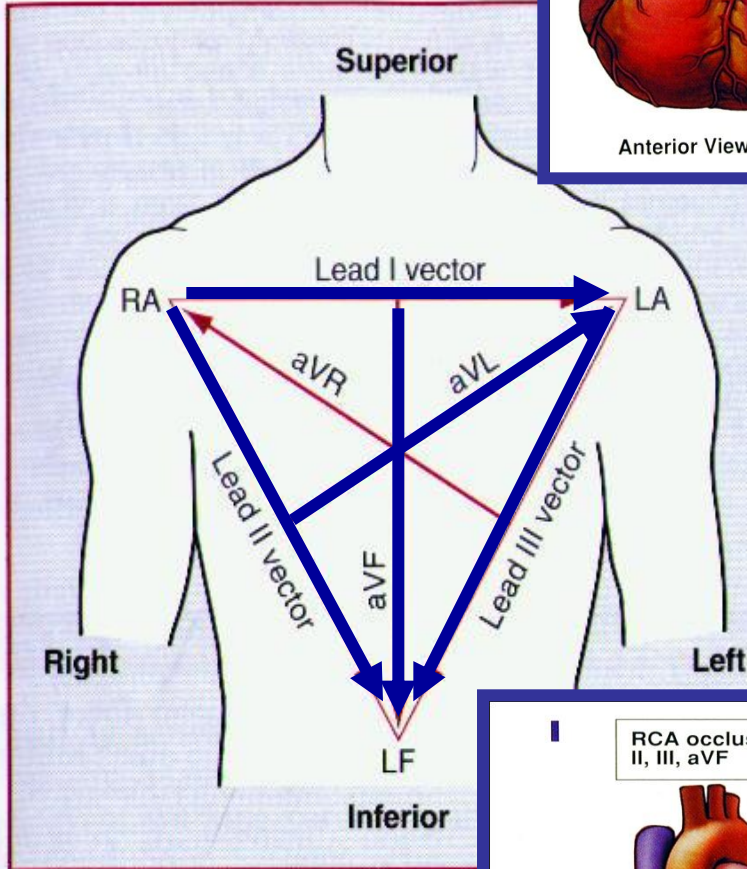
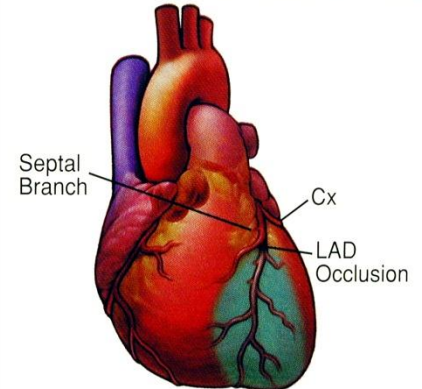




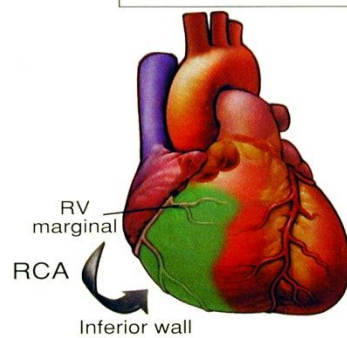
**H** Cx occlusion — I, aVL, possibly V<sub>5</sub>, V<sub>6</sub>



**G** LAD occlusion — V<sub>1</sub> through V<sub>6</sub>



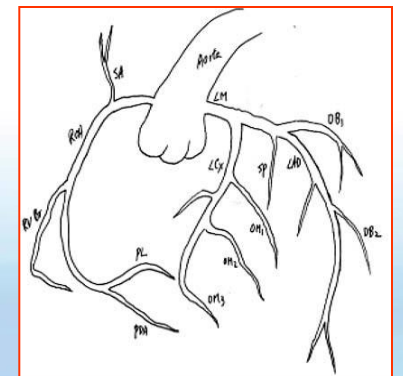
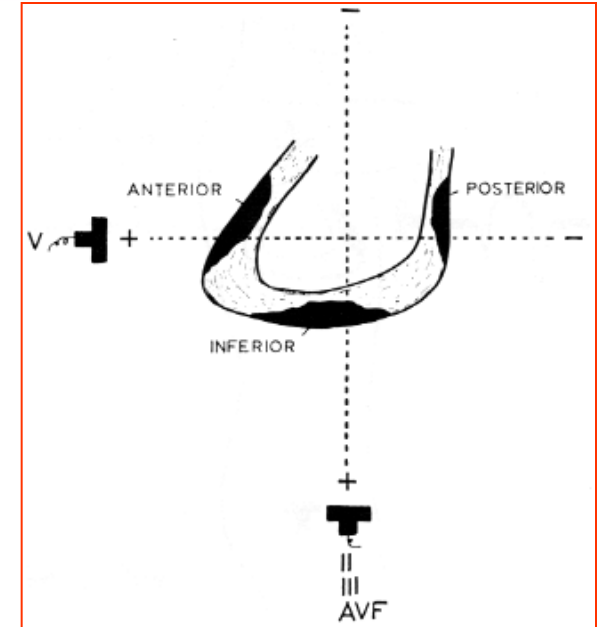
**I** RCA occlusion — II, III, aVF





