Electrocardiografía Básica

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¿QUÉ ES UN ELECTROCARDIOGRAMA?

Es el registro de la actividad eléctrica del corazón, desde la superficie corporal, generada a través de un electrocardiógrafo

Palabra compuesta de raíces griegas:

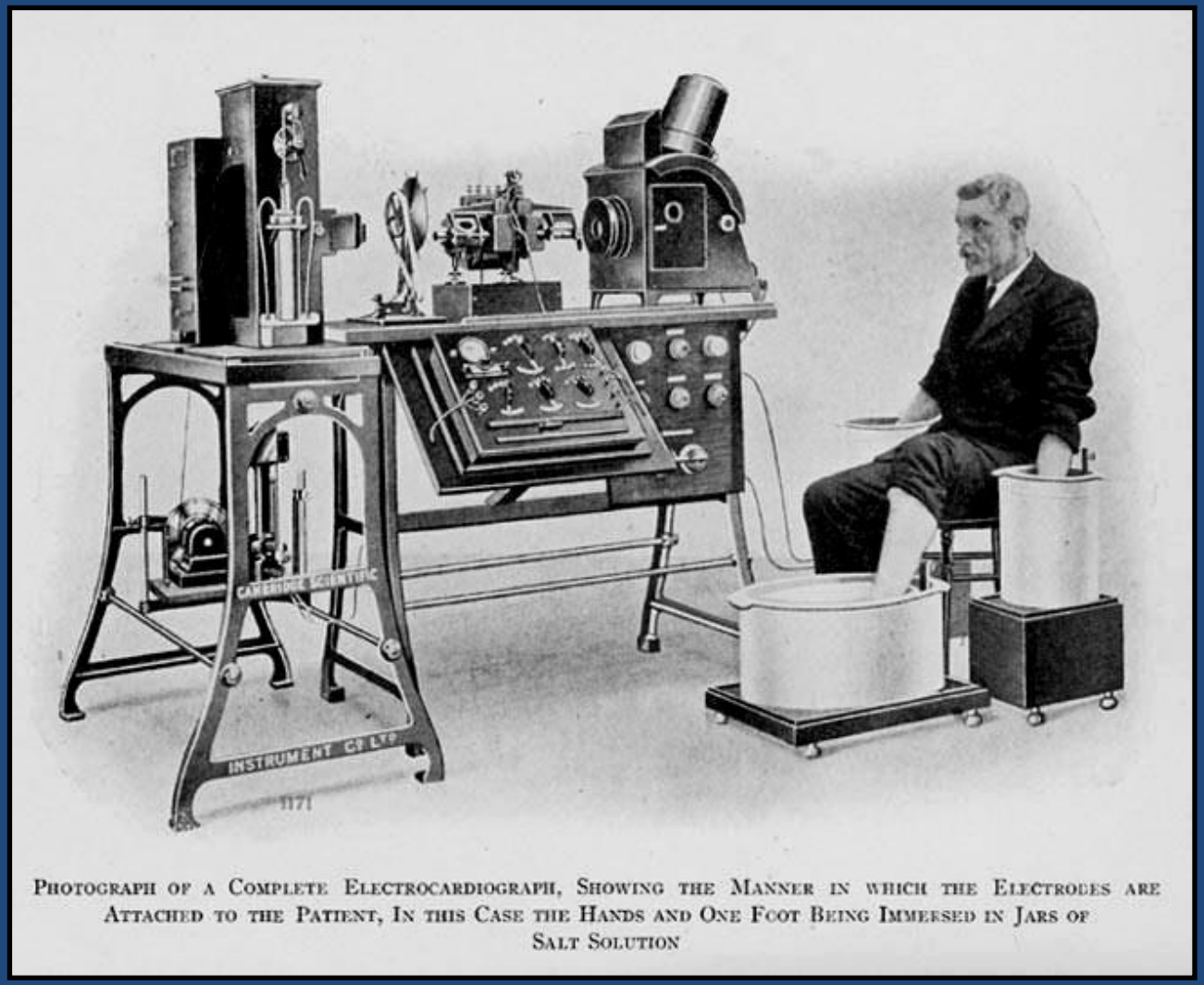
- *electro* $\Rightarrow$ "eléctrico"

- *cardio* $\Rightarrow$ "corazón"

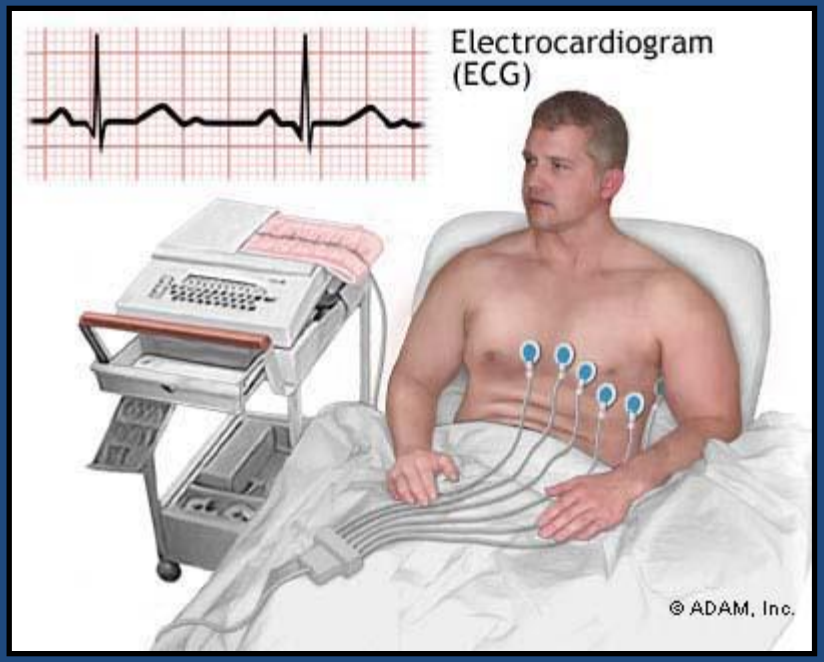
- *gram* $\Rightarrow$ "escribir"

Willem Einthoven, 1903

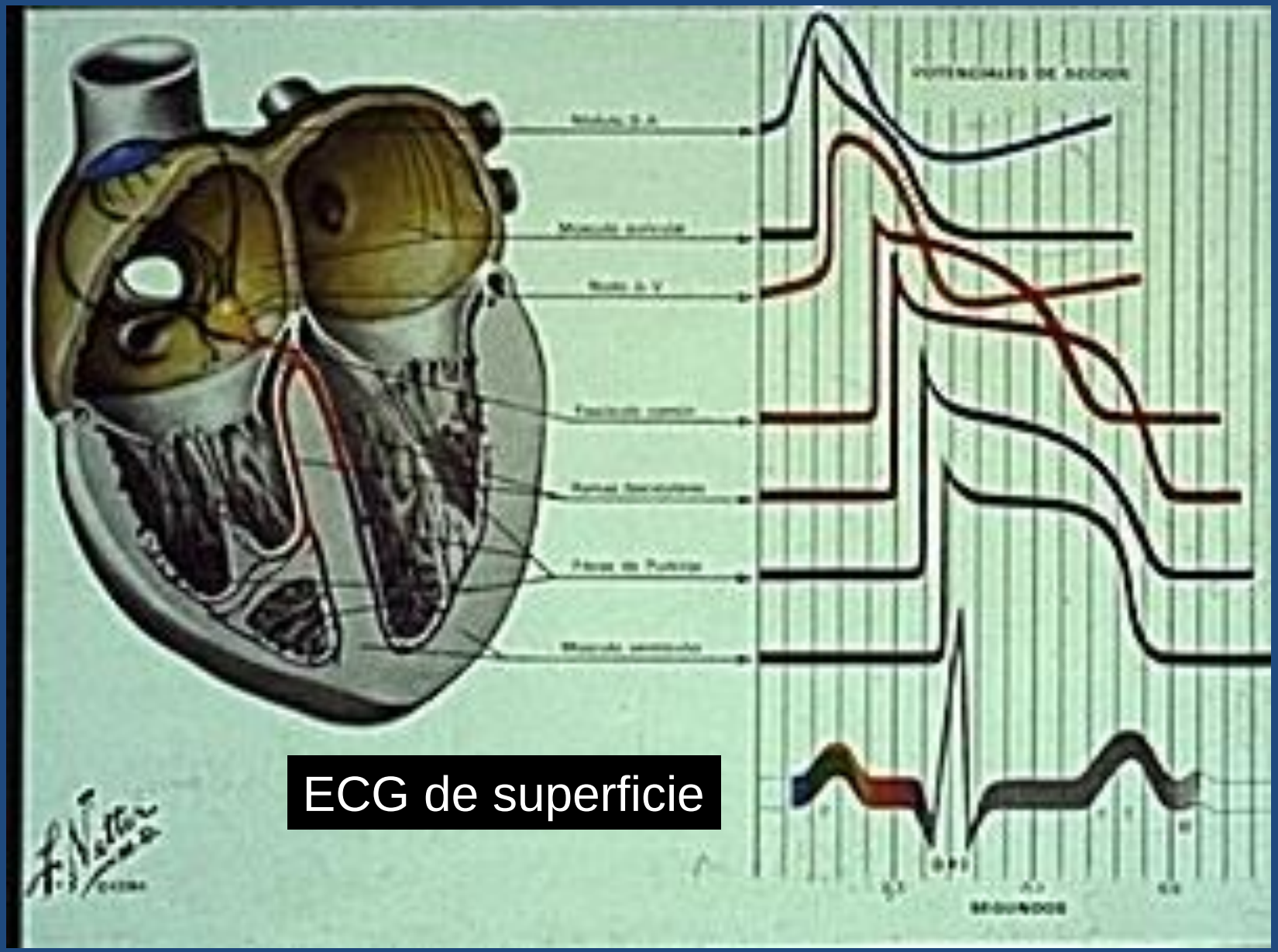
"Lo que Ud. Y yo pensamos no es lo importante, lo que importa es la verdad"

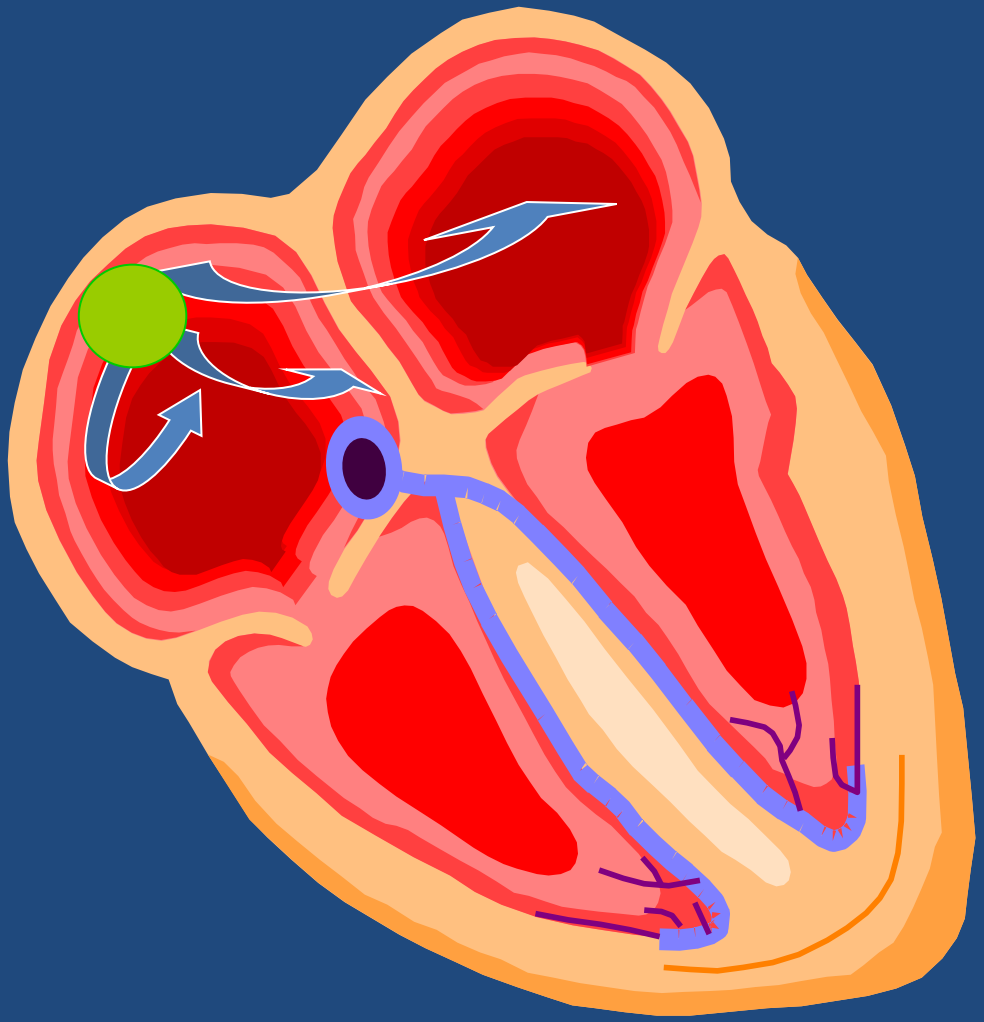


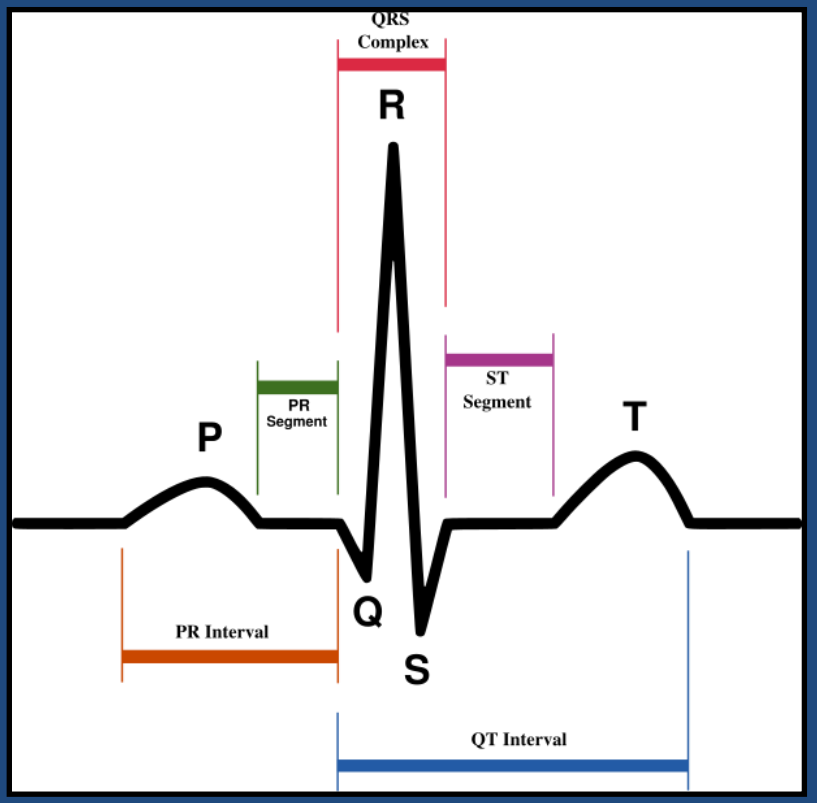
PHOTOGRAPH OF A COMPLETE ELECTROCARDIOGRAPH, SHOWING THE MANNER IN WHICH THE ELECTRODES ARE ATTACHED TO THE PATIENT, IN THIS CASE THE HANDS AND ONE FOOT BEING IMMERSED IN JARS OF SALT SOLUTION

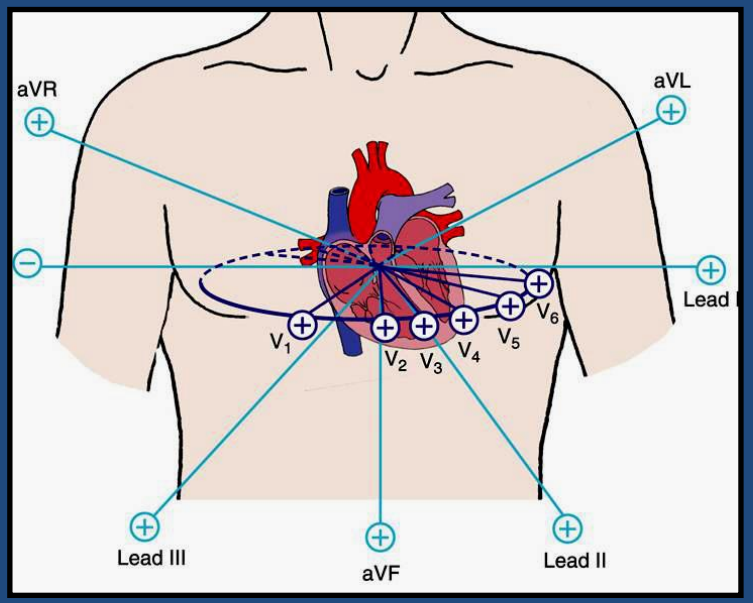

Electrocardiogram
(ECG)
© ADAM, Inc.