# Location of ischemic/ infarction

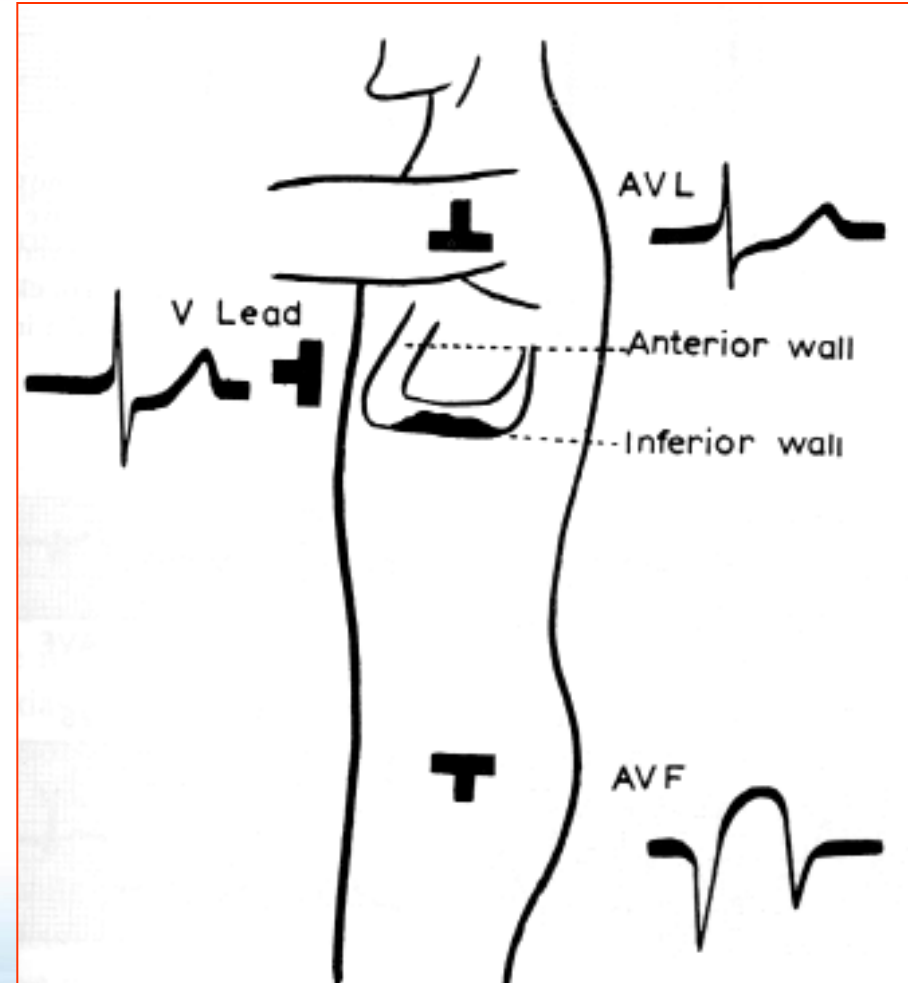
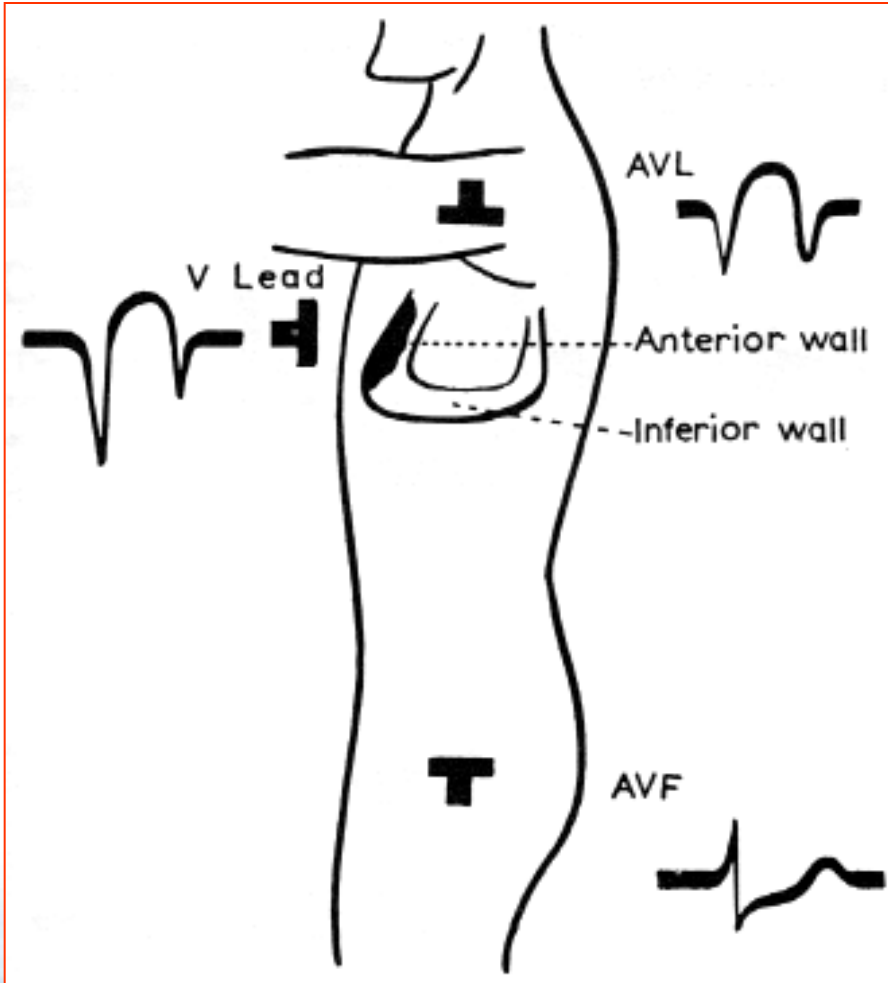
- ❖ Anterior wall : V1-V6
  - antero-septal: V1-V4
  - antero-lateral: V3-V6
  - extensive anterior: V1-V6
- ❖ Lateral wall :V5,V6, lead I, AVL
- ❖ Inferior wall: lead II, III, AVF
- ❖ Posterior wall: Tall R wave and ST depression at V1-V3 ( mirror image)
- ❖ RV infarction: ST elevation in V4R