Electrocardiograma normal

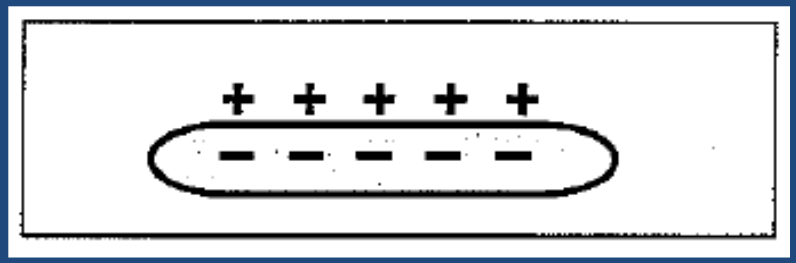

ECG de superficie

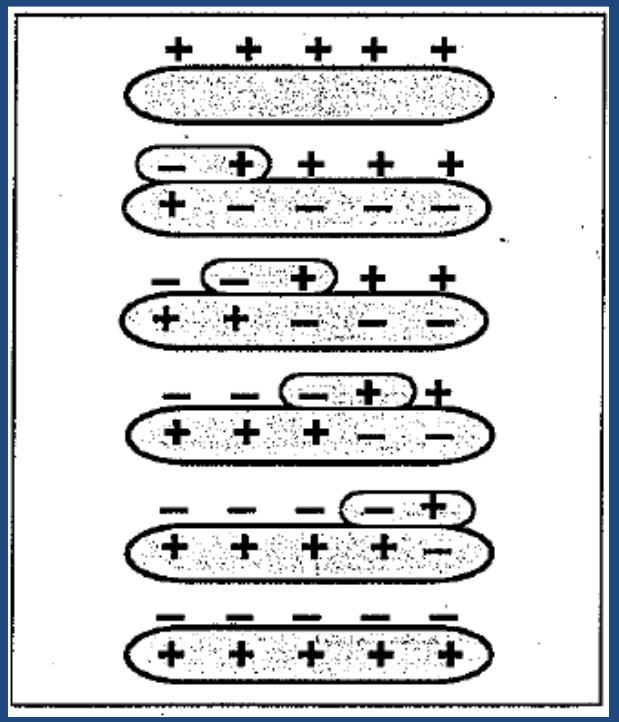


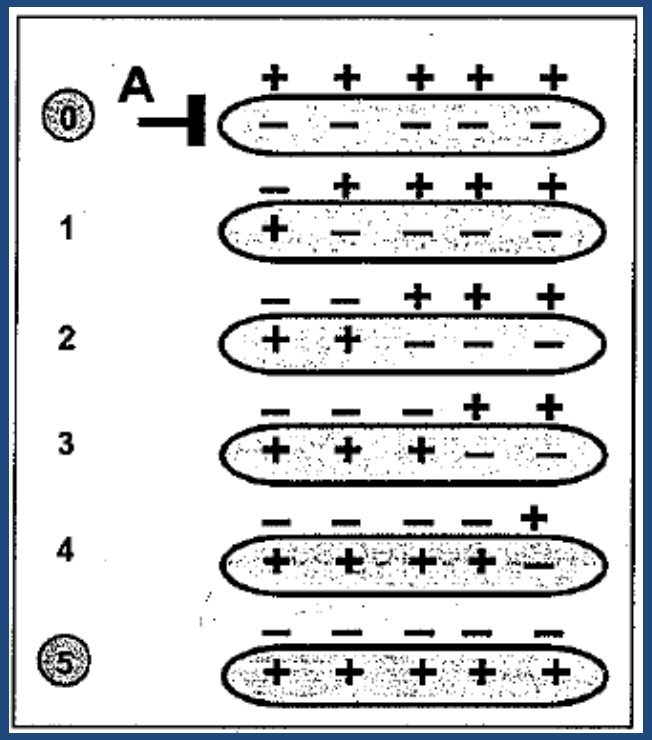

QRS
Complex
R
PR
Segment
ST
Segment
P
T
Q
S
PR Interval
QT Interval


aVR
aVL
Lead I
V1
V2
V3
V4
V5
V6
Lead III
aVF
Lead II

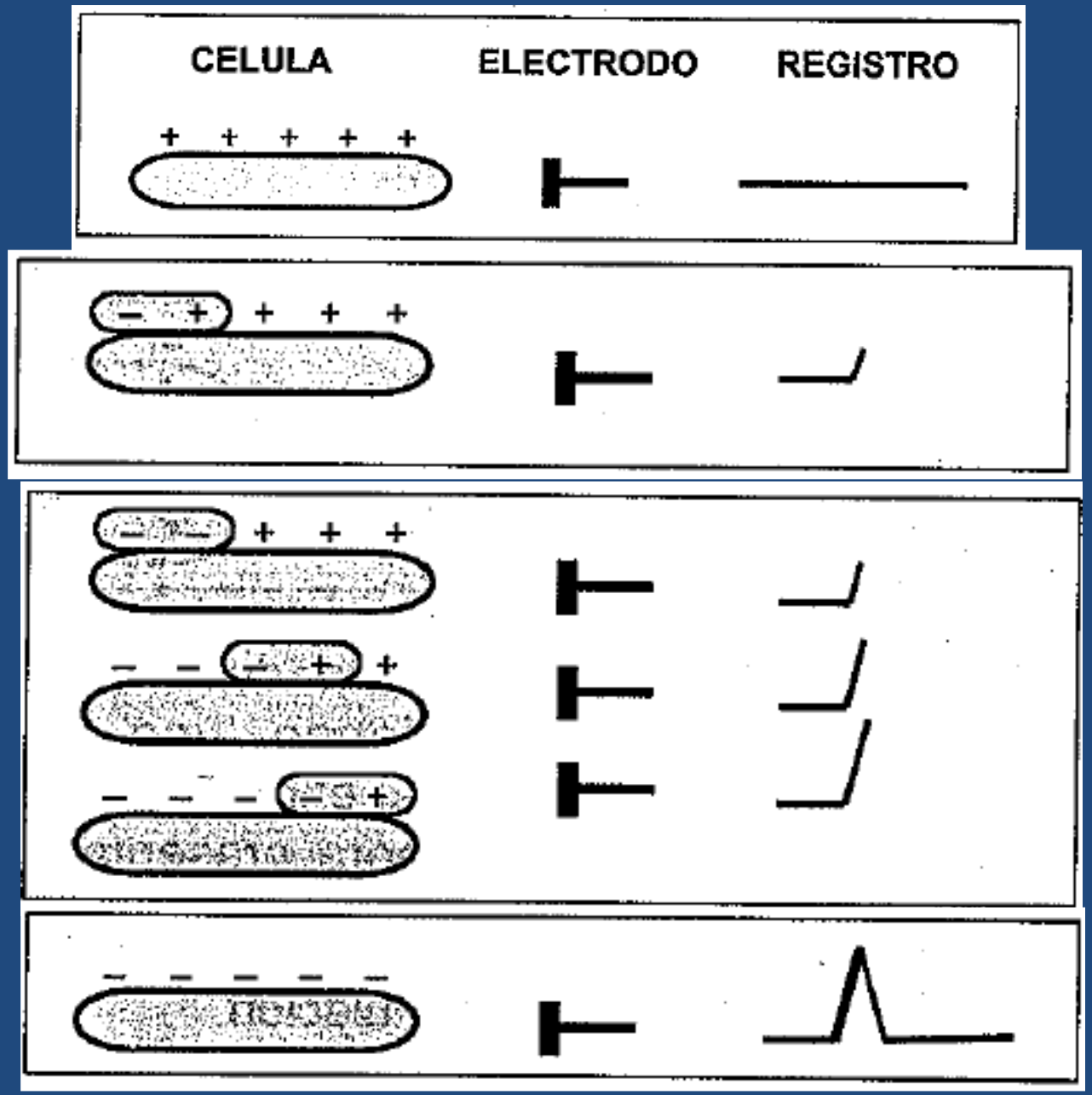
Depolarización – „Dipolo“



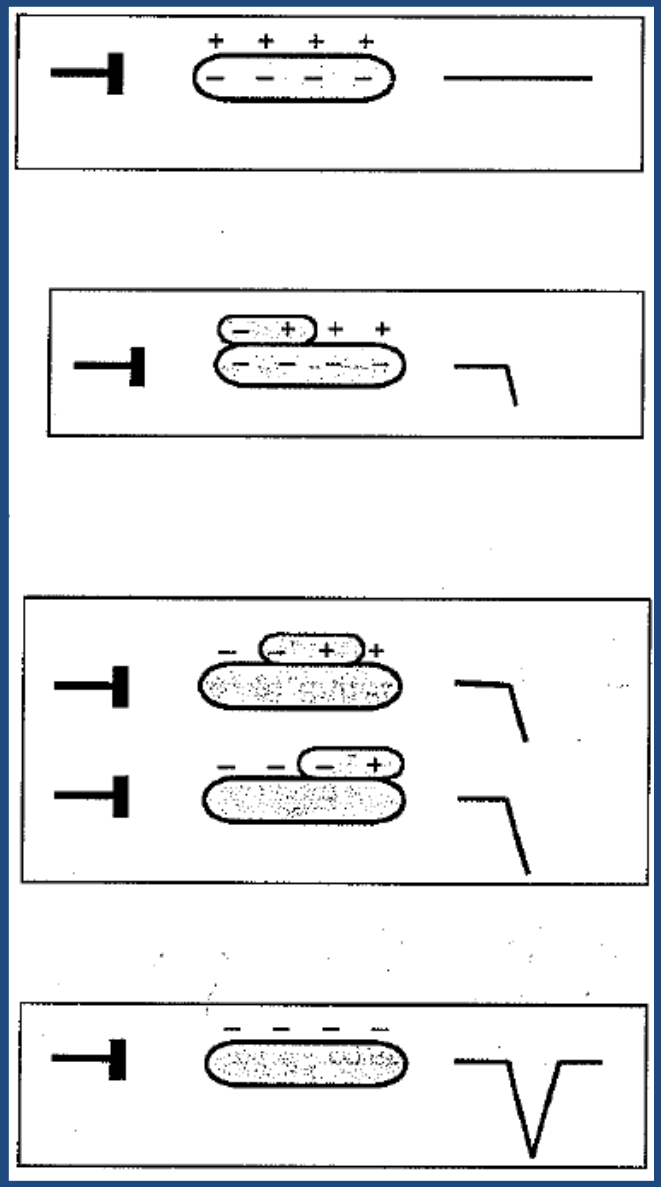


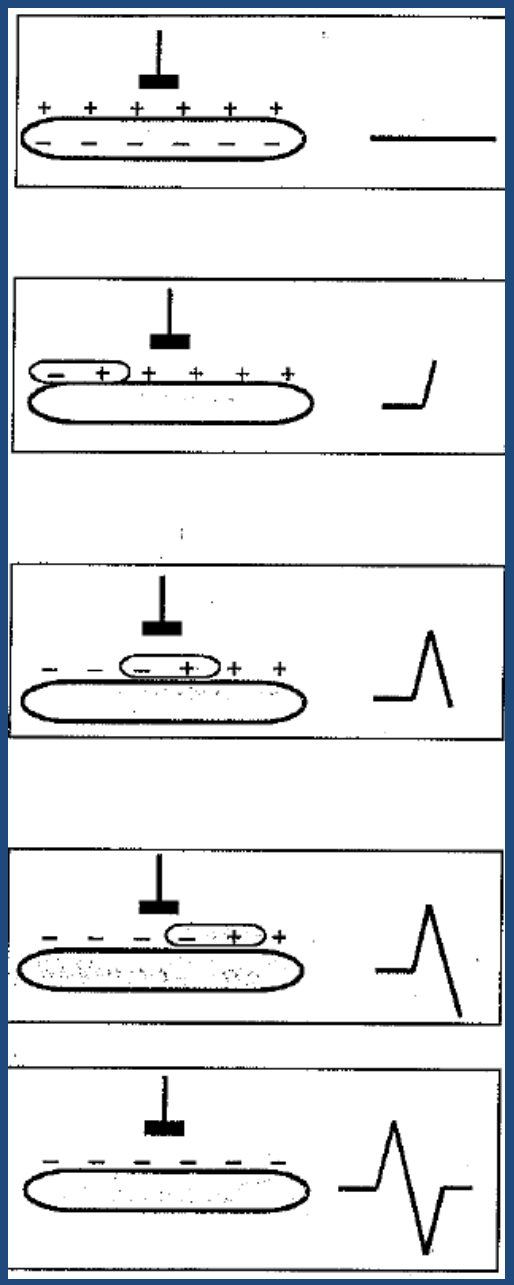


Registro de la actividad eléctrica celular

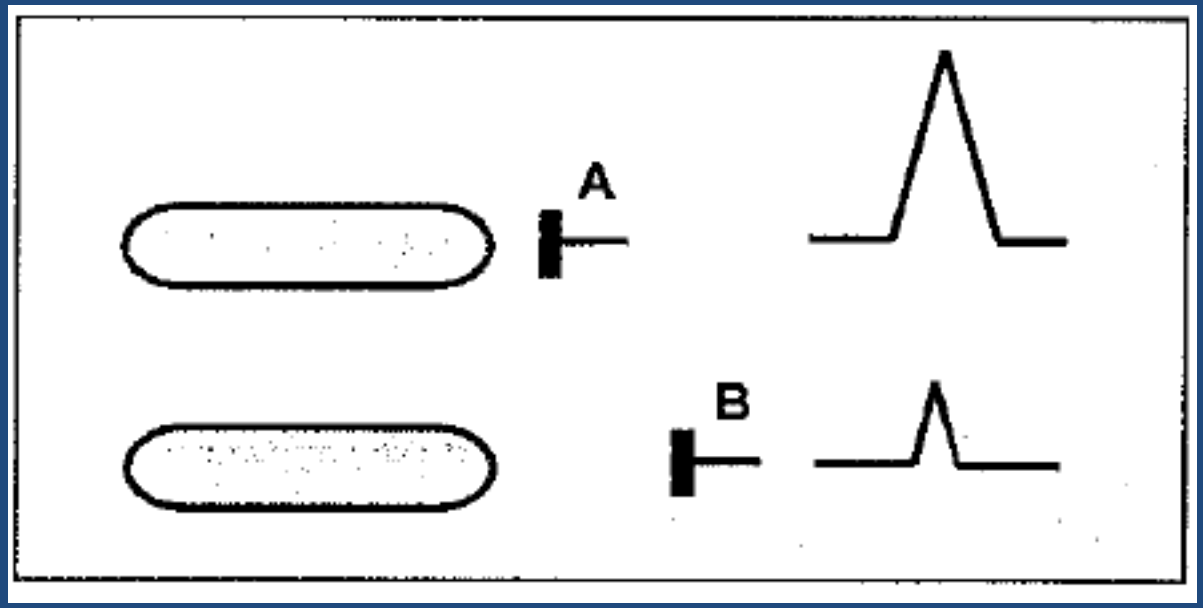


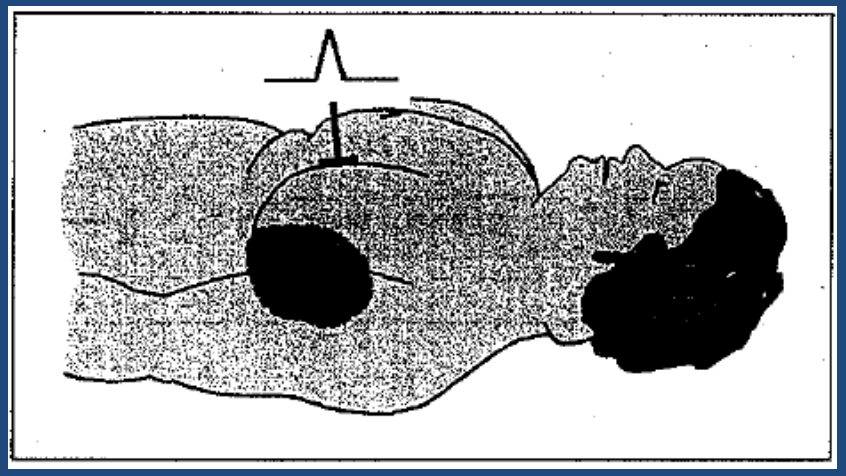
Registro de la actividad eléctrica celular

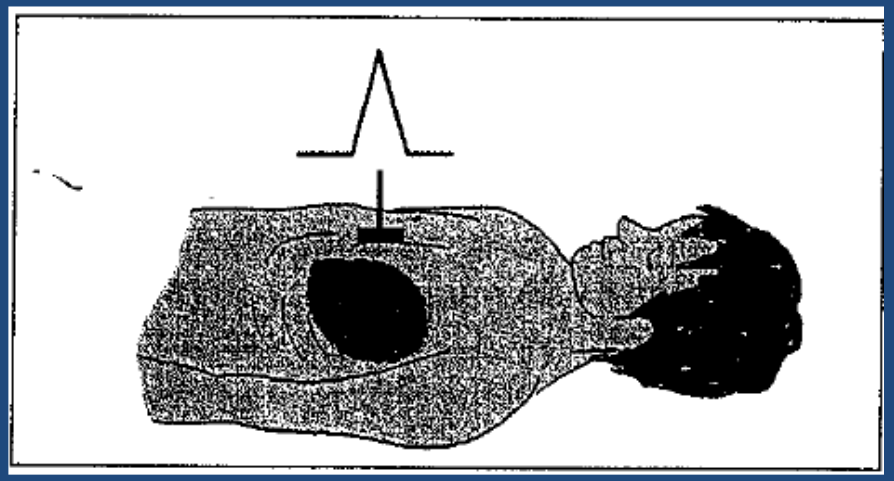




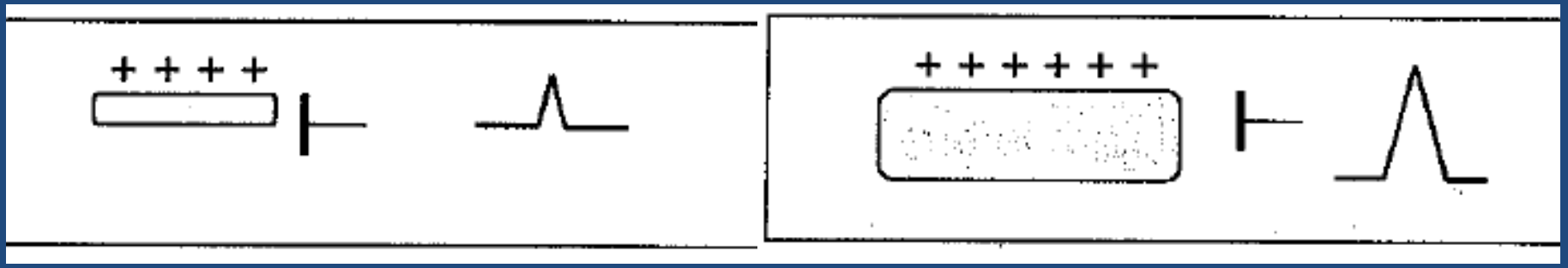
Distancia del electrodo

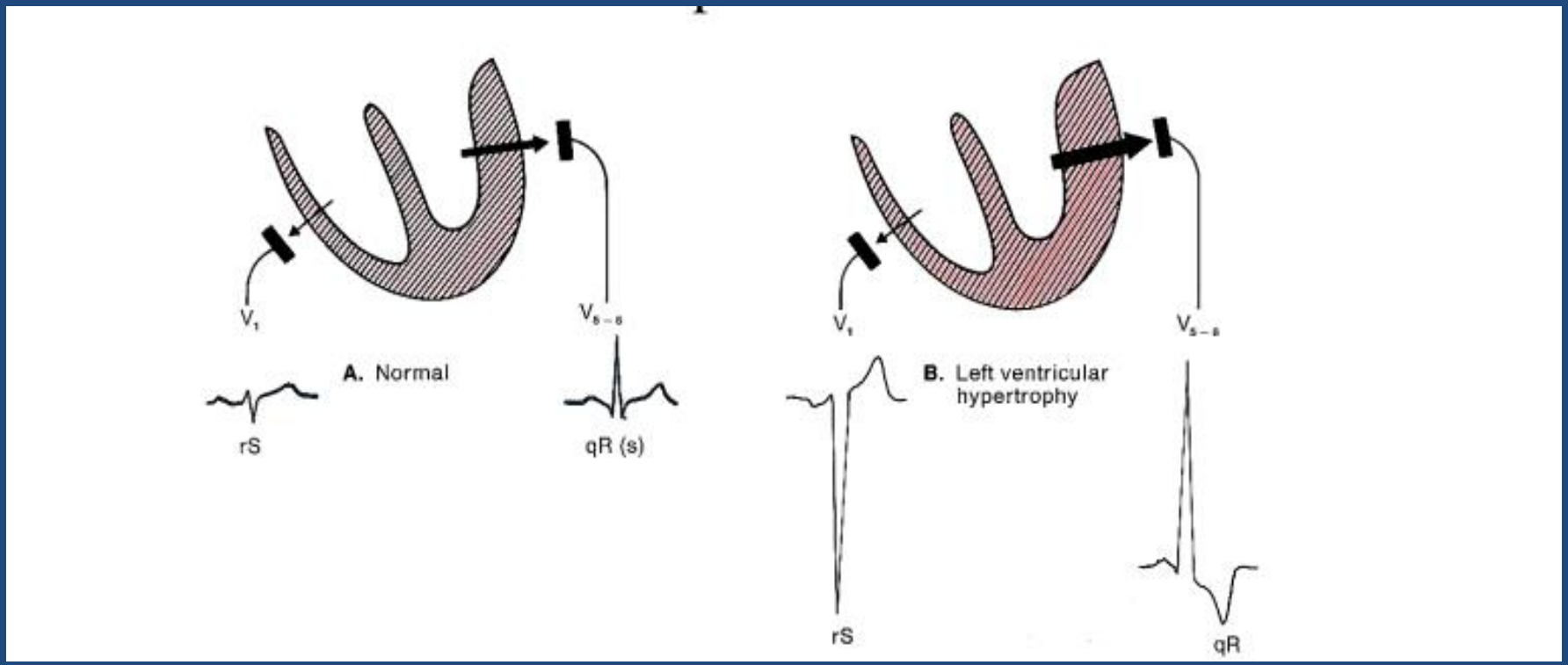




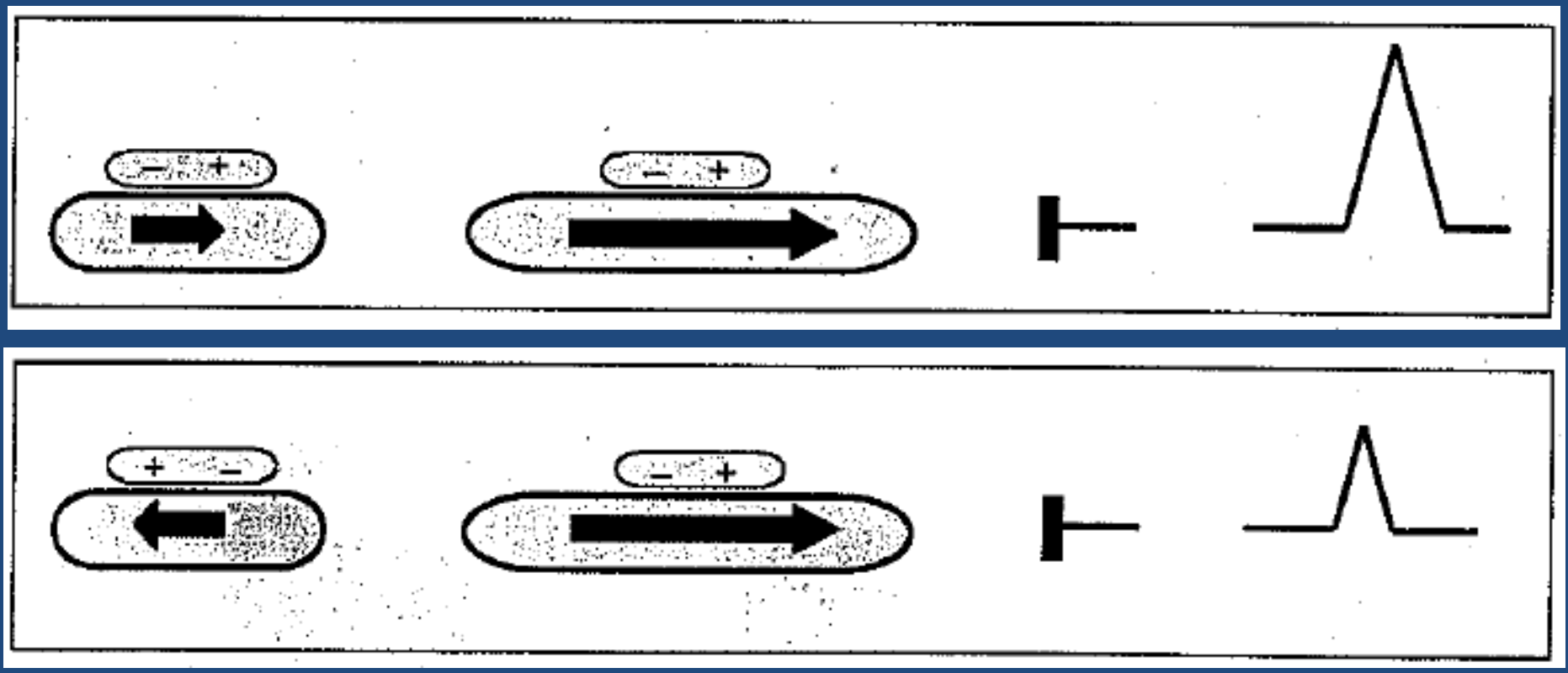


Masa celular: a mayor masa, mayor amplitud

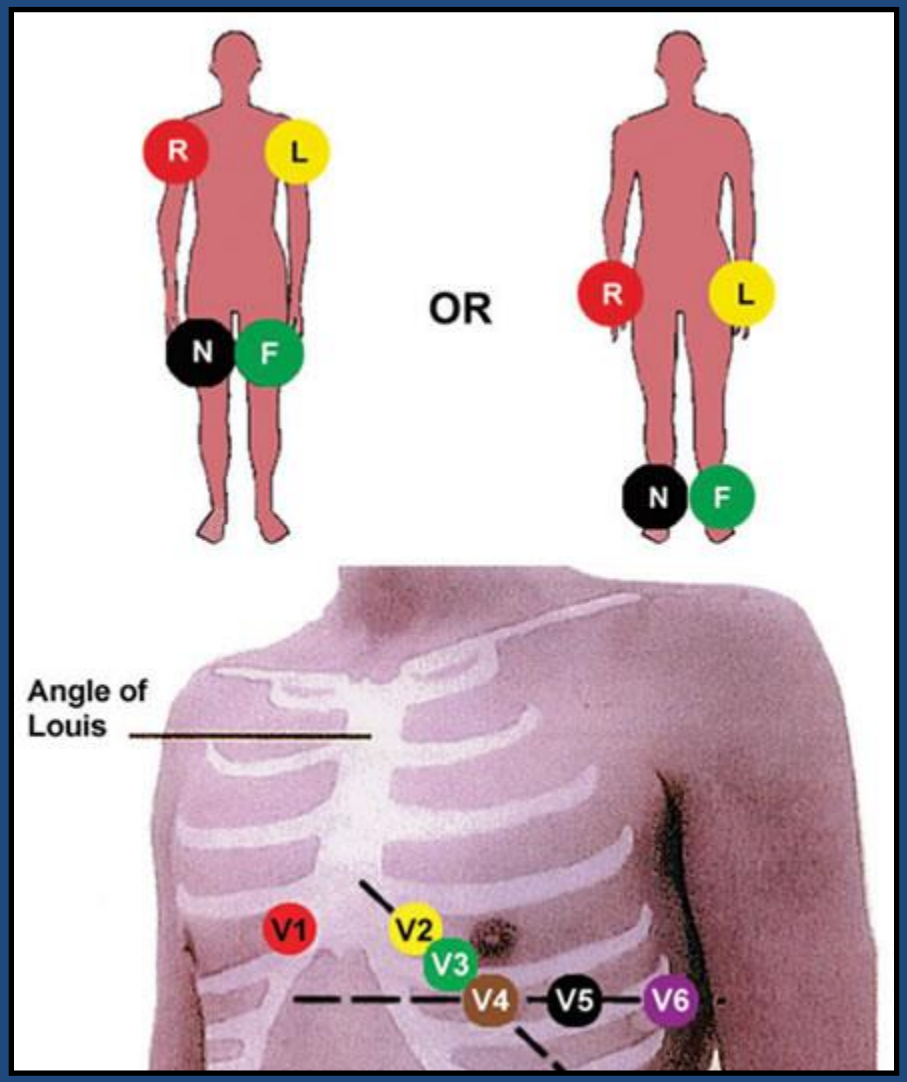




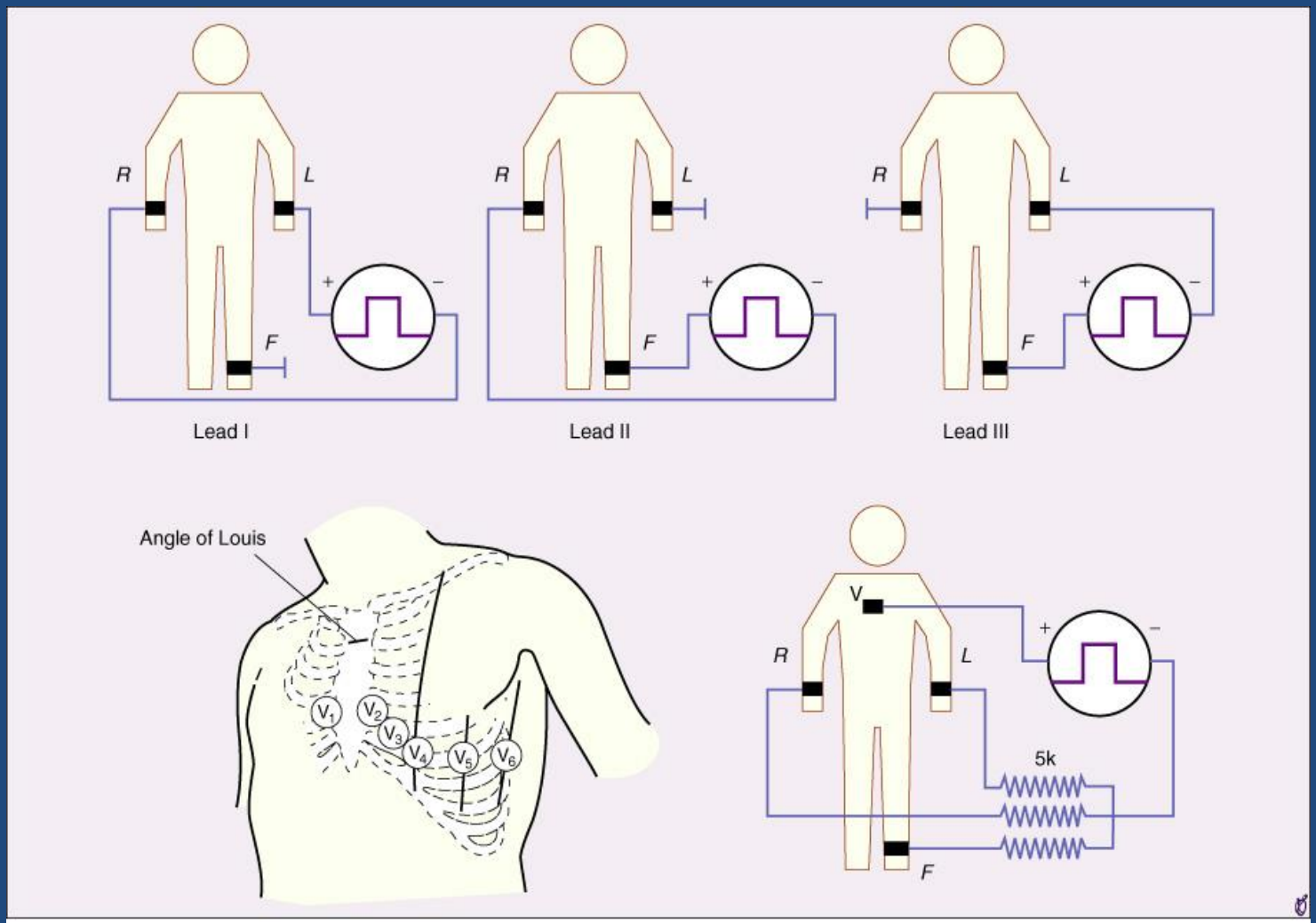
Activación simultánea de más de una célula



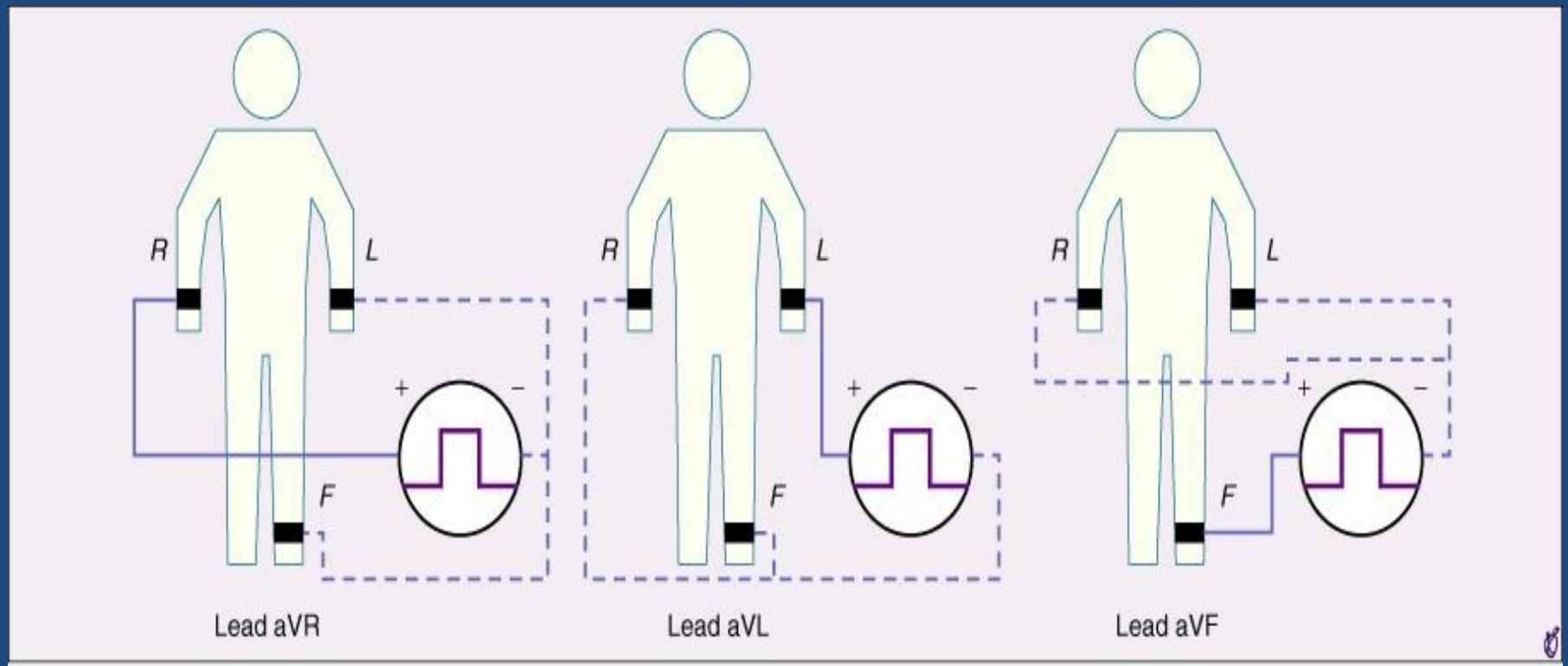
UBICACIÓN ELECTRODOS



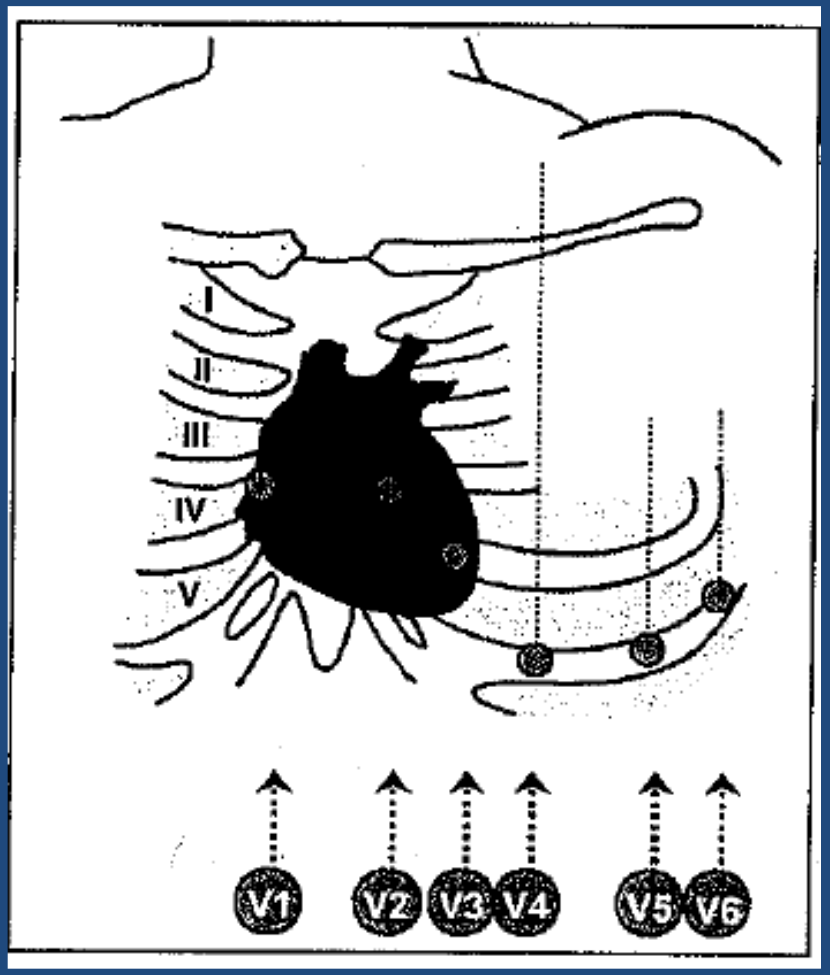
Derivaciones bipolares

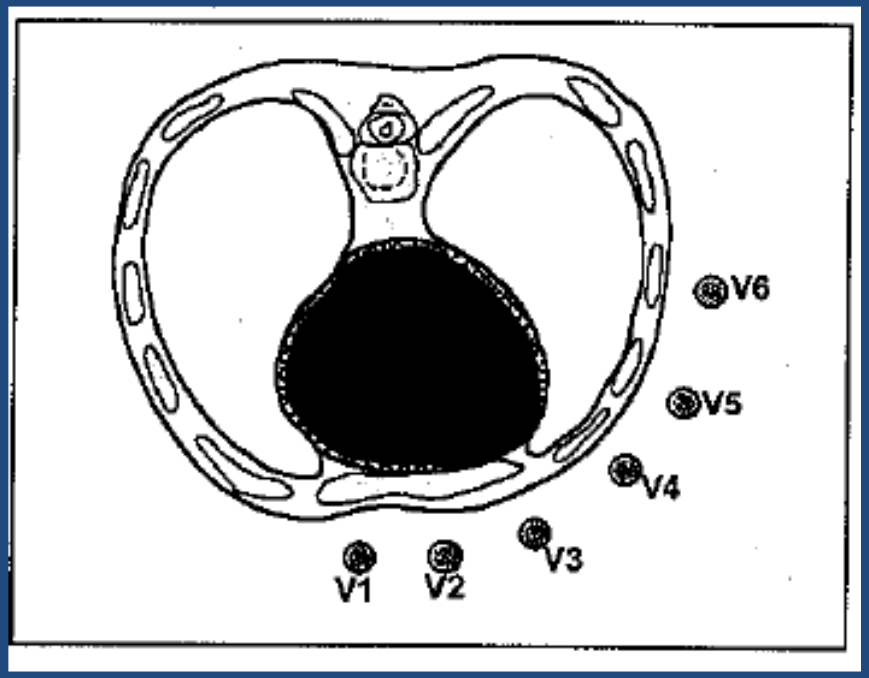


Derivaciones unipolares de los miembros

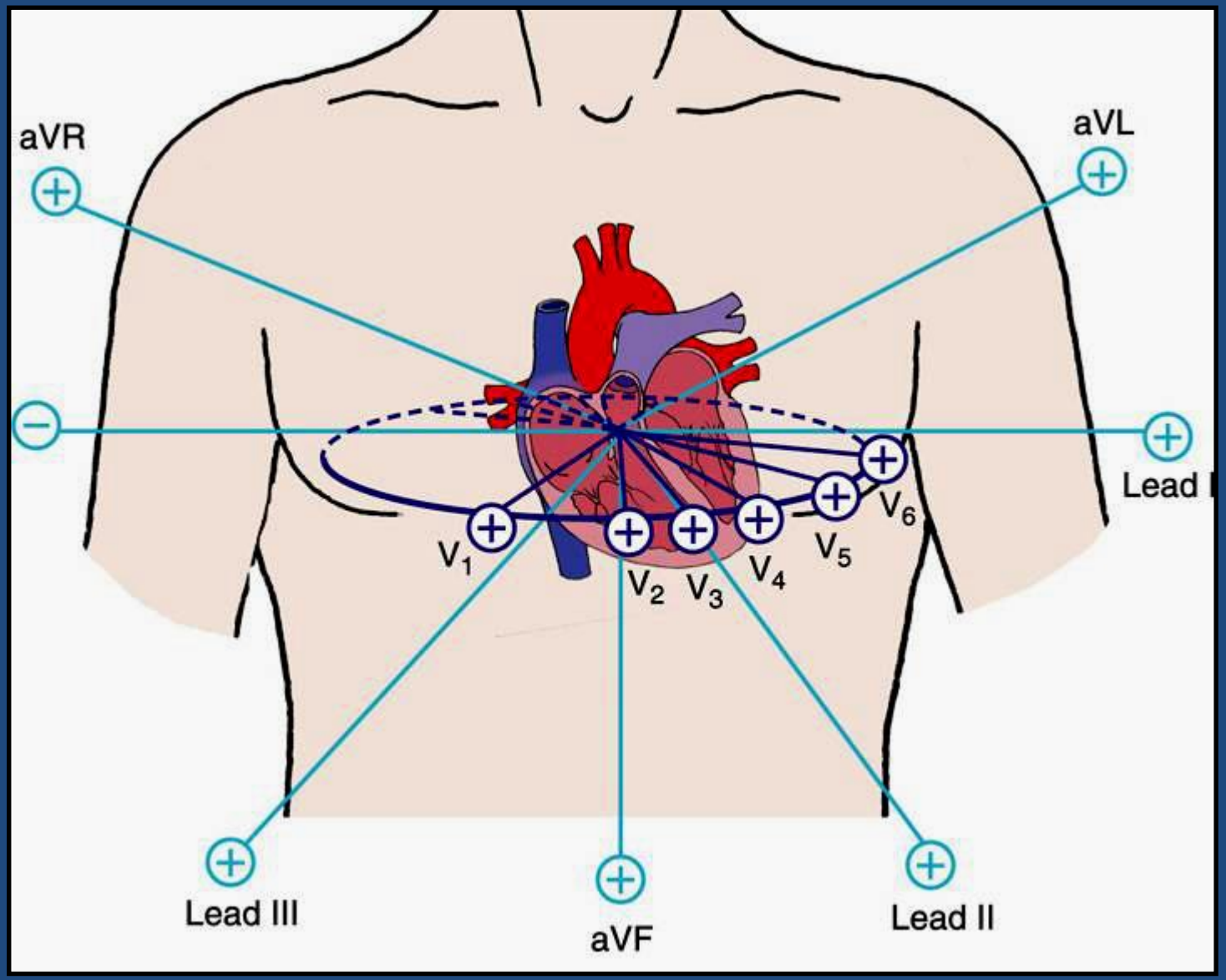


Derivaciones precordiales

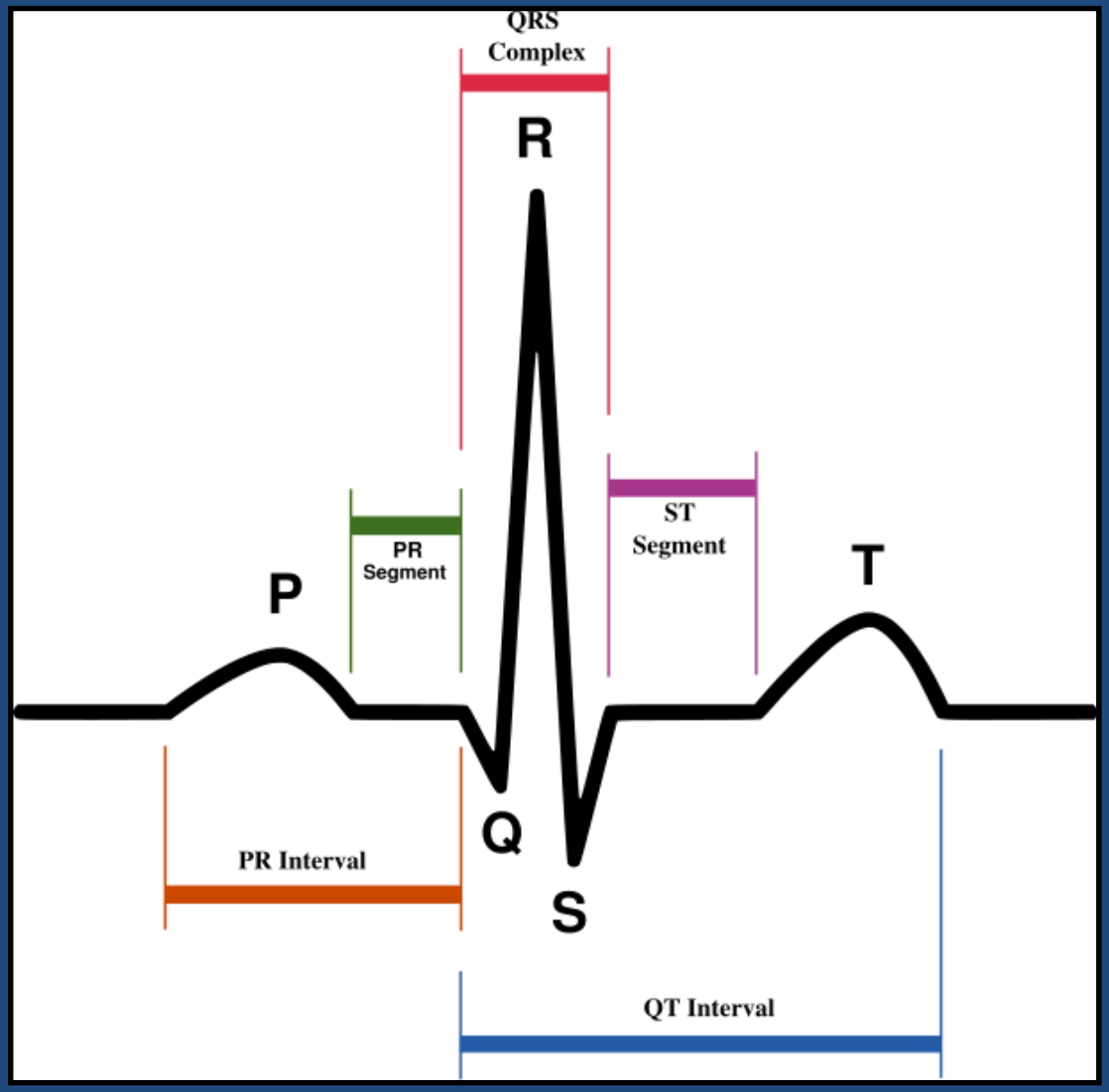




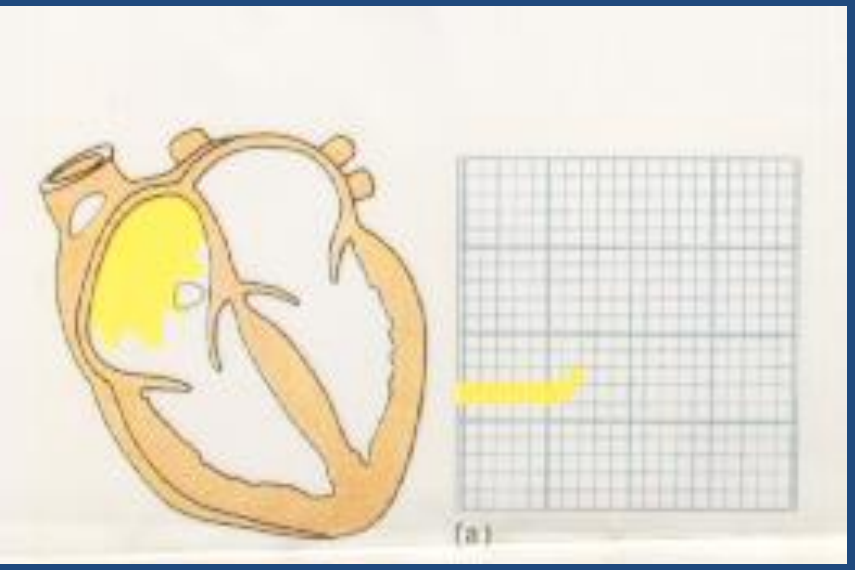
DERIVACIONES

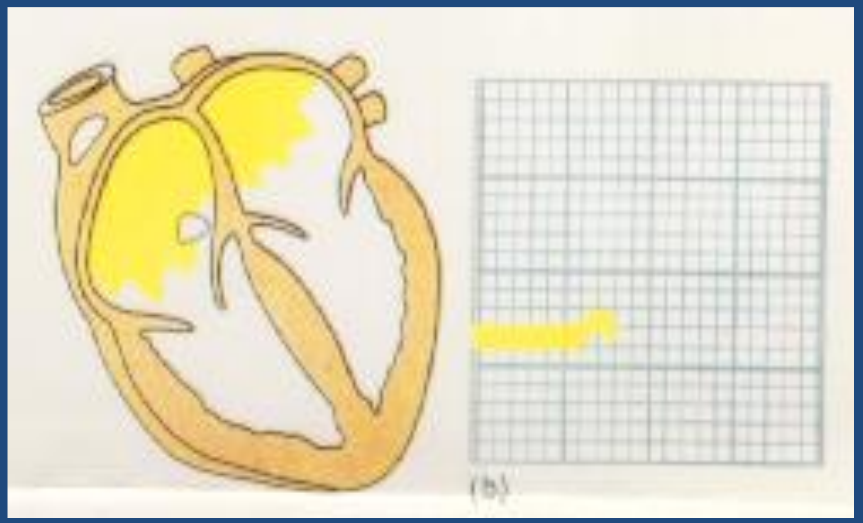


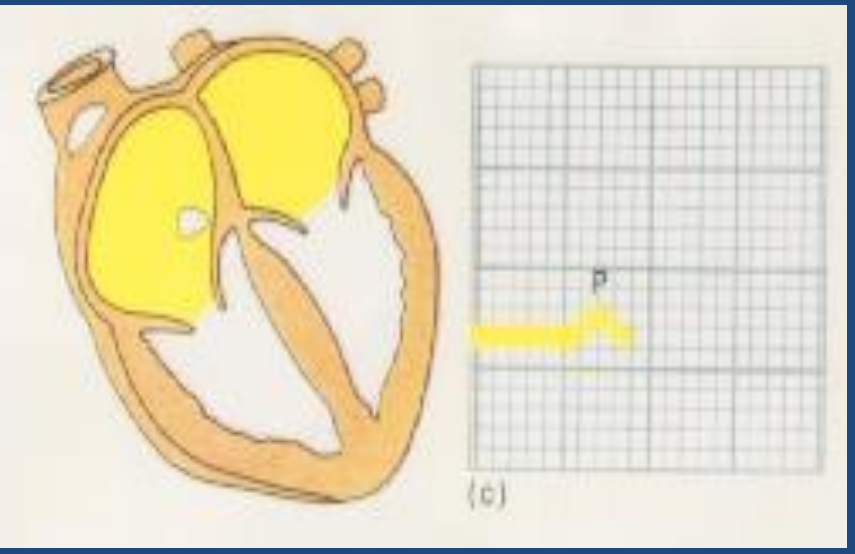
TRAZADO NORMAL

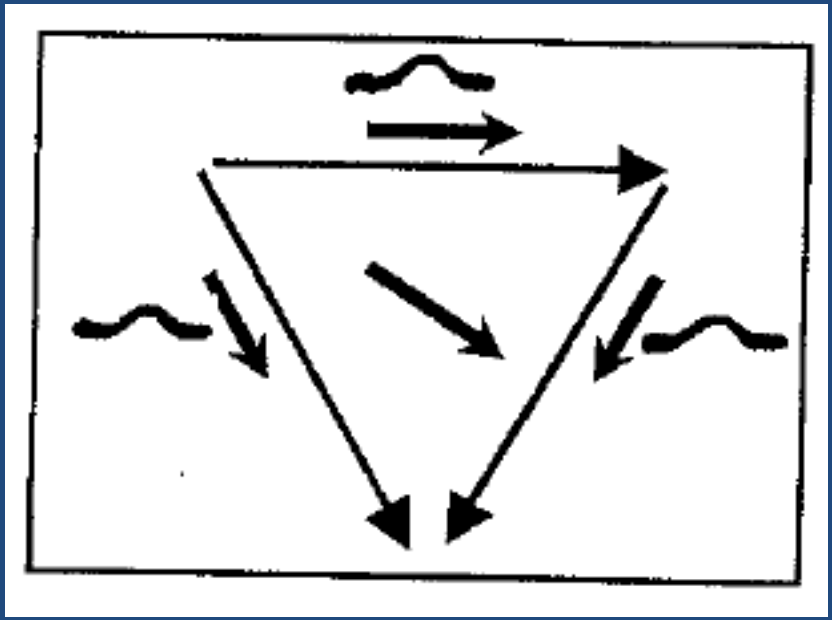


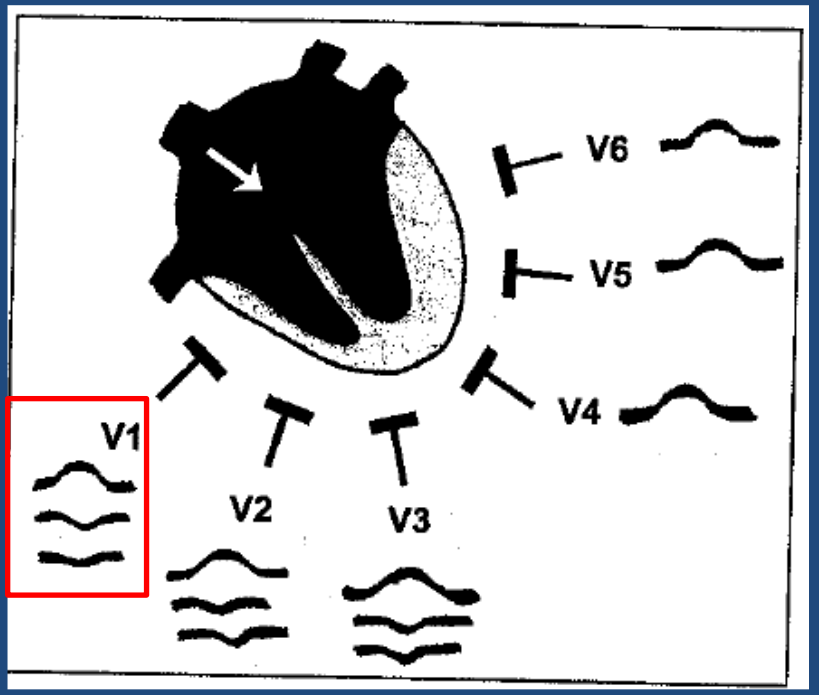
Activación de las aurículas: la onda „P“