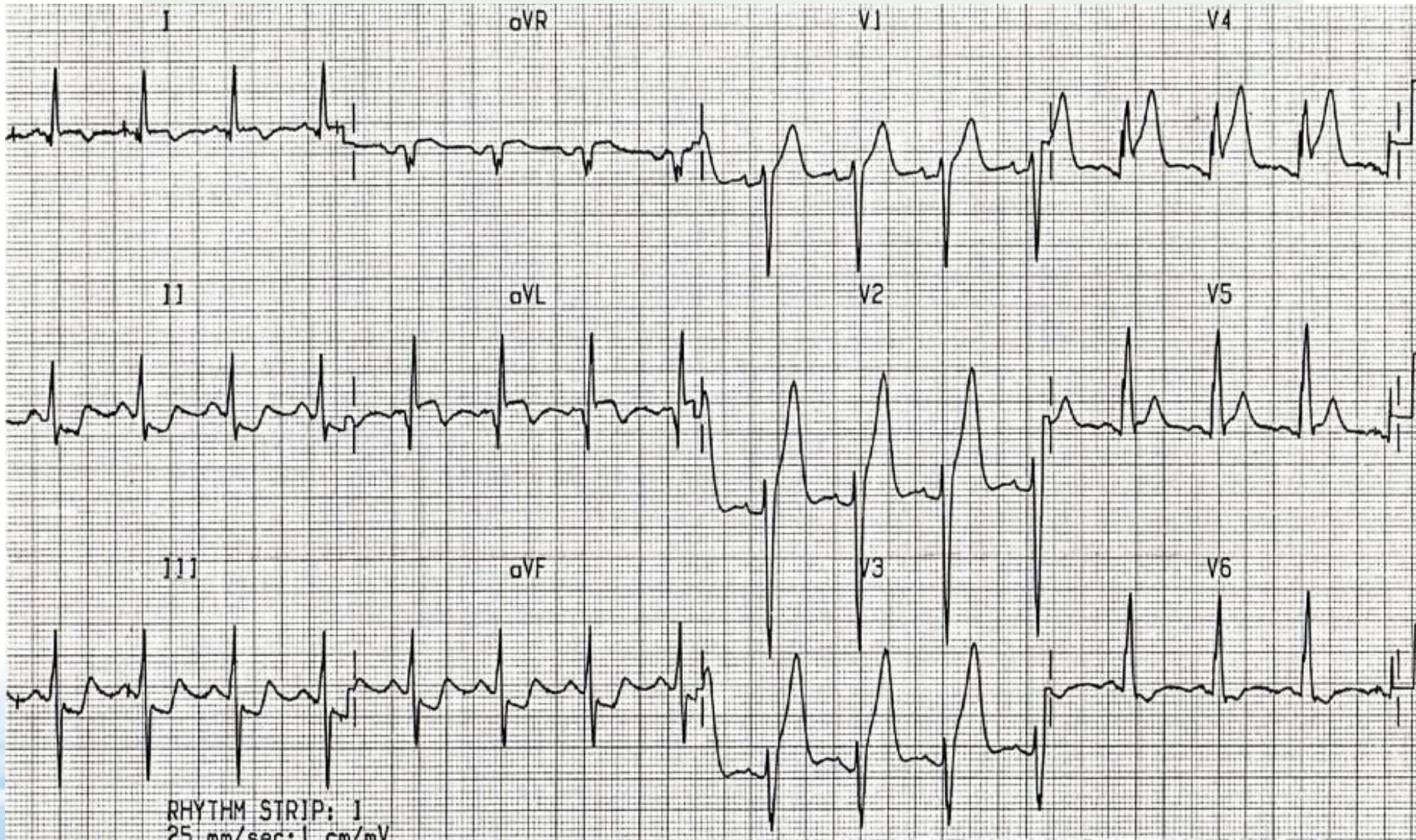


# Reciprocal changes





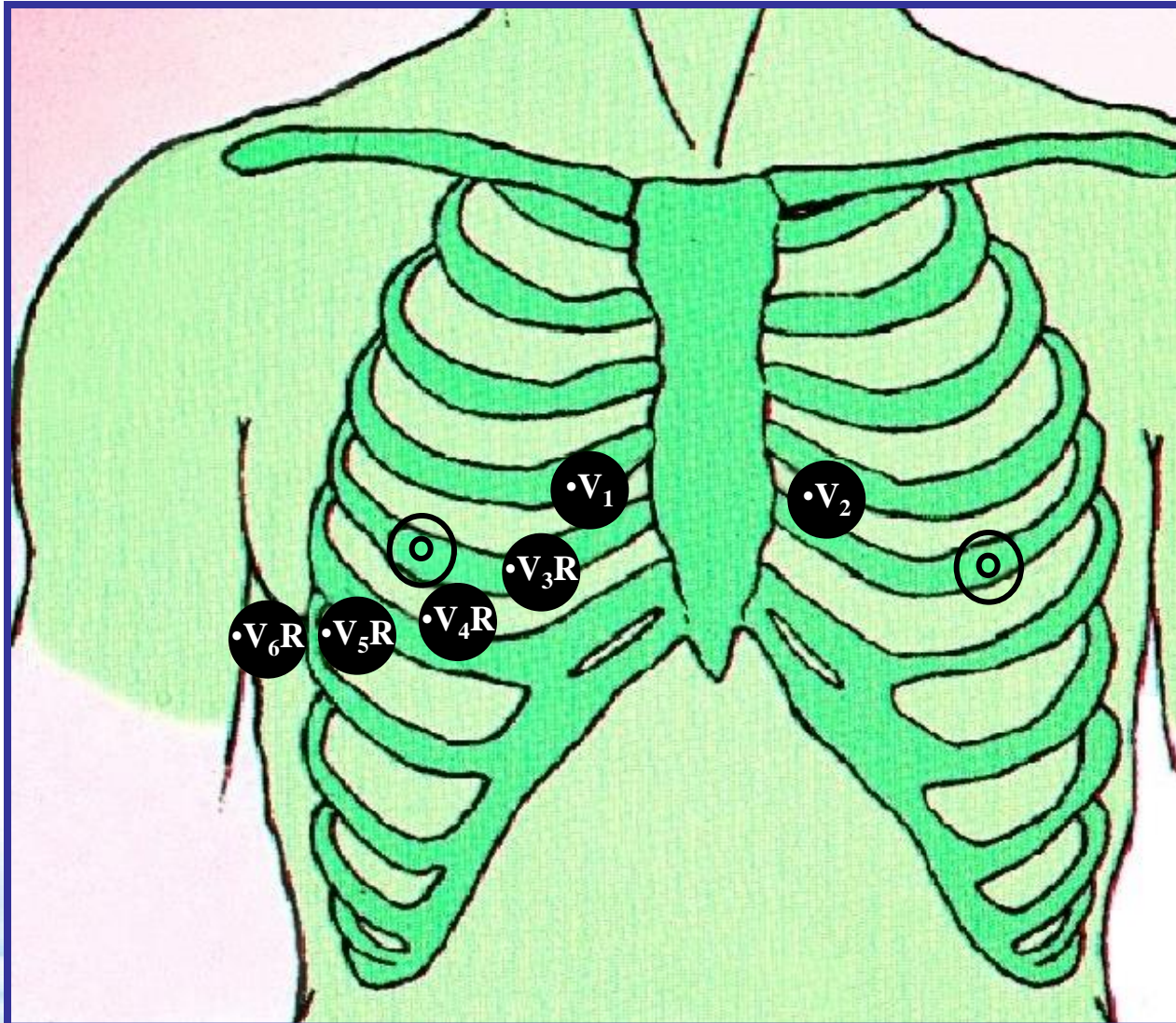
# Hyperacute T wave change