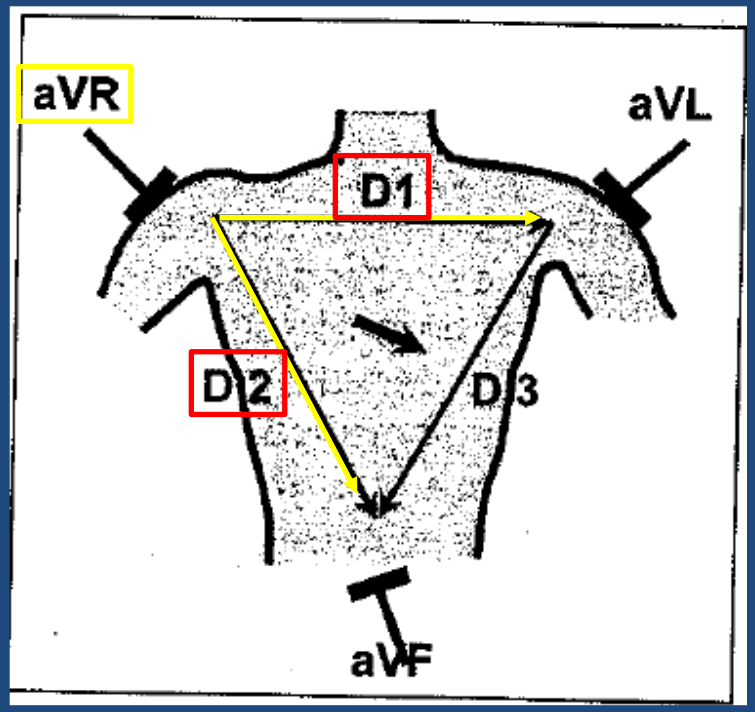




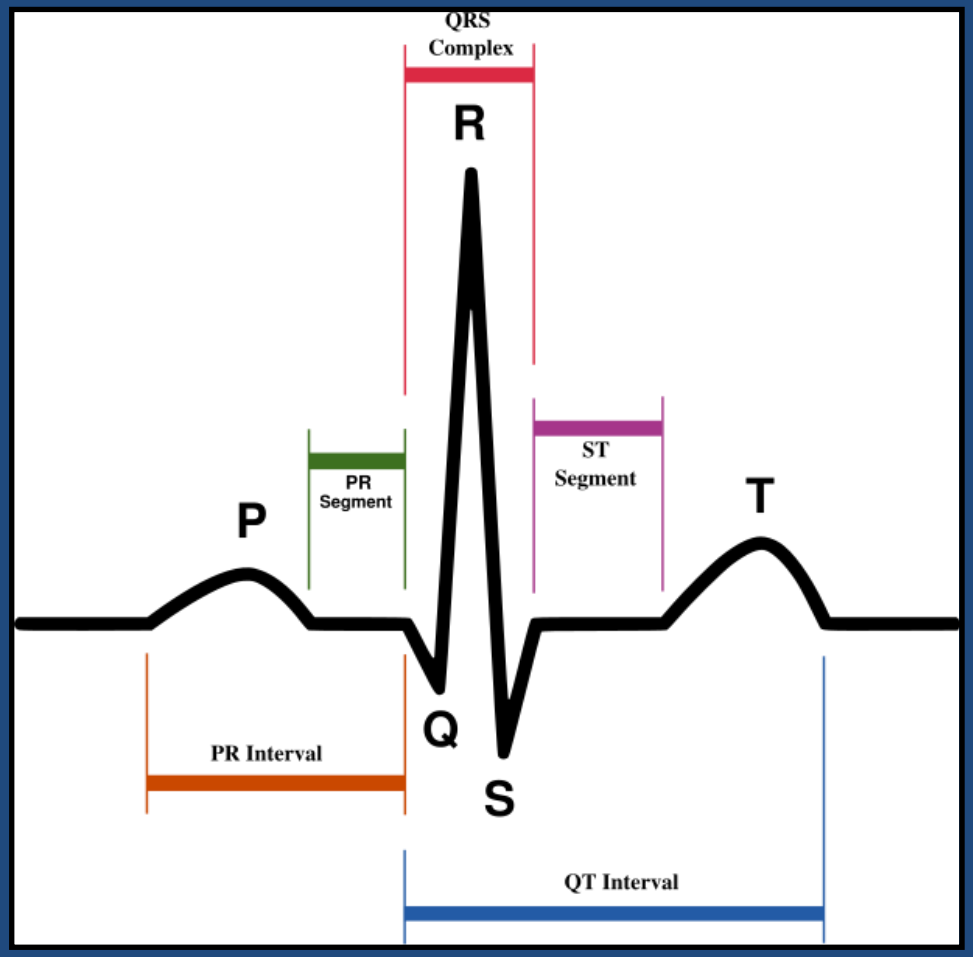





V6
V5
V4
V1
V2
V3


aVR
aVL
D1
D2
D3
aVF

Onda P:



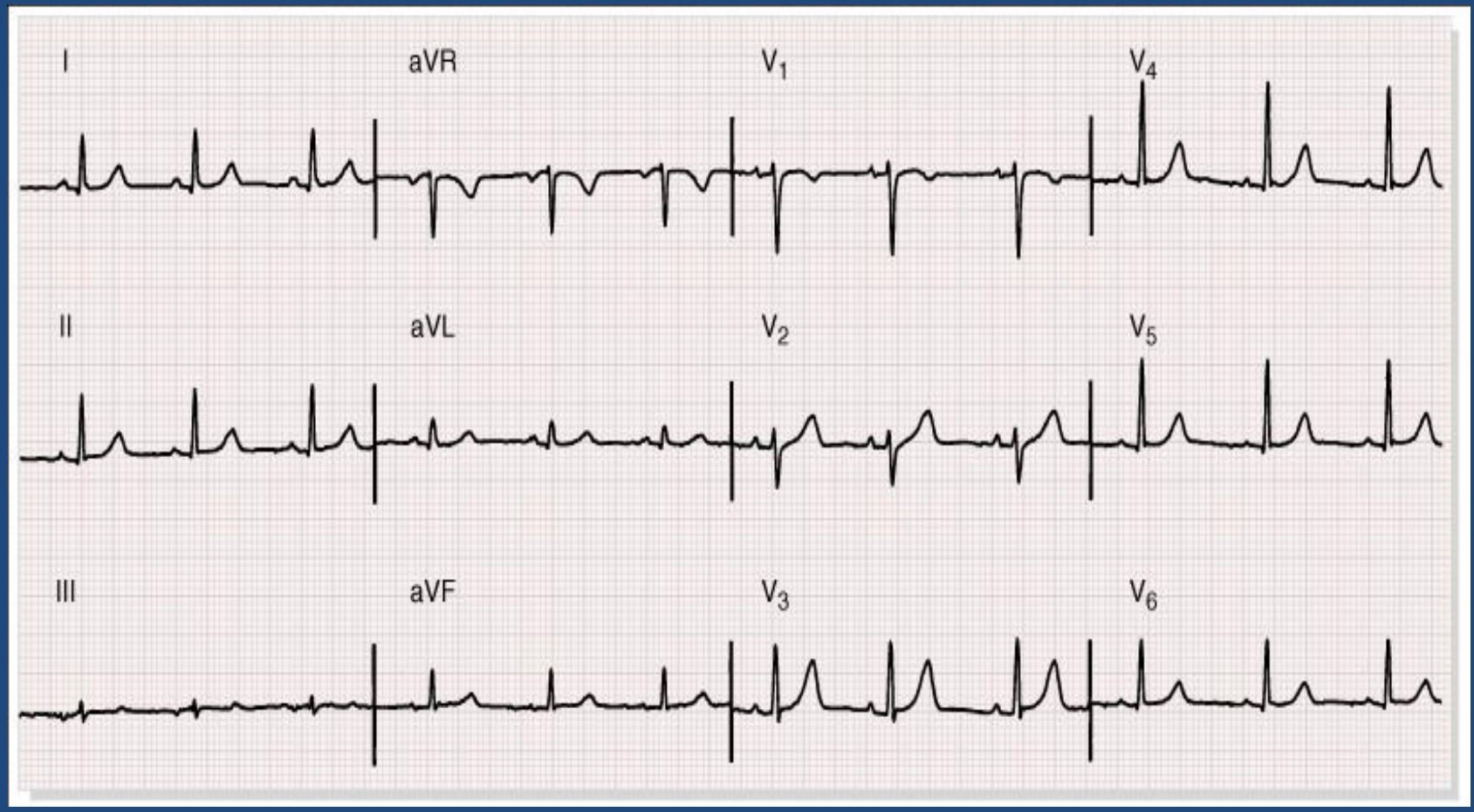
-Mide hasta 2.5 mm de alto y dura < 100 mseg.

-Siempre (+) en DI, DII, V5, V6.

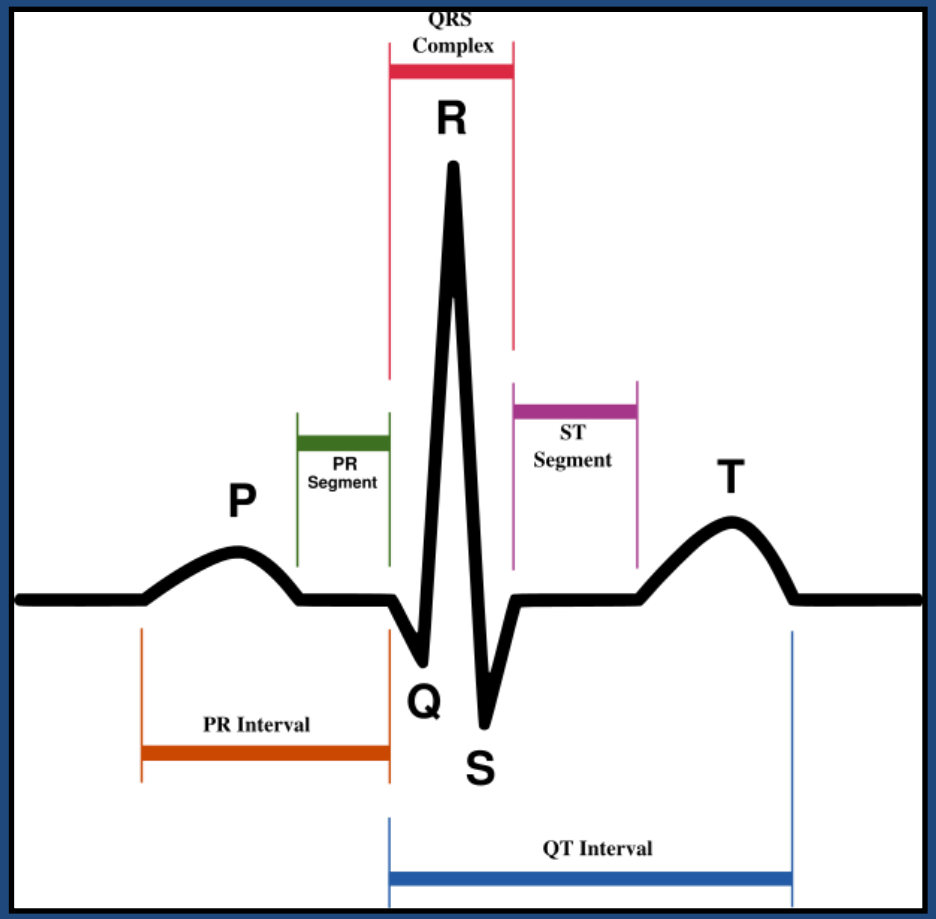
-Siempre (-) en aVR.

-DII redondeada

-Bifásica o (-) en DIII y aVL.

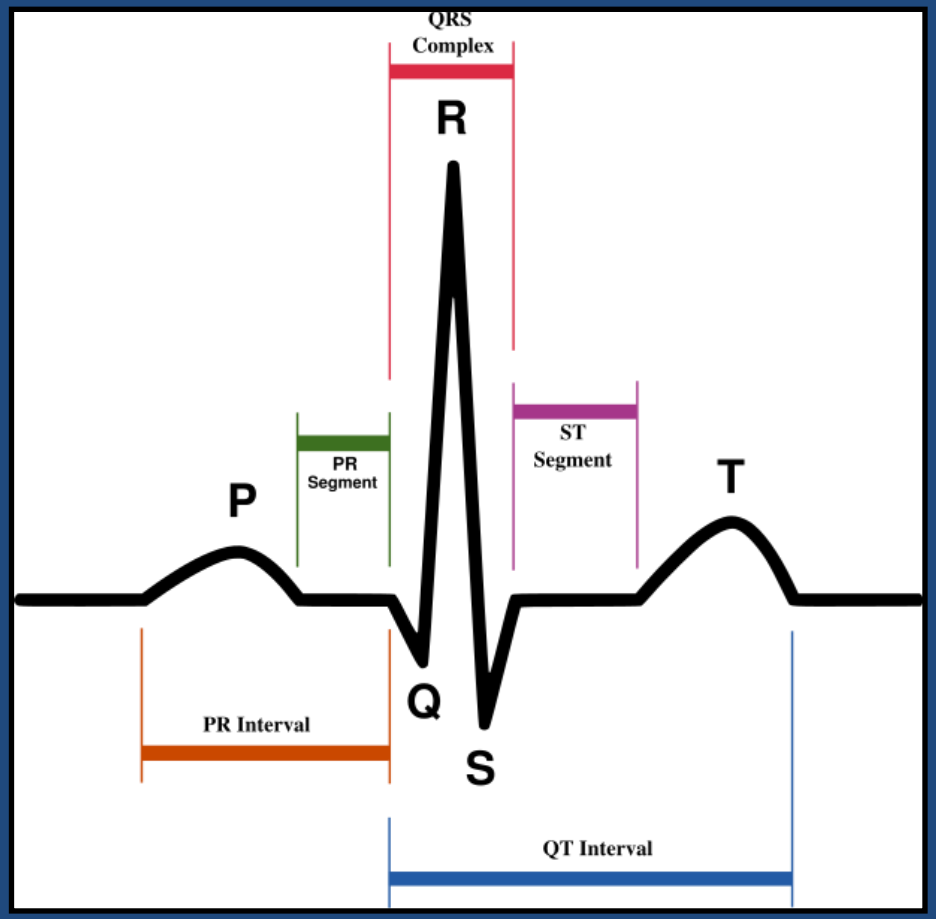

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

Intervalo PR



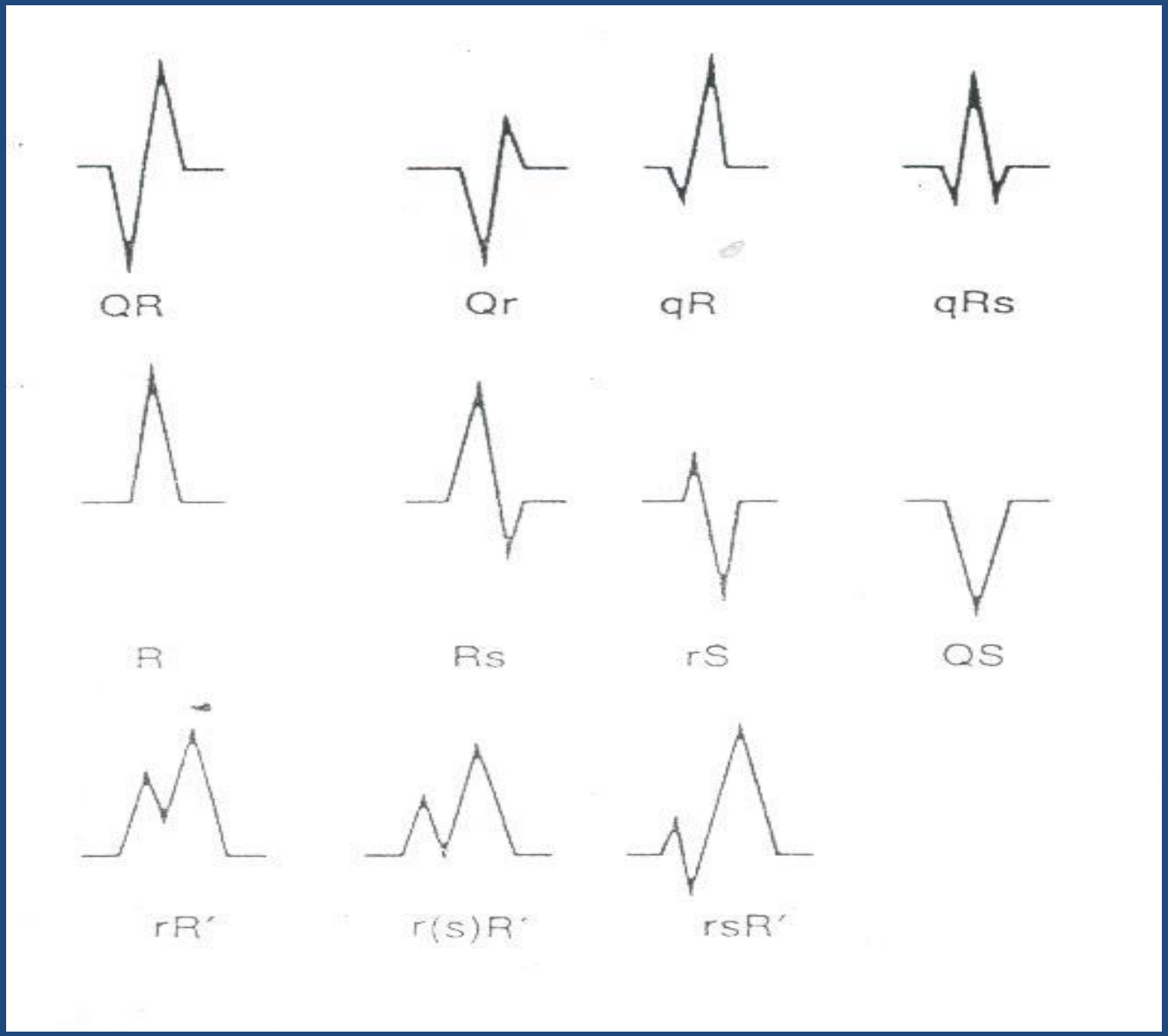
- Los valores normales fluctúan entre 120 y 200 ms (3 hasta 5 cuadrados pequeños), dependiendo de la edad.
- PR largo ⇒ Bloqueo AV de primer grado
- PR corto ⇒ Nodo AV rápido o Pre-excitación ventricular.

COMPLEJO QRS



- Corresponde a la depolarización ventricular.
- Debido a que la masa ventricular es mayor que la auricular, los voltajes son mayores.
- No en todas las derivadas se observa onda Q, onda R y onda S.

Nomenclatura QRS



Complejo QRS:

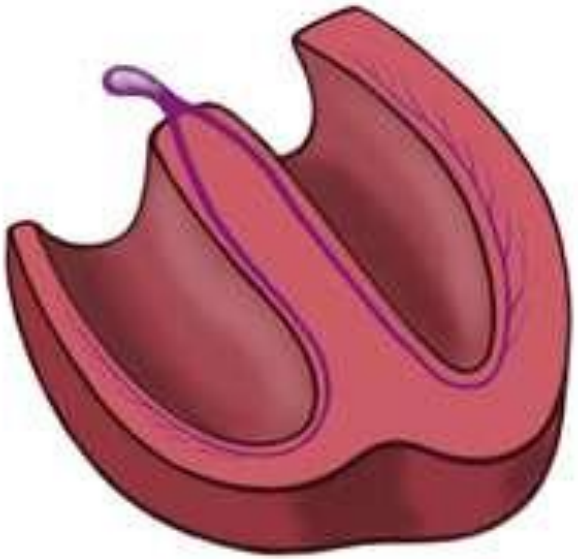
- Duración < 100 -110 ms es normal.

- Onda q normal⇒ Depolarización septum interventricular (I, aVL, V5 y V6), su aparición en otras derivaciones es anormal.

Onda R:

- Máximo 1.5 mV en derivadas de los miembros y 2.5 mV en las precordiales.
- Mínimo 0.5 mV en derivadas de los miembros.