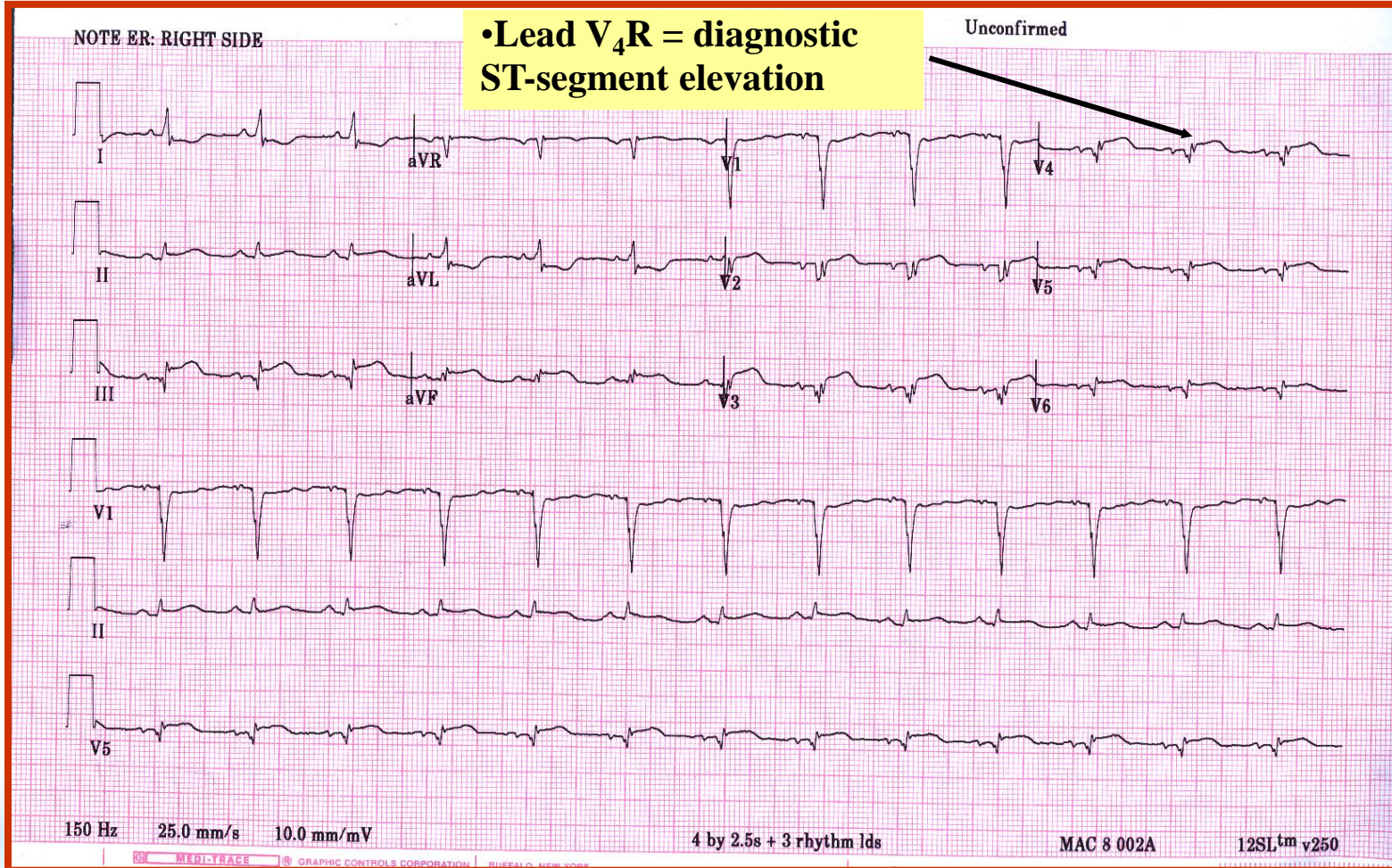
# Lead Placement for a Right-sided ECG







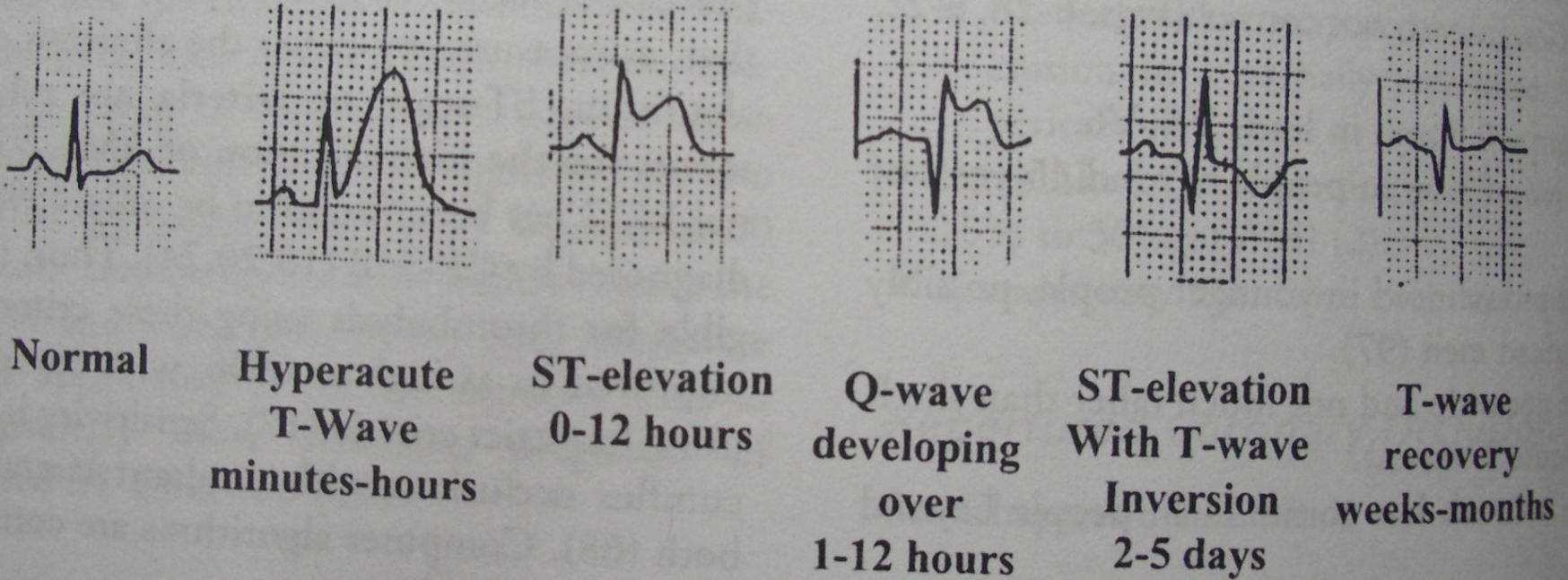