Normal QRS and T wave Creation



Frontosuperior section of the ventricles

Time = t0

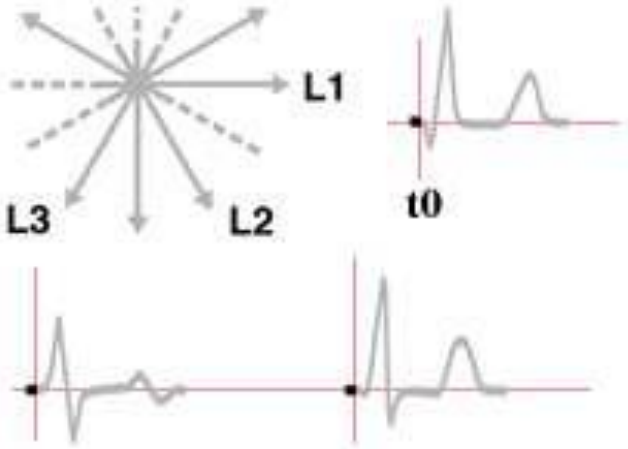
Vector Projections Frontal Plane

t0

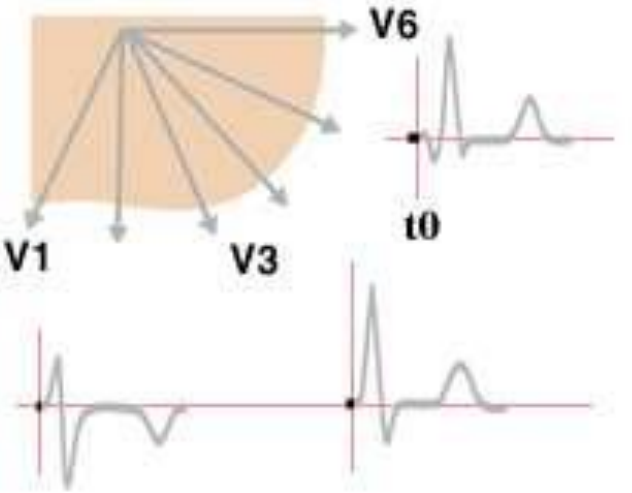
Horizontal Plane

t0

Frontal Lead Projections



Precordial Lead Projections



Normal QRS and T wave Creation

Frontosuperior section of the ventricles

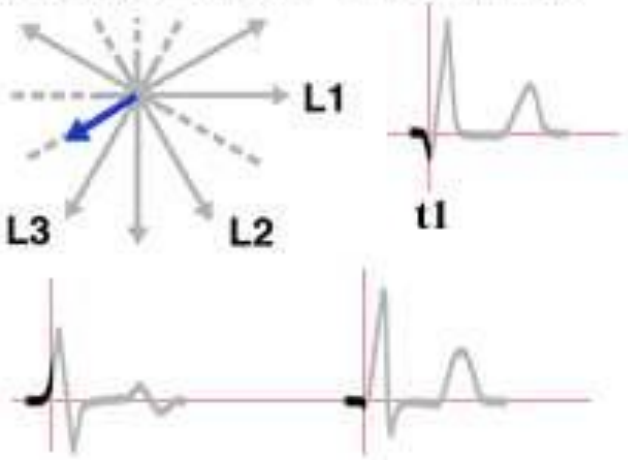
Time = t1

Vector Projections Frontal Plane

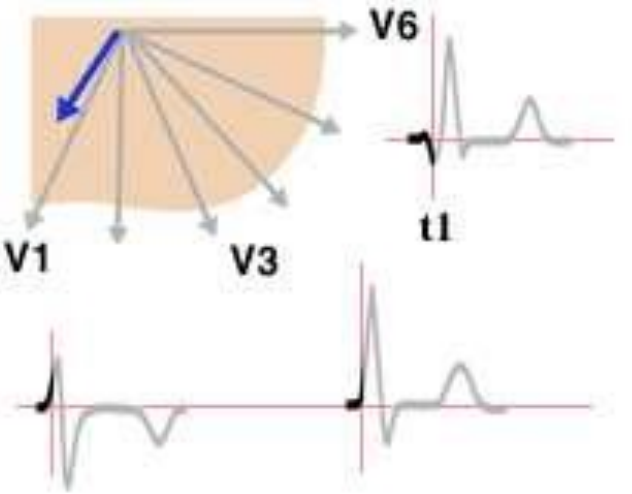
The initial septal vector points leftward, anteriorly, and slightly superiorly or inferiorly.

Horizontal Plane

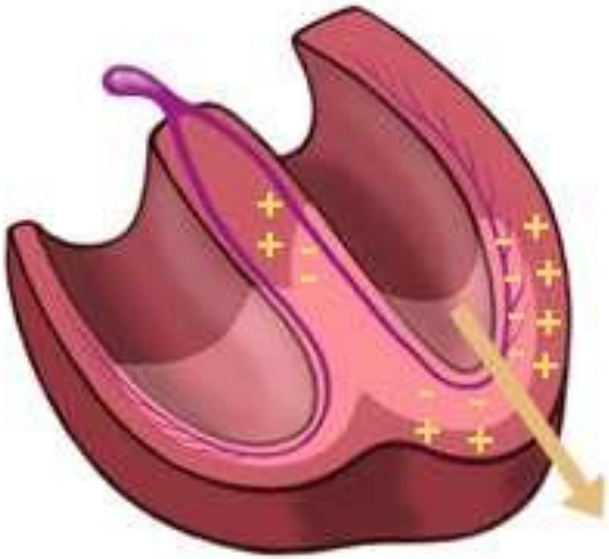
Frontal Lead Projections



Precordial Lead Projections



Normal QRS and T wave Creation

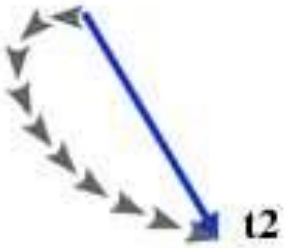


Frontosuperior section of the ventricles

The RV depolarizes early, but is dominated by the LV.

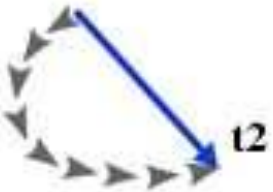
Time = t2

Vector Projections Frontal Plane

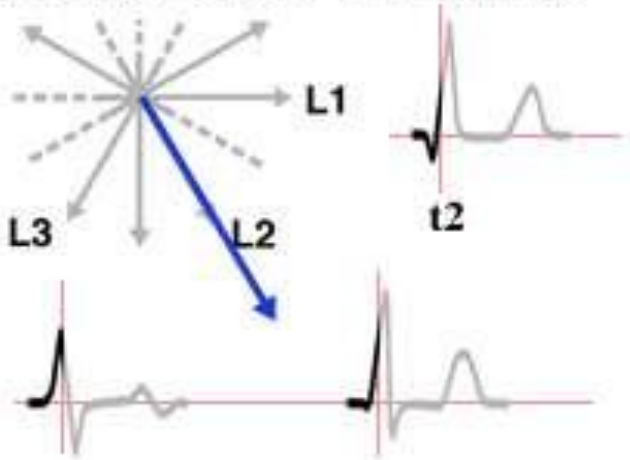


Horizontal Plane

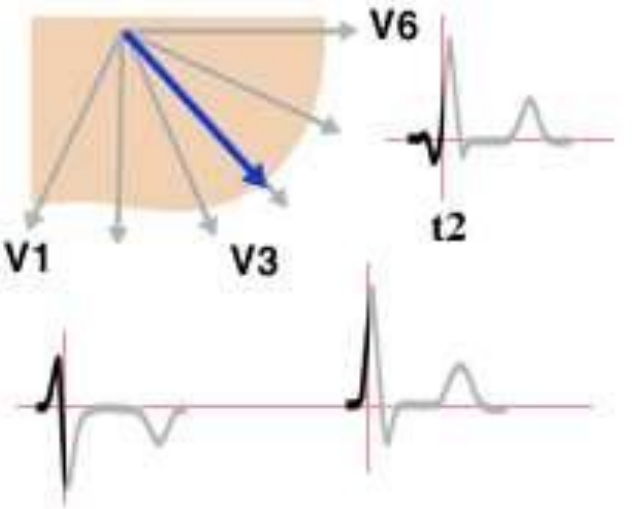
The apical vector swings inferiorly, leftward and anteriorly.



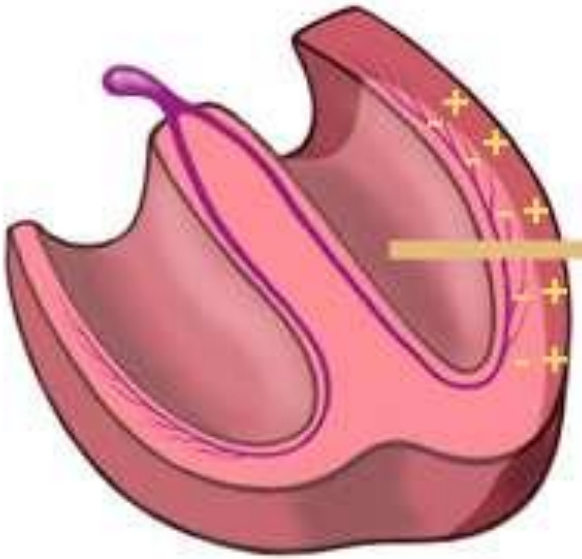
Frontal Lead Projections



Precordial Lead Projections



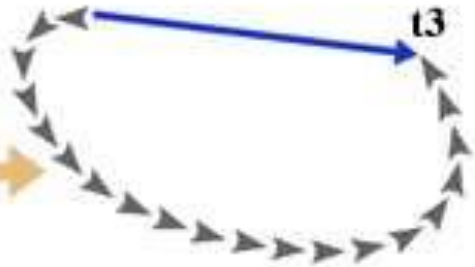
Normal QRS and T wave Creation



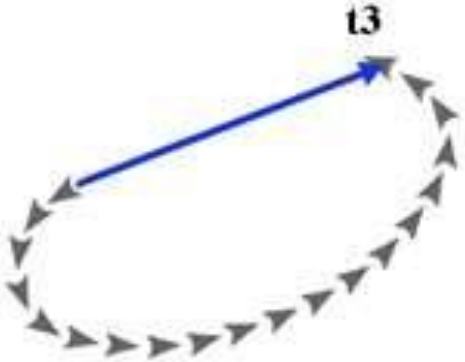
Frontosuperior section of the ventricles

Vector Projections Frontal Plane

The LV free wall vector points laterally.

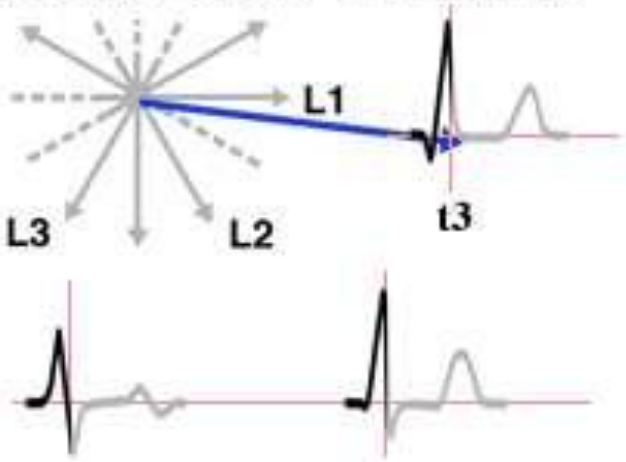


Horizontal Plane

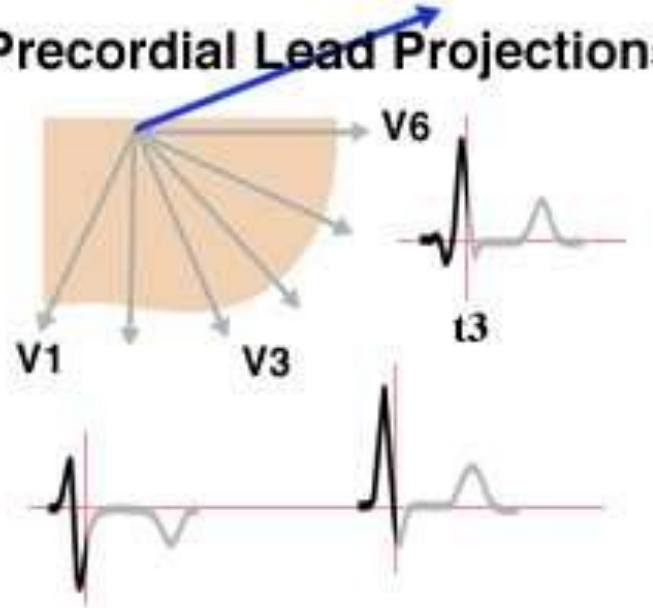


Time = t3

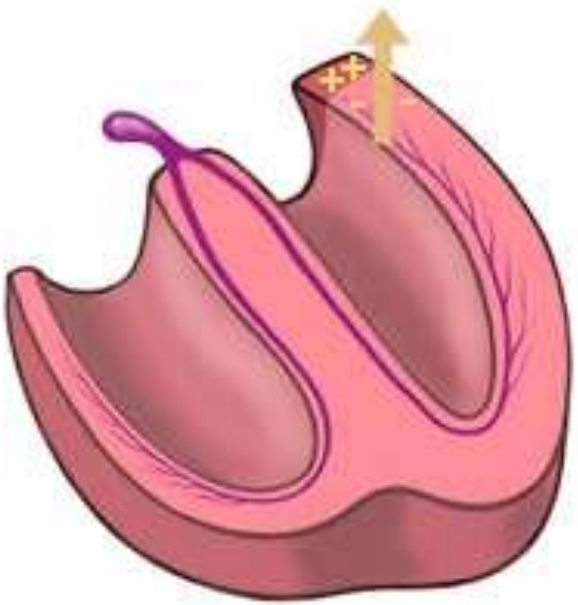
Frontal Lead Projections



Precordial Lead Projections



Normal QRS and T wave Creation

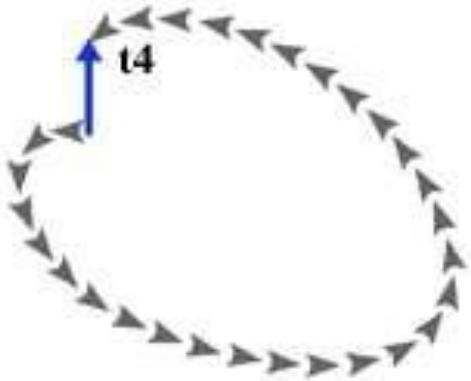


Frontosuperior section of the ventricles

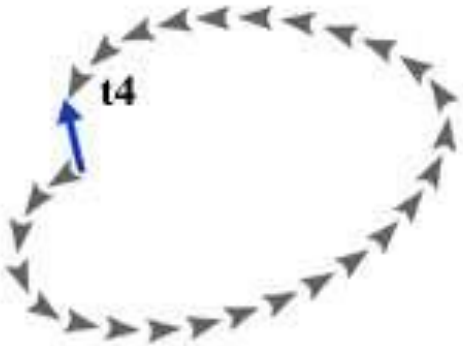
The basal vector creates the terminal QRS.

Time = t4

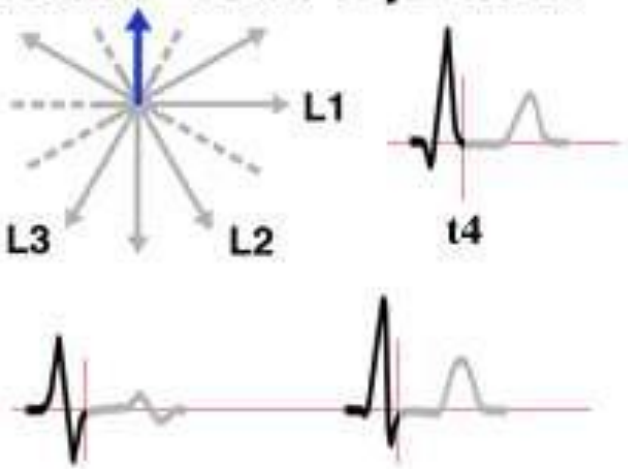
Vector Projections Frontal Plane



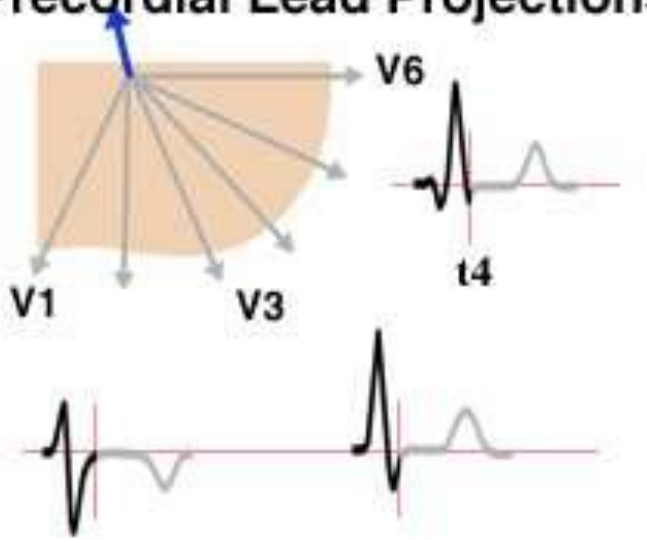
Horizontal Plane



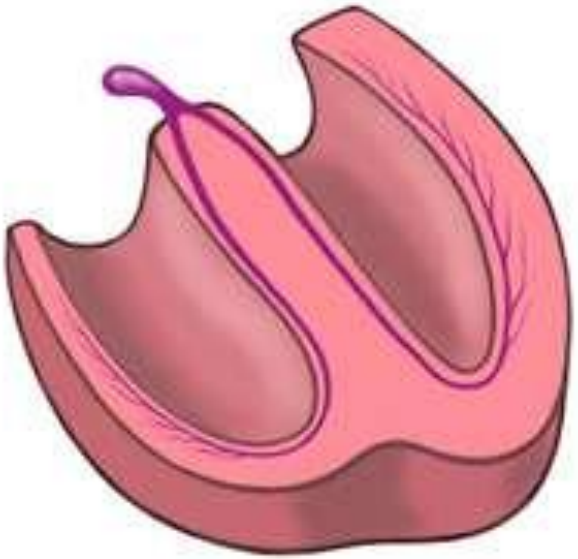
Frontal Lead Projections



Precordial Lead Projections



Normal QRS and T wave Creation

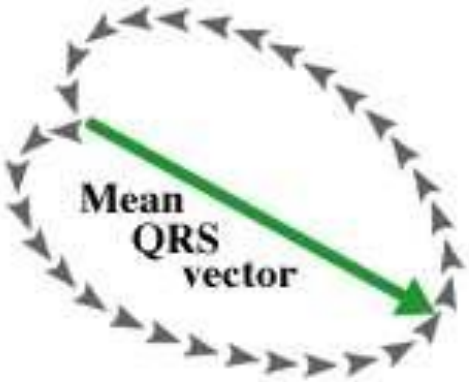


Frontosuperior section of the ventricles

The ventricles are completely depolarized during the ST segment.

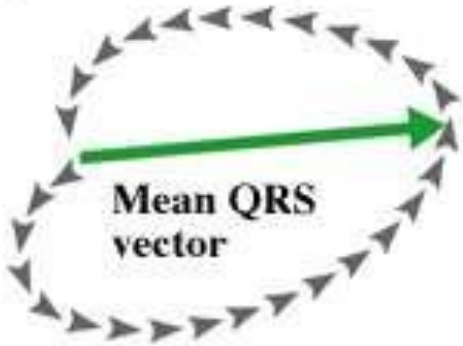
Time = t5

Vector Projections Frontal Plane

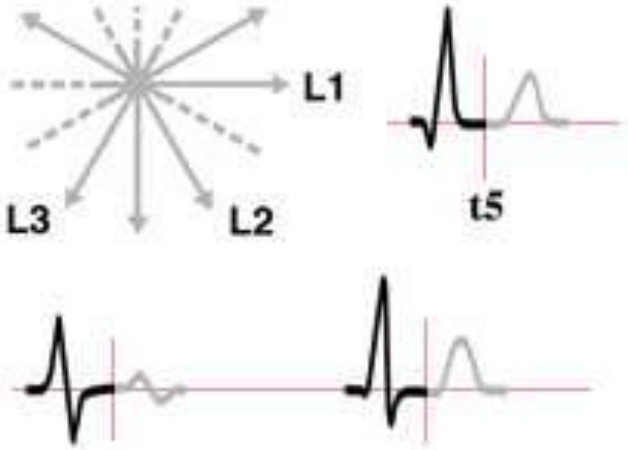


Horizontal Plane

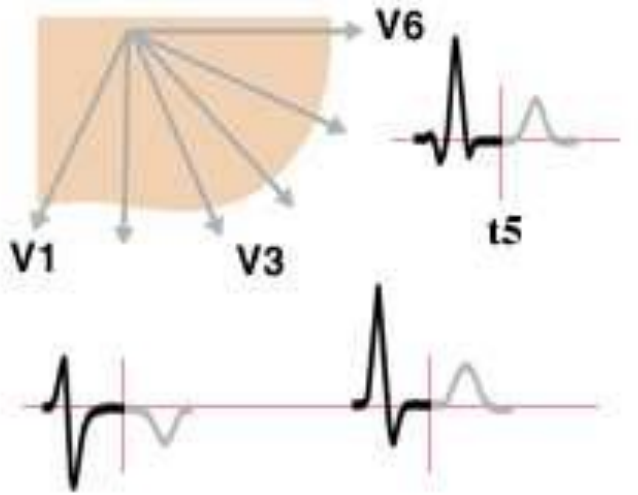
No ST segment vector (ST at baseline).



Frontal Lead Projections



Precordial Lead Projections



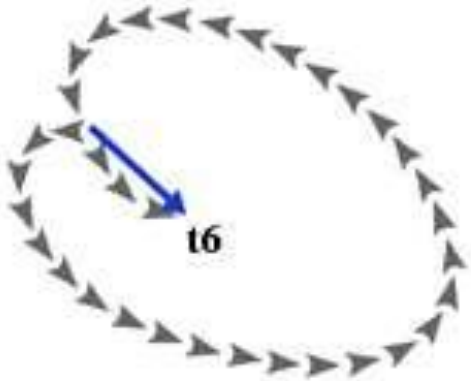
Normal QRS and T wave Creation

Frontosuperior section of the ventricles

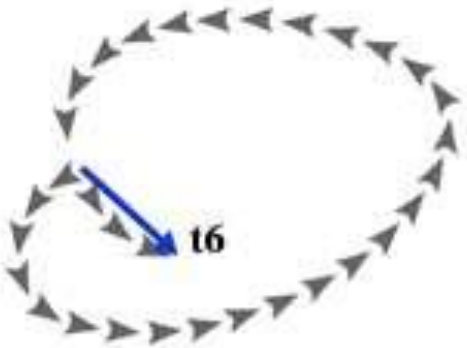
Repolarization begins at the epicardium and is dominated by the left ventricle.

Time = t6

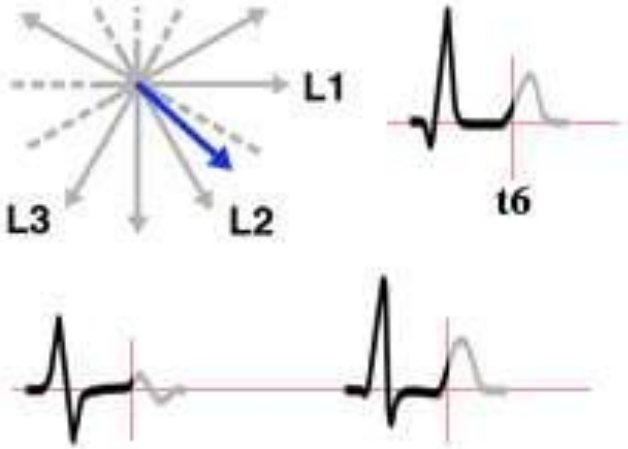
Vector Projections Frontal Plane



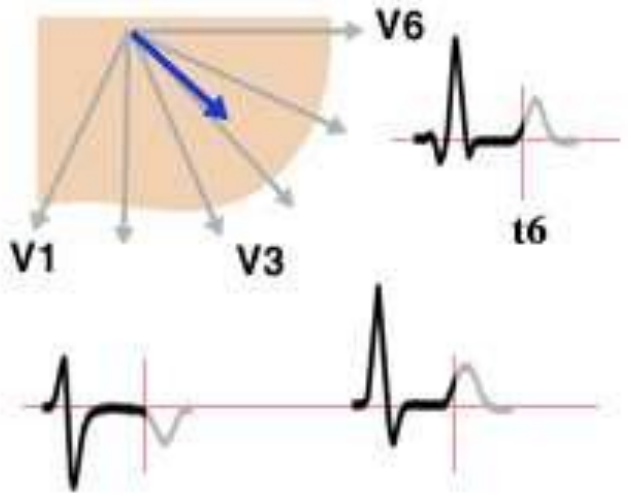
Horizontal Plane



Frontal Lead Projections



Precordial Lead Projections



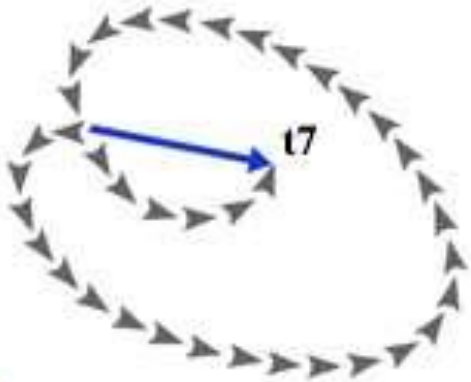
Normal QRS and T wave Creation

Frontosuperior section of the ventricles

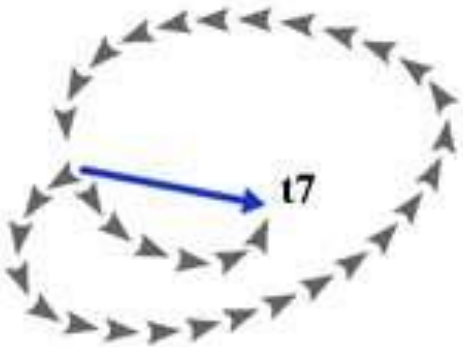
Repolarization progresses toward the endocardium.

Time = t7

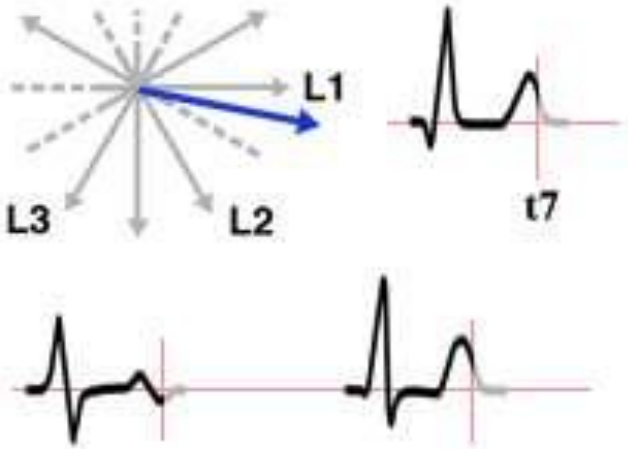
Vector Projections Frontal Plane



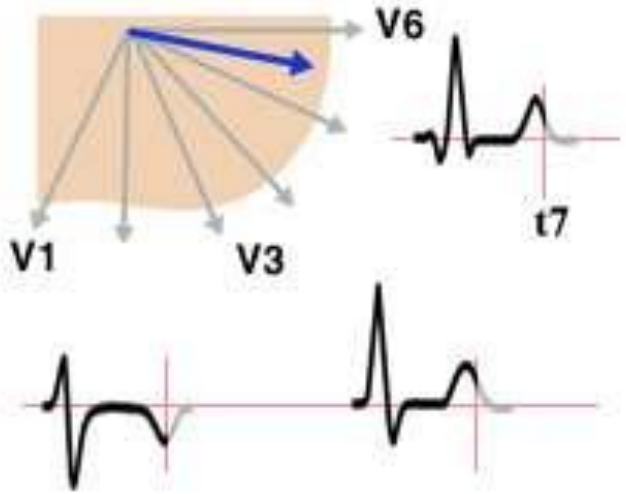
Horizontal Plane



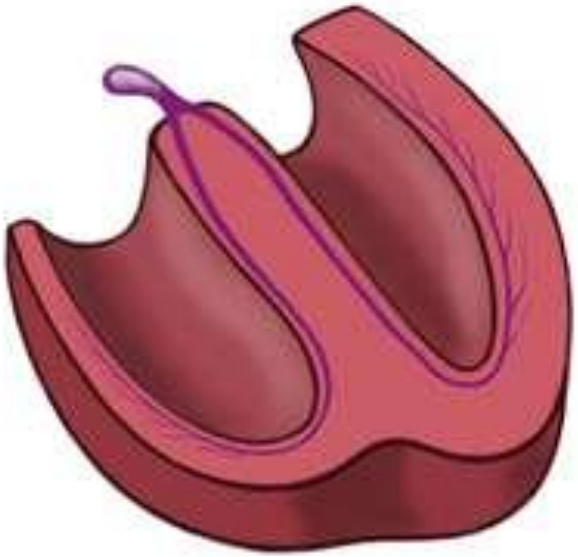
Frontal Lead Projections



Precordial Lead Projections



Normal QRS and T wave Creation

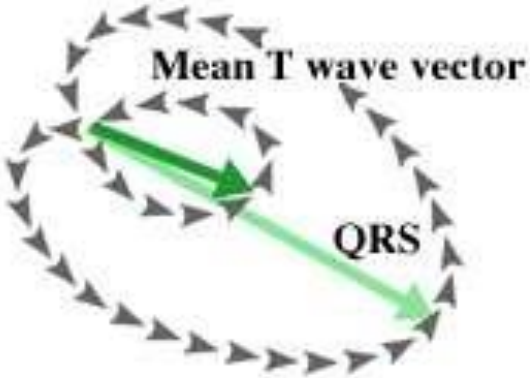


Frontosuperior section of the ventricles

The ventricles are completely repolarized in diastole.

Time = t8

Vector Projections Frontal Plane

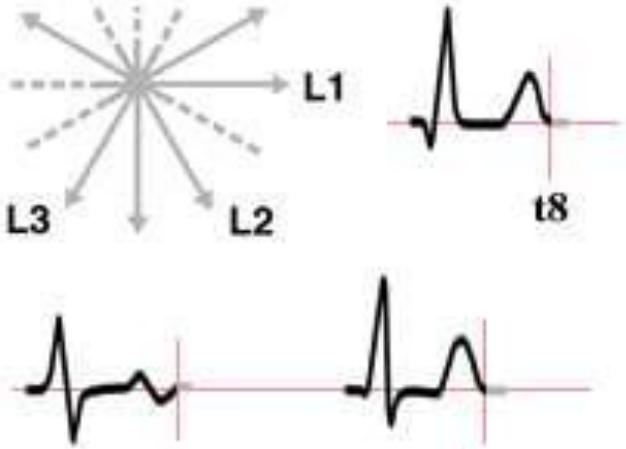


Horizontal Plane

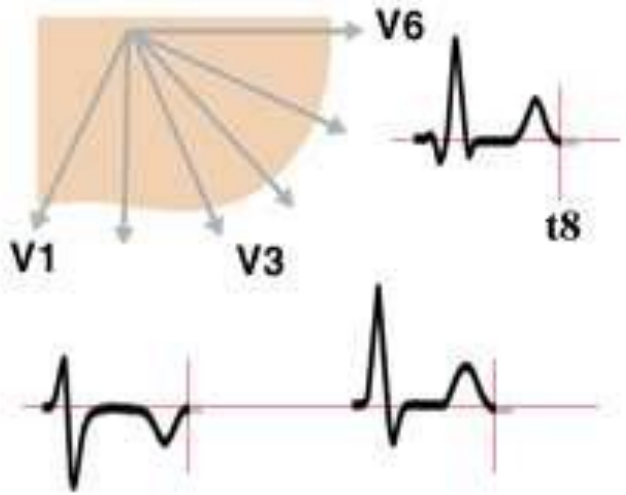
QRS and T wave vectors are in the same direction.

Mean T wave vector

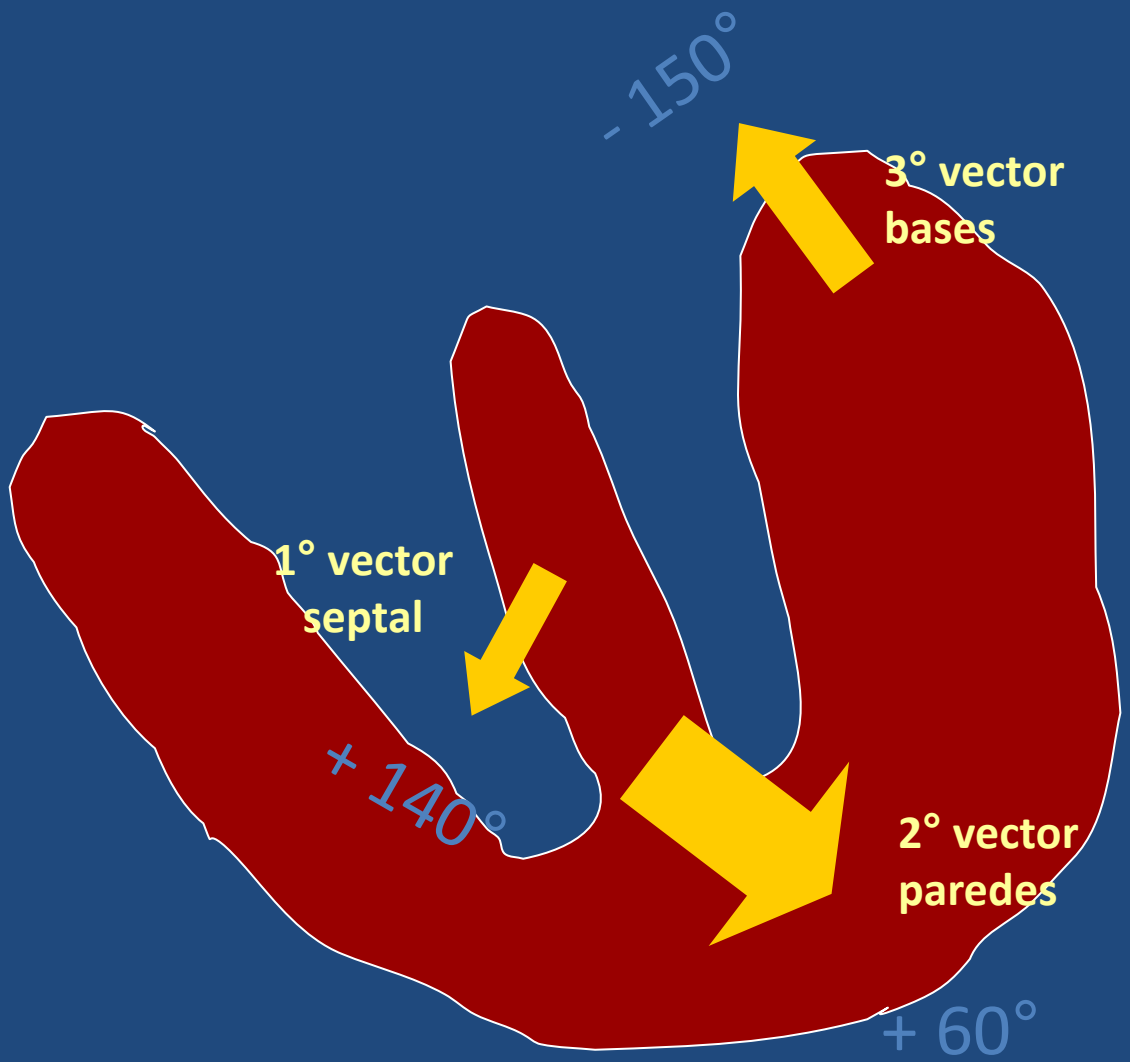
Frontal Lead Projections



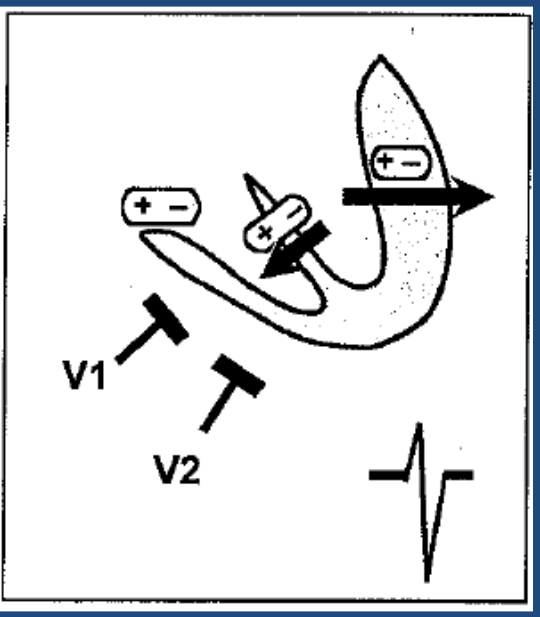
Precordial Lead Projections

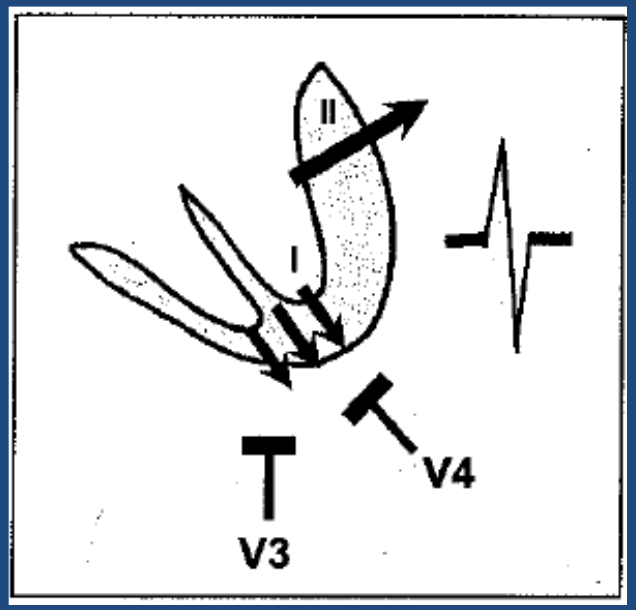


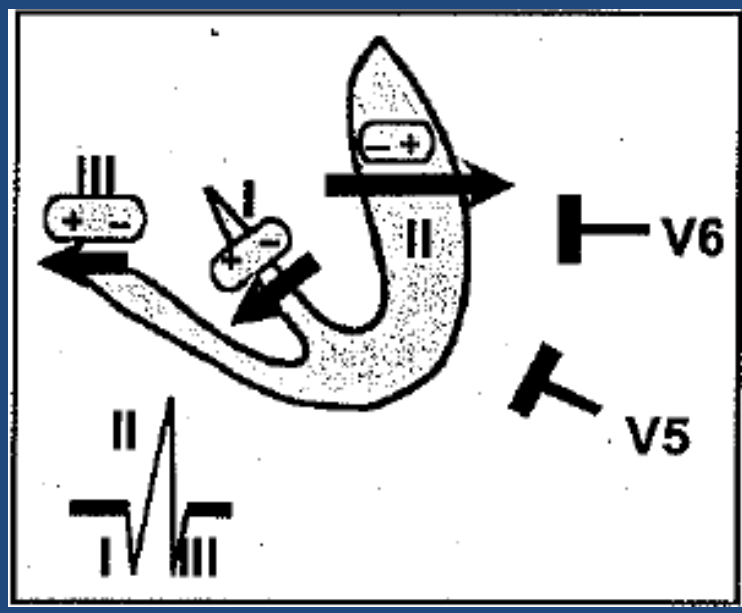
DESPOLARIZACION VENTRICULOS



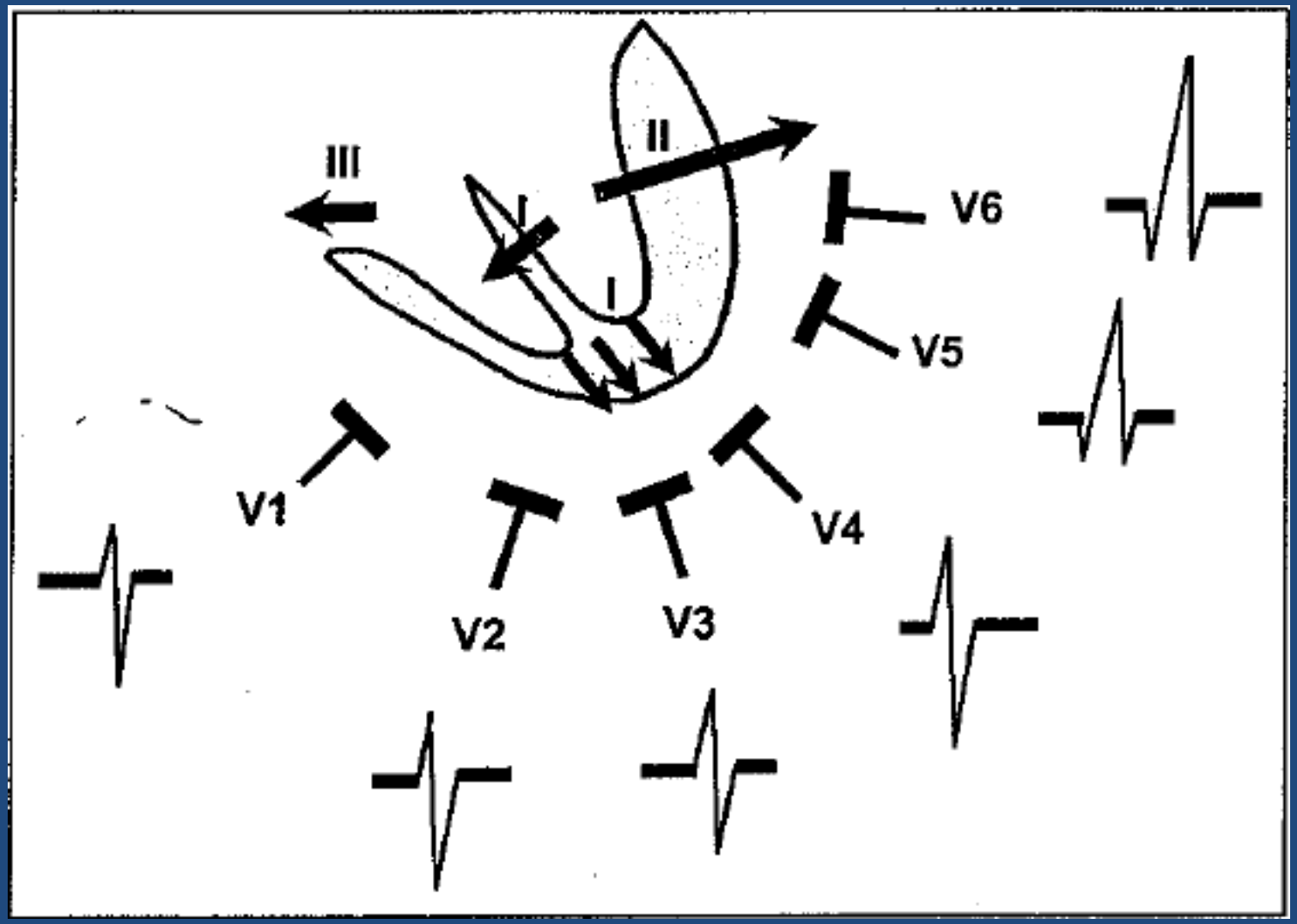
Vectores de depolarización ventricular y su registro





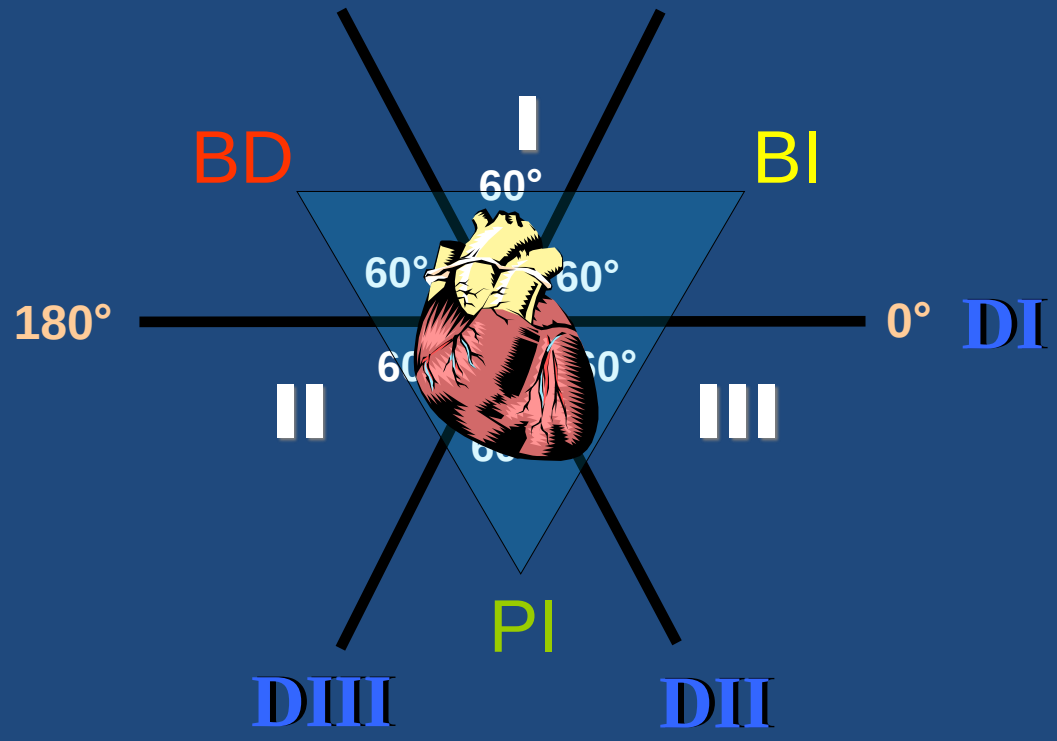


Resumen de los potenciales precordiales



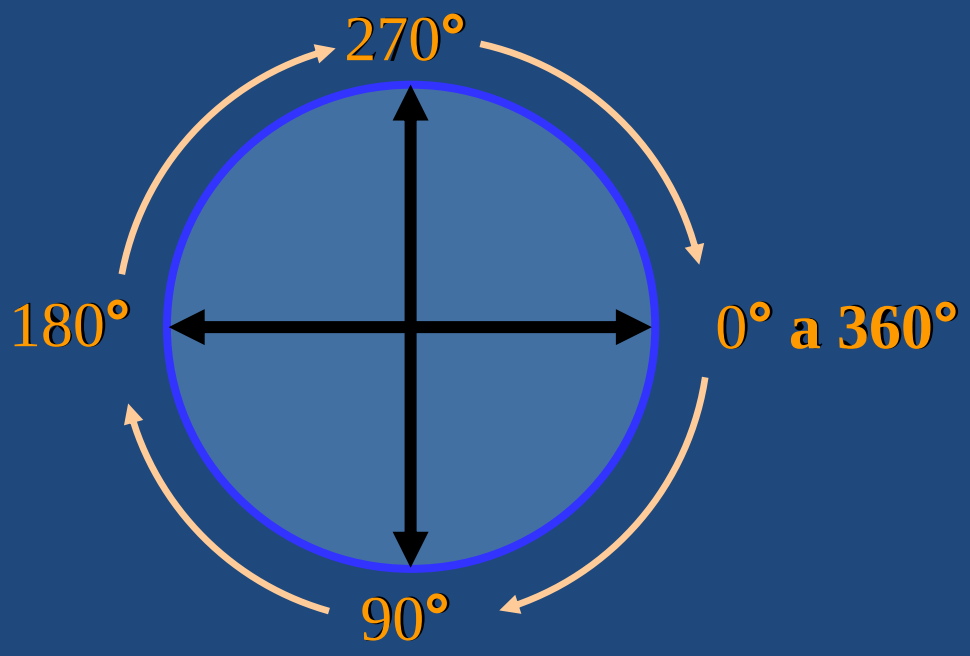
DERIVACIONES DE MIEMBROS DE EINTHOVEN

DERIVACIONES EN SISTEMA TRIAXIAL

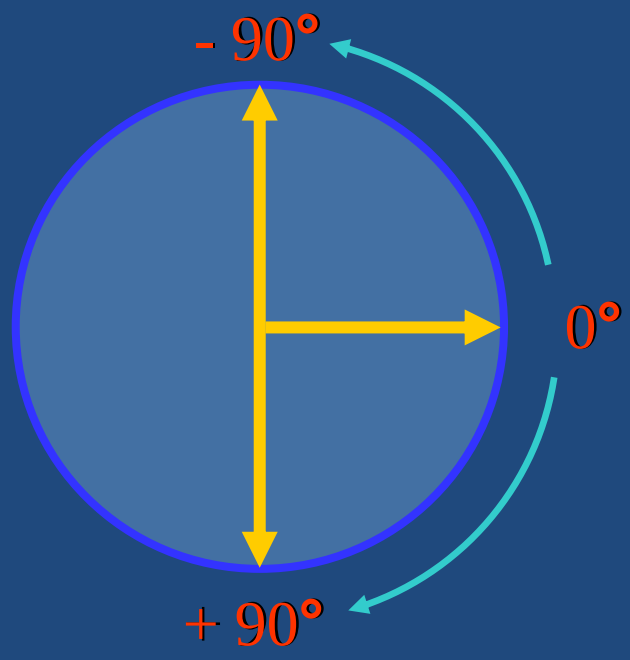


TERMINOLOGIA ECG DE LA DIRECCIÓN VECTORIAL

Luego se sigue el sentido horario y se miden todas las otras direcciones hasta llegar a los 360°