# Right-sided 12-Lead ECG: Patient With Inferior ST-Segment Changes







# Evolutional changes in AMI

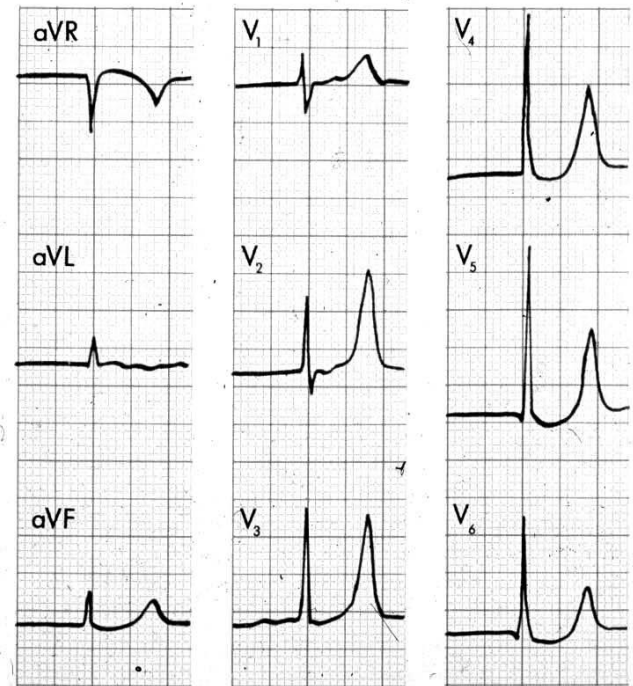


**FIGURE 6-3. Progression of a nonreperfed Q-wave ("transmural") AMI.** (ECG reproduced from unpublished data with permission from K. Wang, M.D).