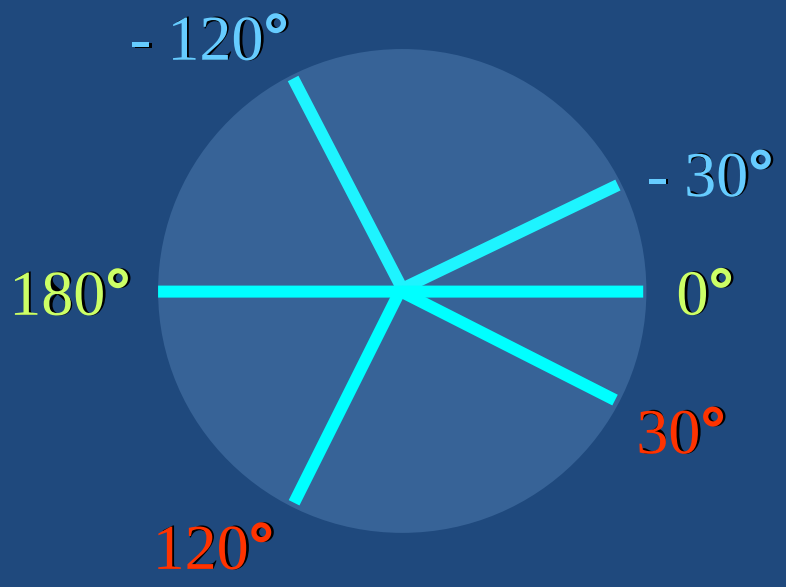


Círculo no geométrico



Círculo ECG no > 180°

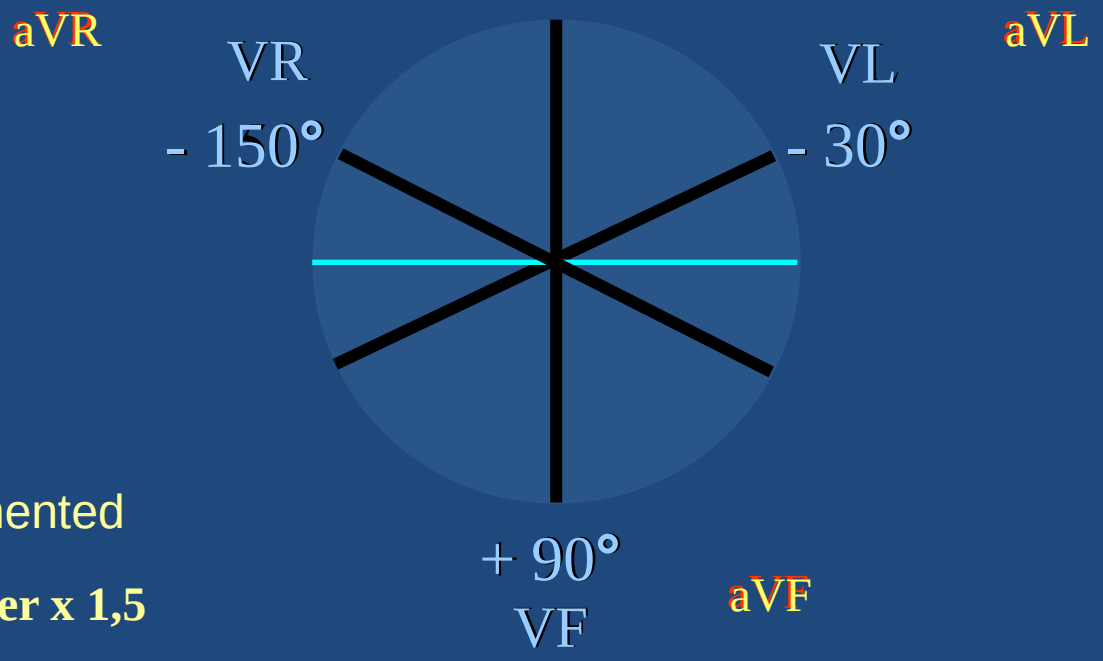
TERMINOLOGIA ELECTROCARDIOGRÁFICA DE LA DIRECCIÓN VECTORIAL



Describir la dirección del radio

DERIVACIONES UNIPOLARES DE EXTREMIDADES

Los complejos electrocardiográficos registrados con el sistema de Wilson son demasiado pequeños para ser útiles.

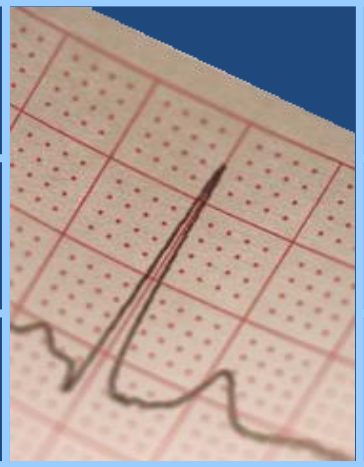


a= augmented

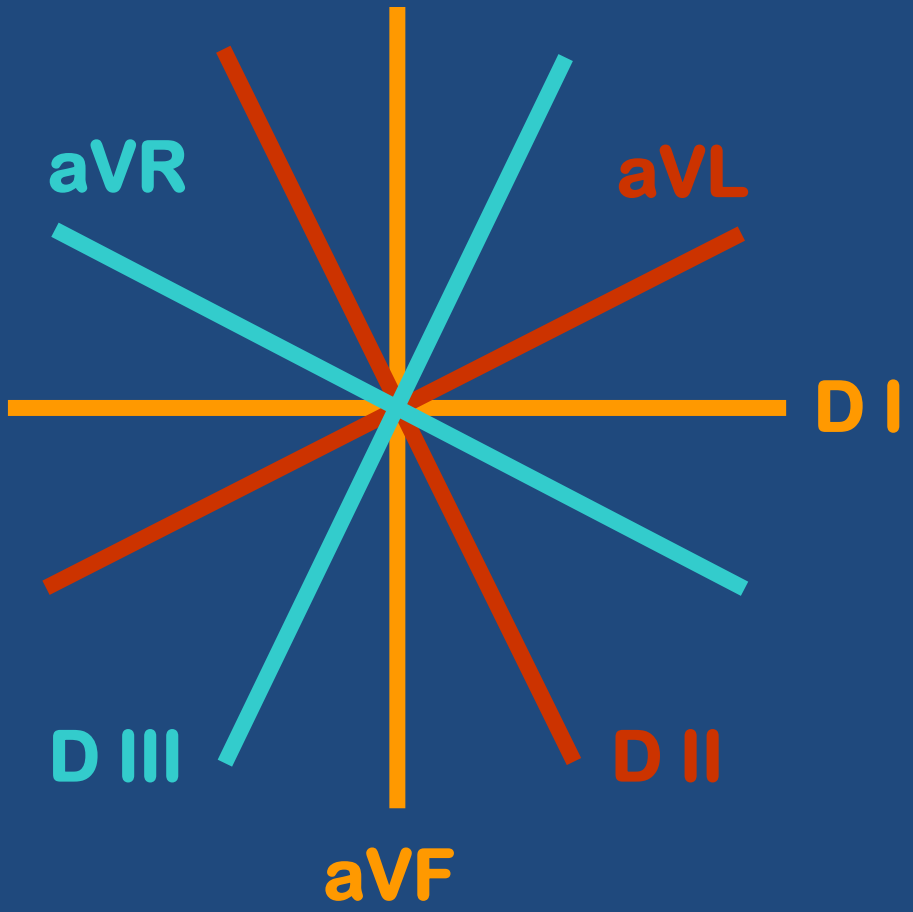
Goldberger x 1,5

Las derivaciones han sido aumentadas (a)

DERIVACIONES EN EL PLANO FRONTAL

	(+)	(−)	Eje eléctrico
D I	BI	BD	0 a 180°
D II	PI	BD	+ 60 a - 120
D III	PI	BI	+ 120 a - 60
aVR	BD		- 150 a + 30
aVL	BI		- 30 a + 150
aVF	PI		90 a - 90

DERIVADAS PERPENDICULARES

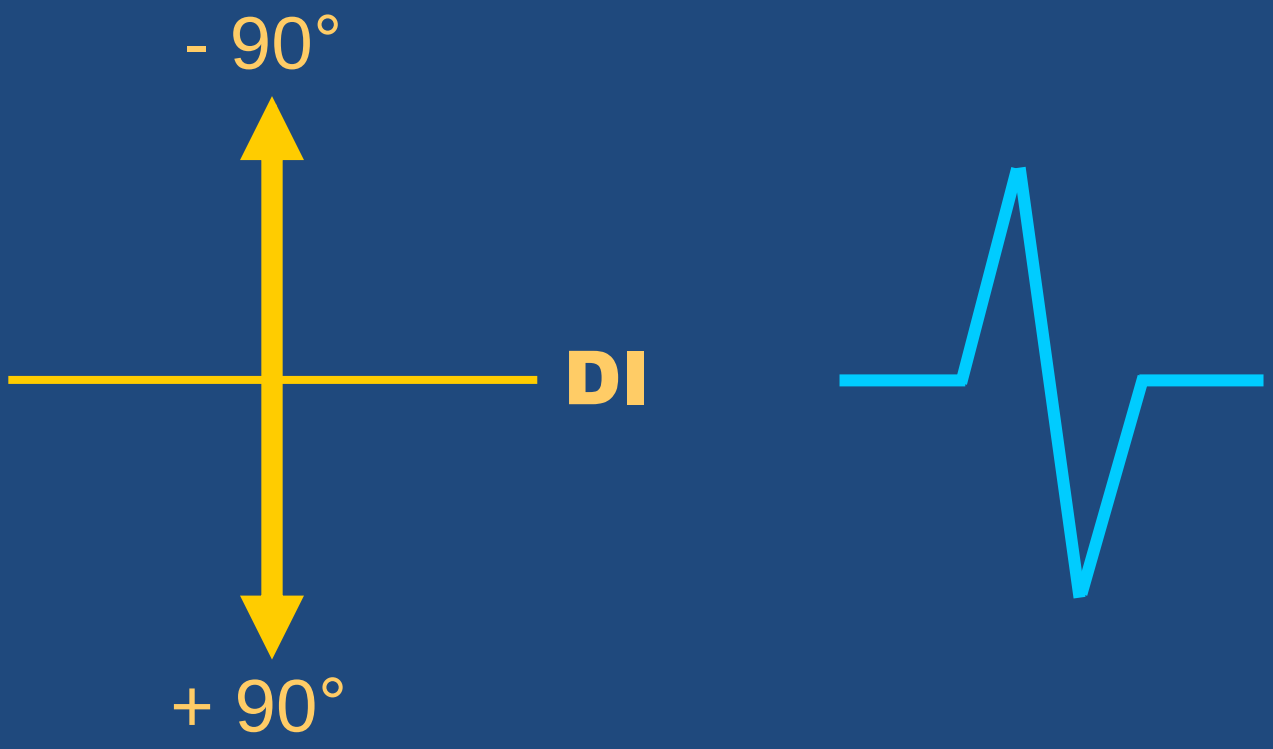


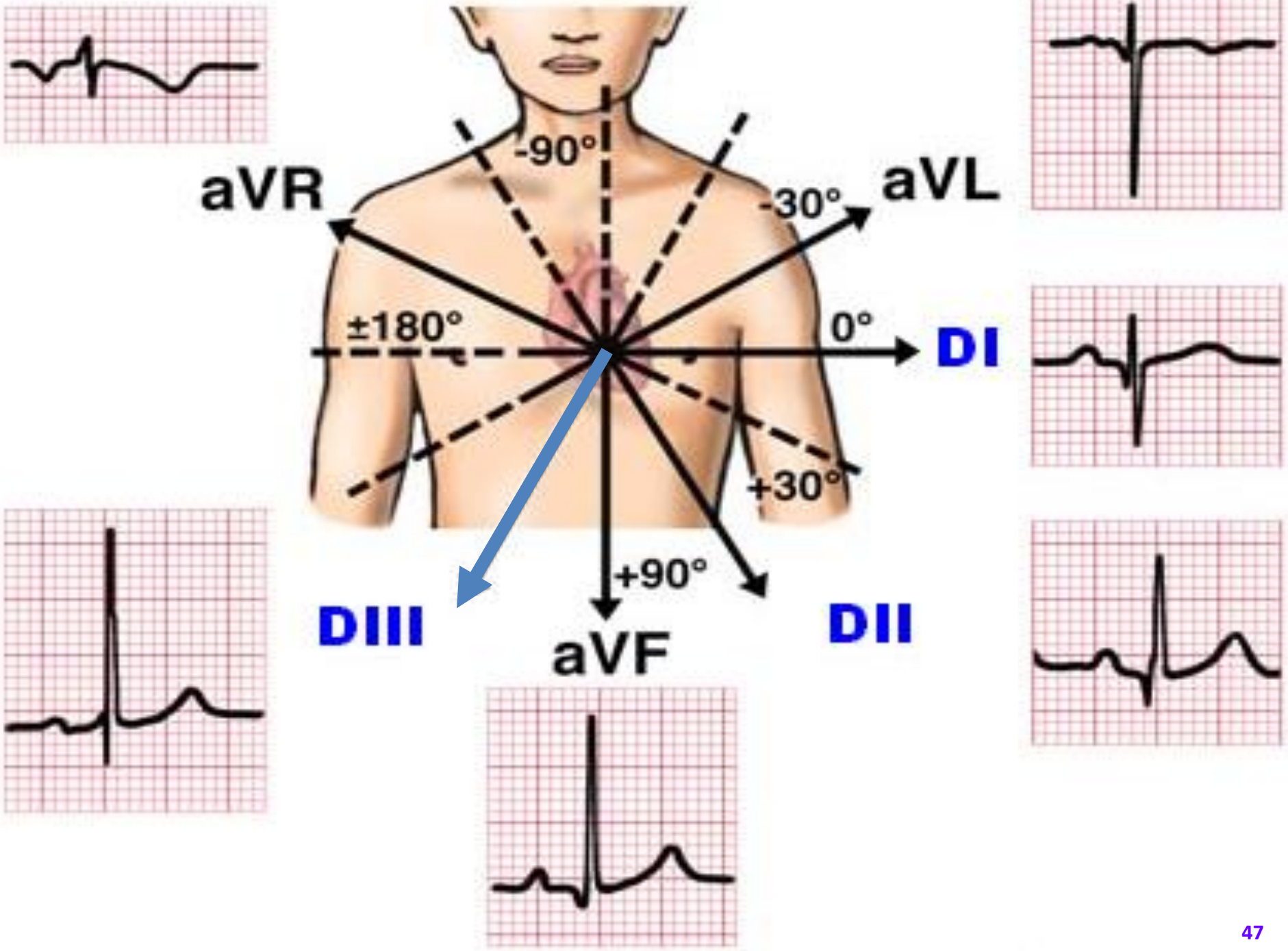
D I	aVF
D II	aVL
D III	aVR

DIRECCIÓN COMPLEJO QRS

Si un complejo QRS es isodifásico en **DI**

¿ En qué dirección se desplaza ?




aVR
-90°
aVL
-30°
±180°
0°
DI
+30°
+90°
DIII
aVF
DII

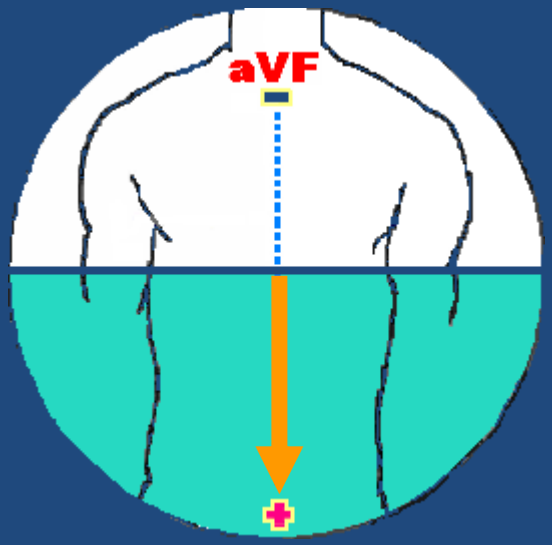
EJE CARDIACO VIENDO DI y aVF

QRS negativo

Vector hacia arriba

aVF

QRS positivo



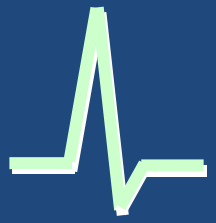
Vector hacia abajo

EJE CARDIACO VIENDO DI y aVF

DI

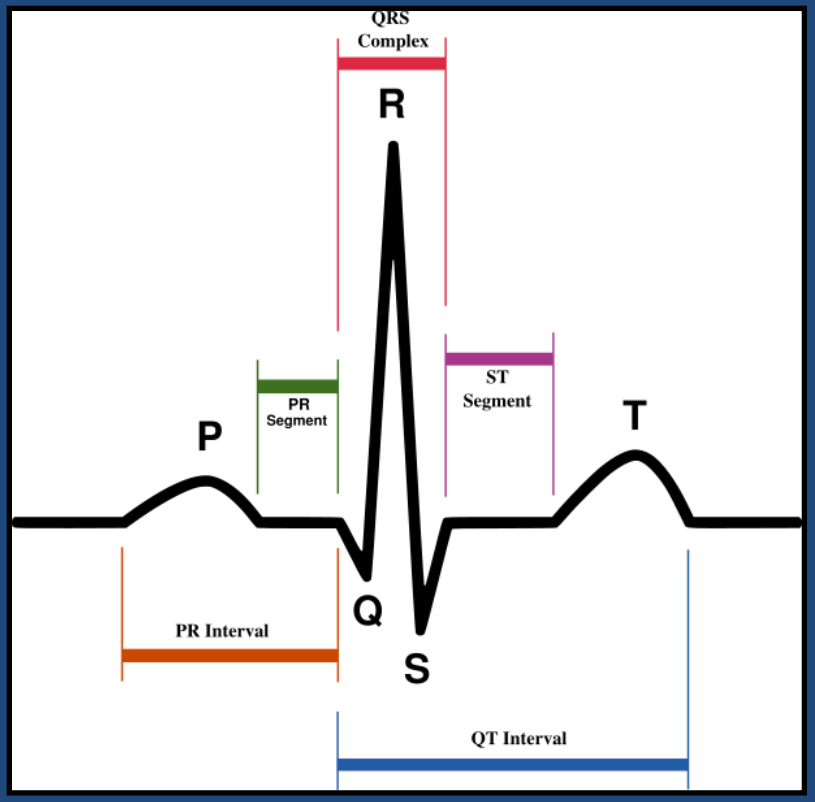
EE QRS normal.

aVF



SEGMENTO ST

- **Representa el período durante el cual el ventrículo está depolarizado.**
  - **Suele ser isoeléctrico. Elevación o depresión es anormal. (DD isquemia)**



ONDA T

- Representa la repolarización ventricular.
- Suele tener igual polaridad que el complejo QRS y su inversión puede reflejar isquemia.
- Alteraciones electrolíticas producen cambios en su morfología.

Onda T:

(+) DI, DII, V3-V6.

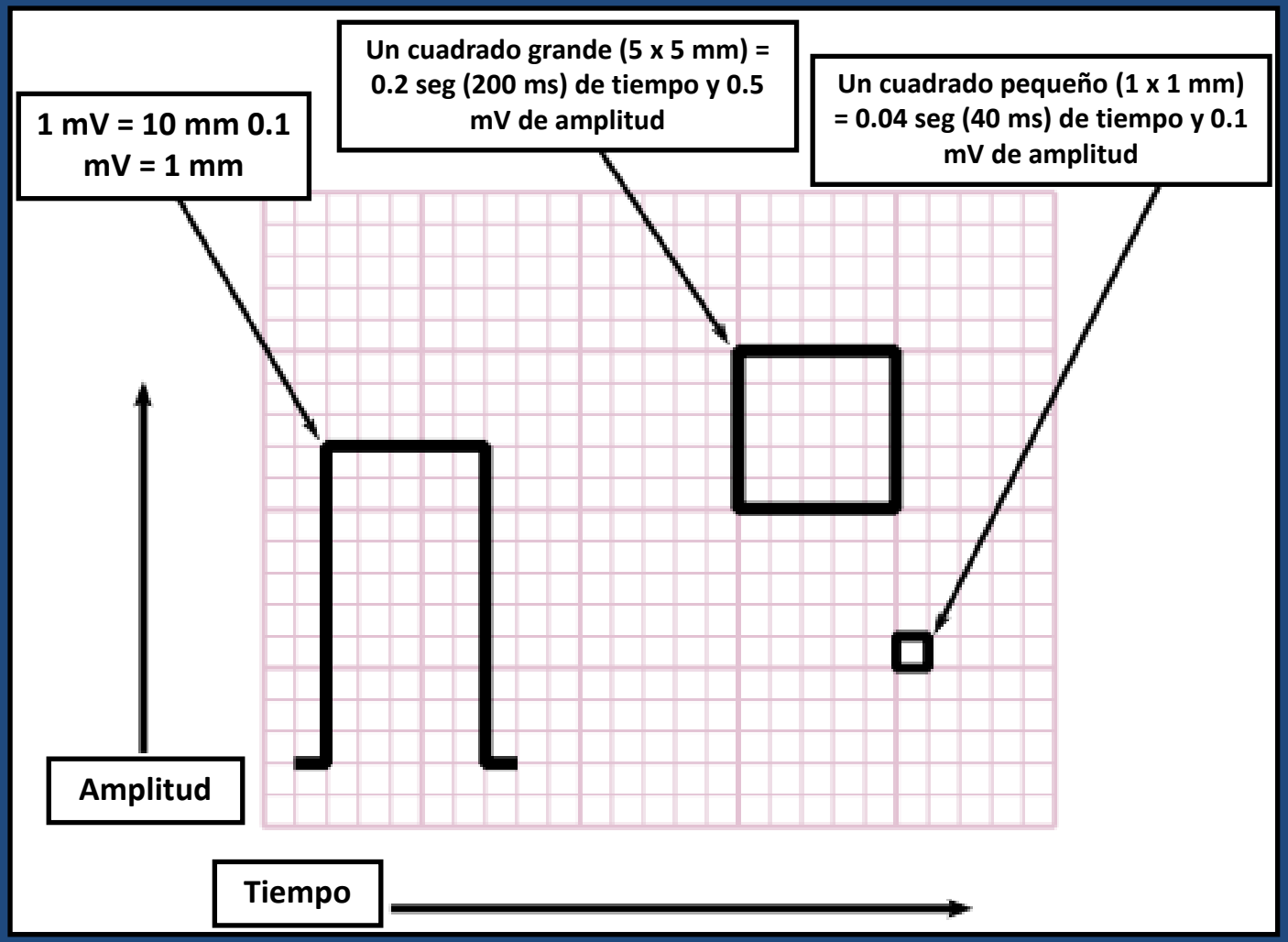
(+/-) DIII, aVF, V1.

(-) V1 y aVR.

¿QUÉ MIDE UN ELECTROCARDIOGRAMA?