# Hyperkalemia

- ❖ Tenting of T wave
- ❖ Flat of P wave
- ❖ Widened of QRS
- ❖ ST-T change
- ❖ Arrhythmias







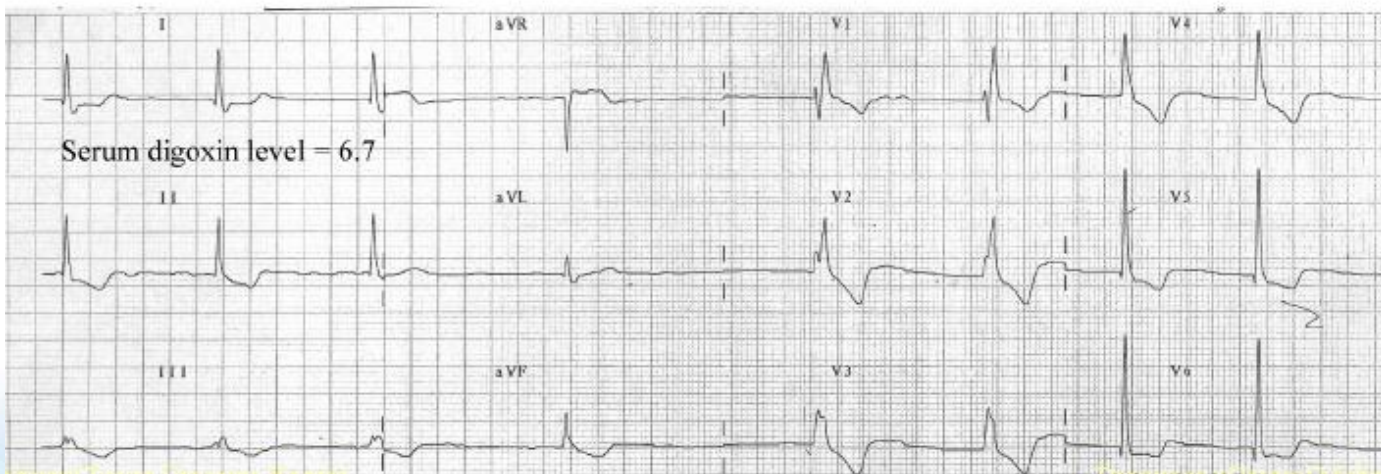
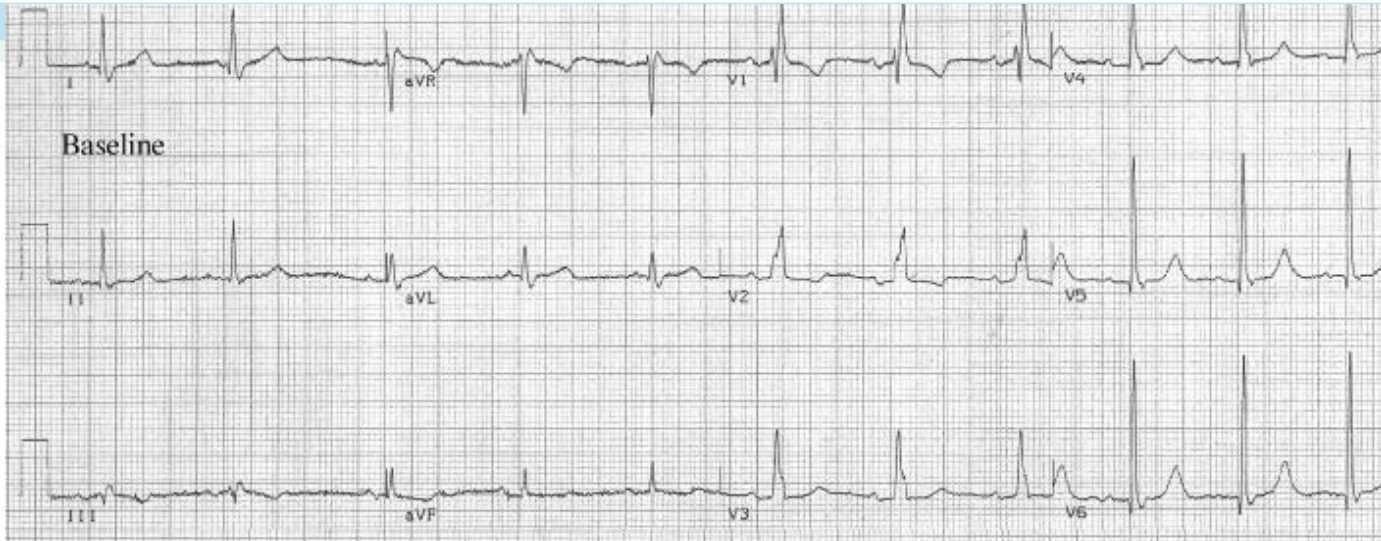
# Hypokalemia

- ❖ U wave and flat T wave
- ❖ Peaking P wave (pseudo P pulmonale)
- ❖ ST-T change

血清鉀濃度(mEq/l)	ECG 發現	心電圖記錄例
3.5 到 5.0	正 常	
2.5 到 3.5	U 波振幅增加； S T 間段壓低	
1.5 到 2.5	T 波變平	
< 1.5	QRS 綜合波延長 ； U 波落在 T 波上	



# Digitalis:



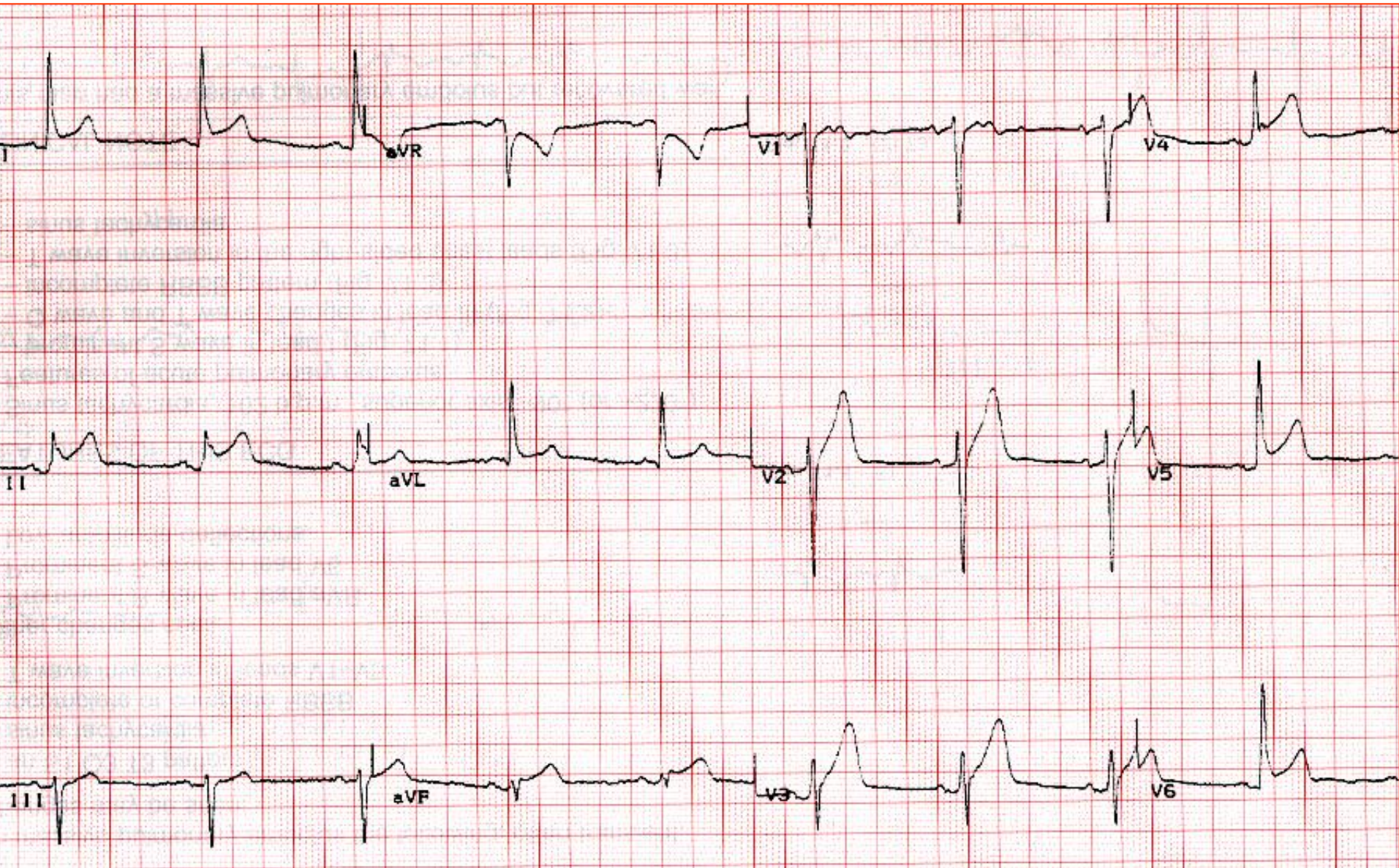
- ❖ Sagging ST depression, AV block, AT, Various arrhythmias





# A 25-year-old male developed chest pain and dyspnea

## Acute pericarditis





# Pulmonary embolism

RVH with RV strain

RAD

S1Q3T3

Sinus tachycardia