Voltaje (eje vertical) ⇒ Representa la suma de la activación eléctrica de todas las células cardíacas

Tiempo (eje horizontal) ⇒ Sus medidas indican frecuencia y regularidad del ritmo cardíaco, y también los intervalos de tiempo


1 mV = 10 mm 0.1 mV = 1 mm
Un cuadrado grande (5 x 5 mm) = 0.2 seg (200 ms) de tiempo y 0.5 mV de amplitud
Un cuadrado pequeño (1 x 1 mm) = 0.04 seg (40 ms) de tiempo y 0.1 mV de amplitud
Amplitud
Tiempo

Papel Cuadriculado

Velocidad de registro : 25 mm/seg

1 cuadrado : 0.2 seg; 1 cuadradito : 0.04 seg

Estandarización : 10 mm = 1mV

Frecuencia Cardíaca :

60/intervalo RR (seg)

o

1500/N de cuadraditos entre R y R

o

300/N cuadrados grandes entre R y R

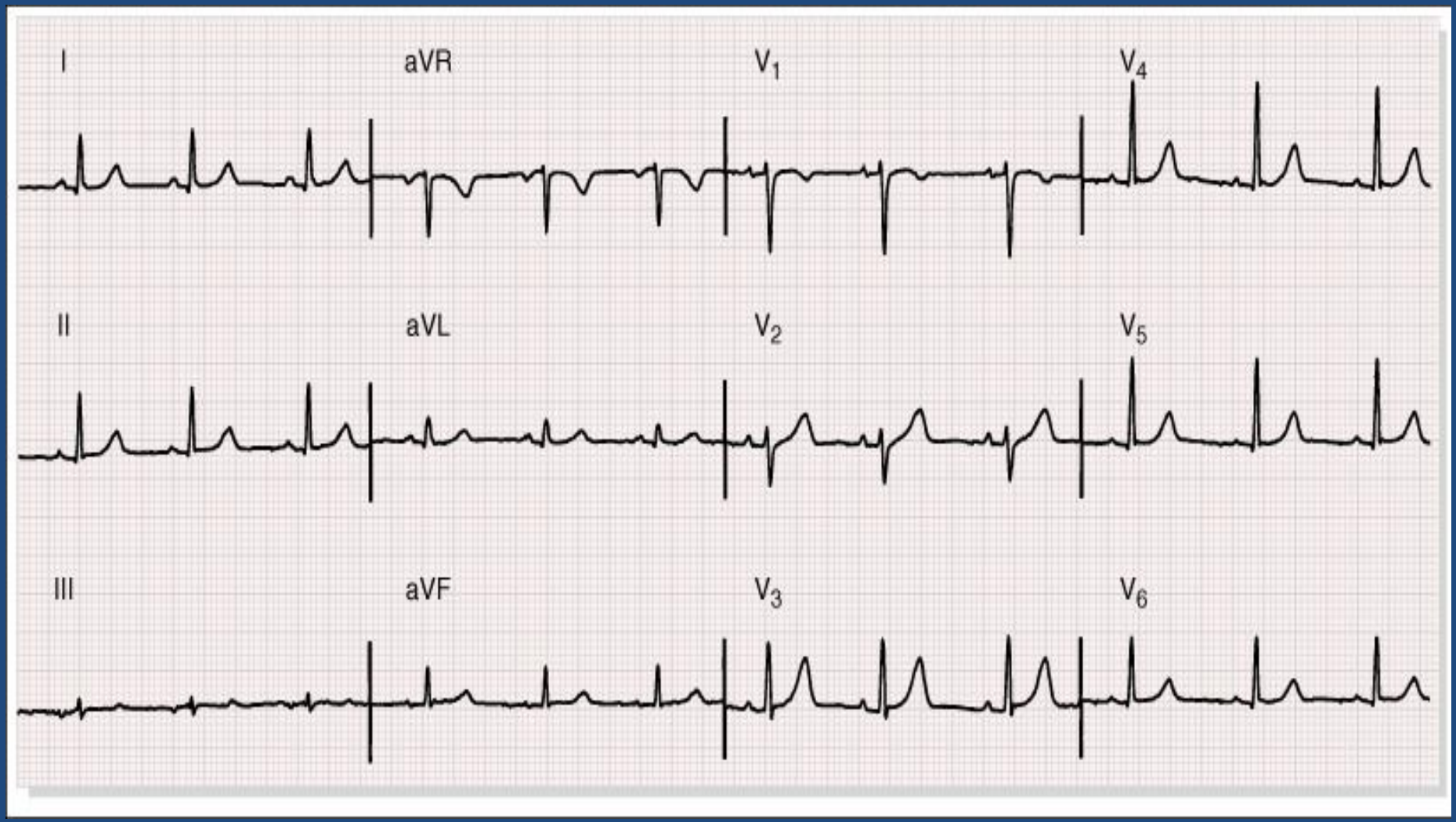
o

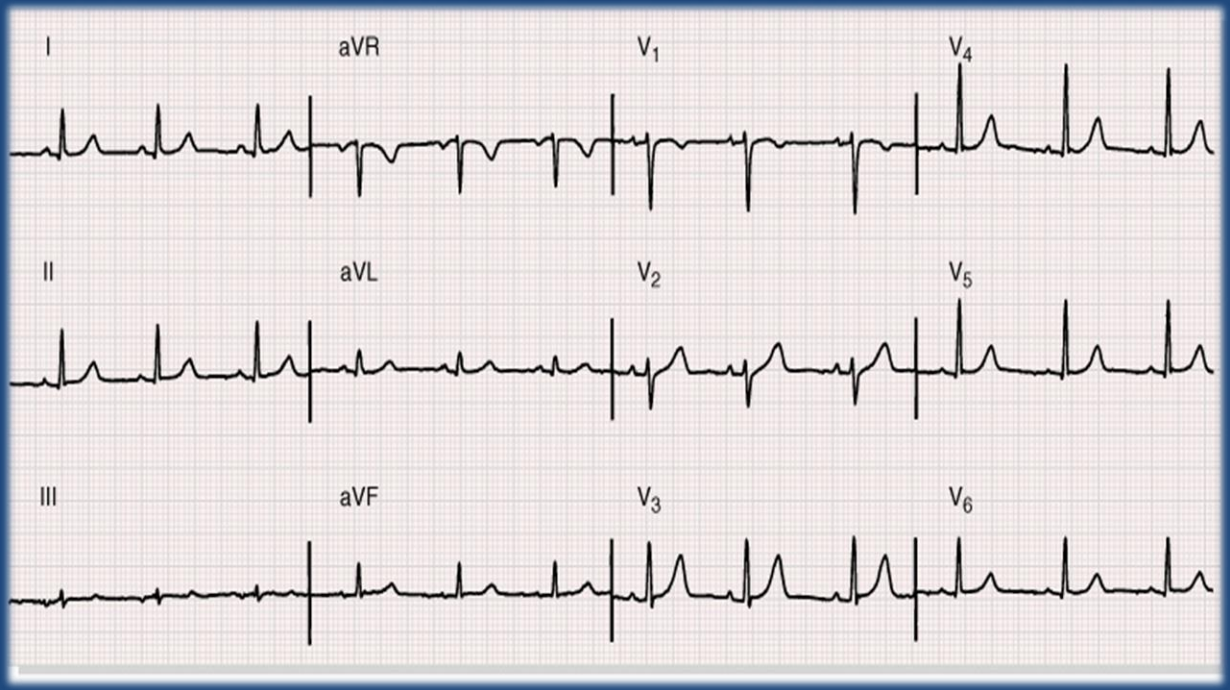
N° eventos (QRS) en 6 segundos (30 cuadrados) x 10

(útil cuando el ritmo es irregular)

Informe del ECG

- **Ritmo** (sinusal), frecuencia (60-100 lpm)
- Onda P: Vector, forma, hasta 100 ms, 0.25 mV
- PR (asociación AV): 0.12-0.20 s, asociación 1:1
- EE QRS (-30° a 100°)
- QRS (duración hasta 0.10 s, amplitud, morfología, signos patológicos)
- ST-T
- QT (QT corregido): (hasta 450 ms en hombres, 470 ms en mujeres) – (Fórmula de Bazett)
- **Conclusión**


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6



1. Ritmo sinusal
2. Frecuencia 60-100 lpm
3. Onda P normal
4. Intervalo PR normal
5. Eje Eléctrico QRS normal
6. QRS normal
7. Segmento ST normal
8. Onda T normal
9. Intervalo QT normal

Conclusión: Electrocardiograma normal

¿Qué podemos ver en el ECG?

- Ritmo cardiaco y frecuencia, Arritmias
- Crecimiento/hipertrofia de cavidades
- Alteraciones de la conducción AV y en ramas
- Presencia de vías accesorias (preexcitación ventricular)
- Isquemia miocárdica/infarto
- Alteraciones electrolíticas (potasio, calcio)
- Acción de marcapaso cardiaco

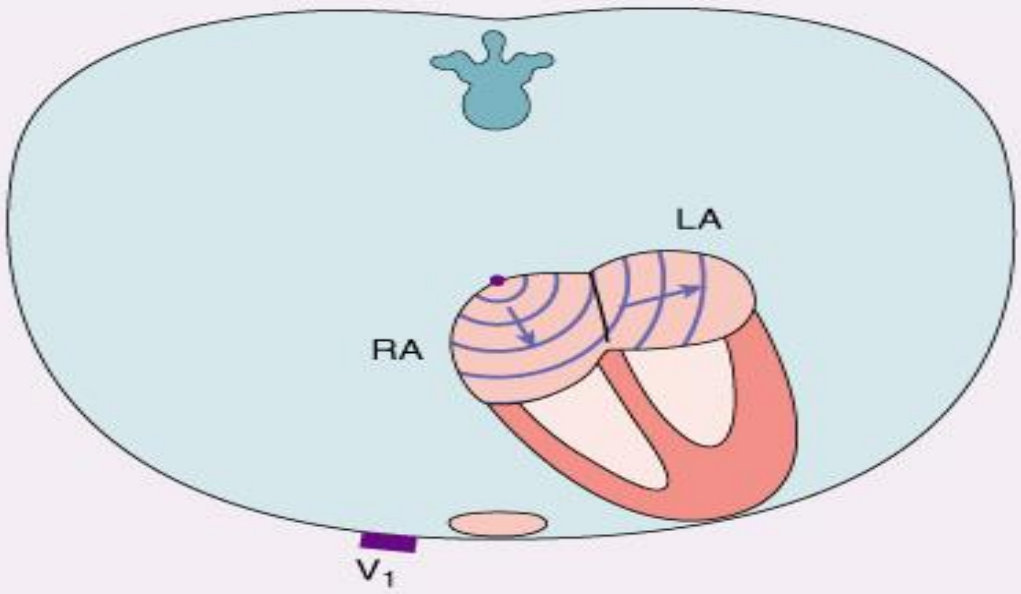
Algunas alteraciones del Electrocardiograma

ONDA P

- **Diferente morfología ⇒ Ritmo auricular ectópico.**
- **Aumento de voltaje ⇒ Crecimiento AD.**
- **Aumento de duración ⇒ Crecimiento AI.**

Crecimientos auriculares („Reacciones auriculares“)

Depolarización auricular



	Normal	Right	Left
II	RA LA	RA LA	RA LA
V_1	RA LA	RA LA	RA LA

COMPLEJO QRS

- **Aumento de voltaje** ⇒ **Crecimiento ventricular.**

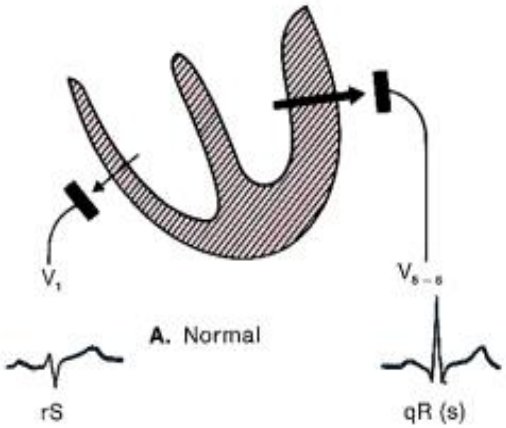
  (o personas delgadas)

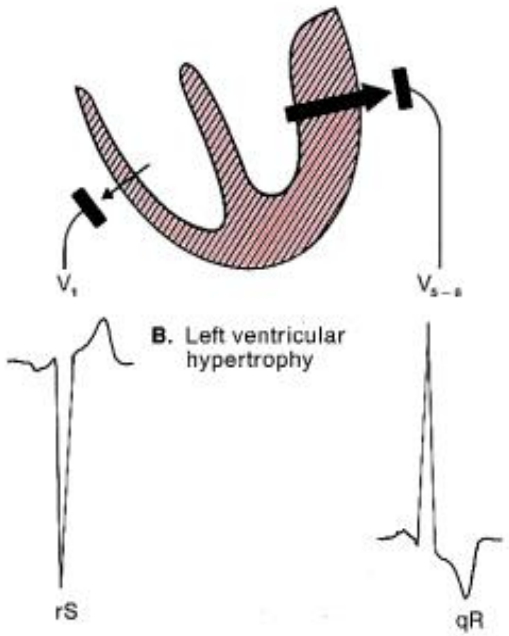
- **Aumento de duración** ⇒ **Enlentecimiento de la conducción a nivel ventricular: Bloqueos de rama o enlentecimiento intraventricular**

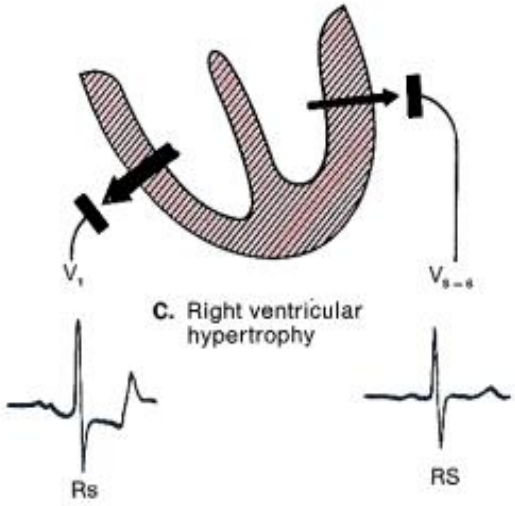
- **Diferente morfología** ⇒ **Depolarización anormal (origen ventricular ectópico o bloqueos de rama)**

- **Ondas Q patológicas: Neccrosis (o hipertrofia)**

Vectores en Hipertrofias Ventriculares

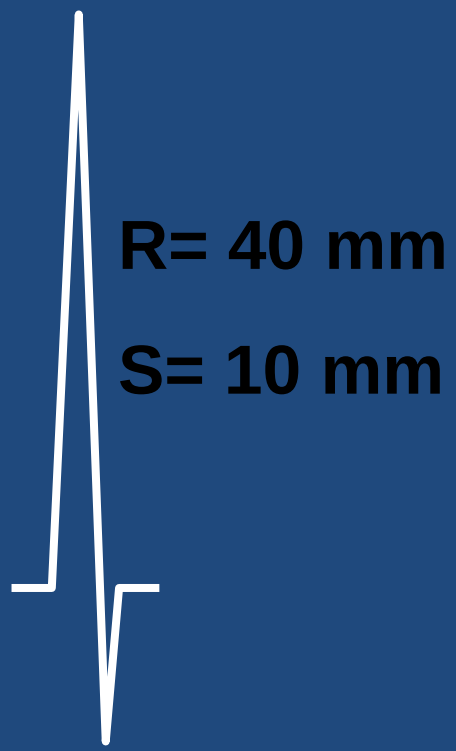






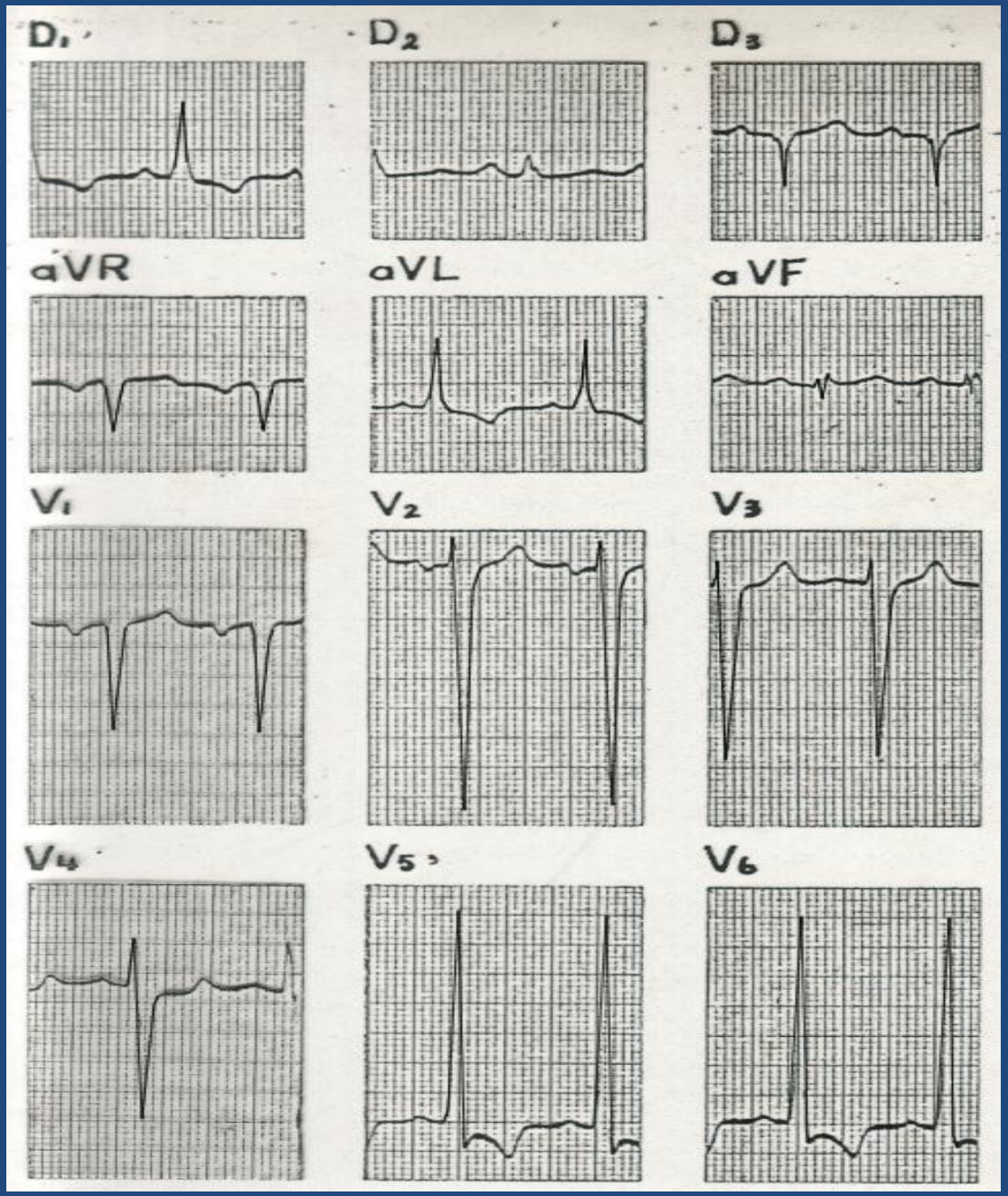
HIPERTROFIA DE VENTRICULO IZQUIERDO

- **Indice de Sokolow - Lyon.-** R en V5 o V6
  + Onda S en V1 o V2 > 35 mm.



- **Una R en aVL > 11 *mm*.**
- Indice de Ungerleider.- R en DI + S en DIII ≥ 25 *mm*.
- Una R en aVF > 20 *mm*.
- **Indice de Lewis.- Positividad neta en DI + negatividad neta DIII ≥ 17 *mm*.**

HVI

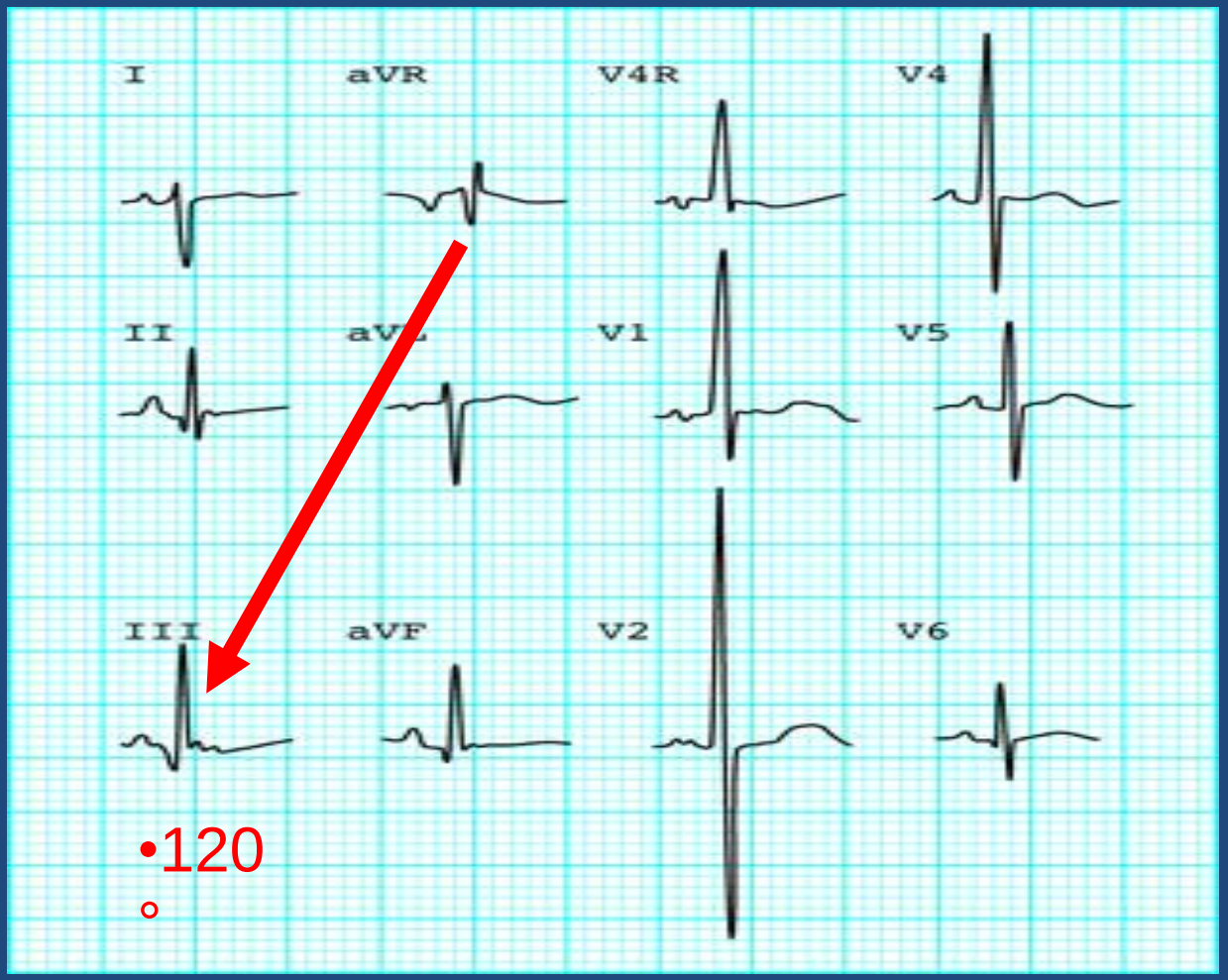


HIPERTROFIA DE VENTRICULO DERECHO

- Desviación del eje del QRS a la derecha.
- R en aVR > de 5mm.
- R en V1 ó V2 > 7mm, excepto en Infarto Posterior del VI.
- Si existe BIRD, cuando R tiene más de 15 mm de altura.
- R/S > 1 V1- V2

HIPERTROFIA DE VENTRICULO DERECHO

Criterios HVD: • Eje QRS a la derecha • R en V1 ó V2 > 7 *mm* • R/S > 1



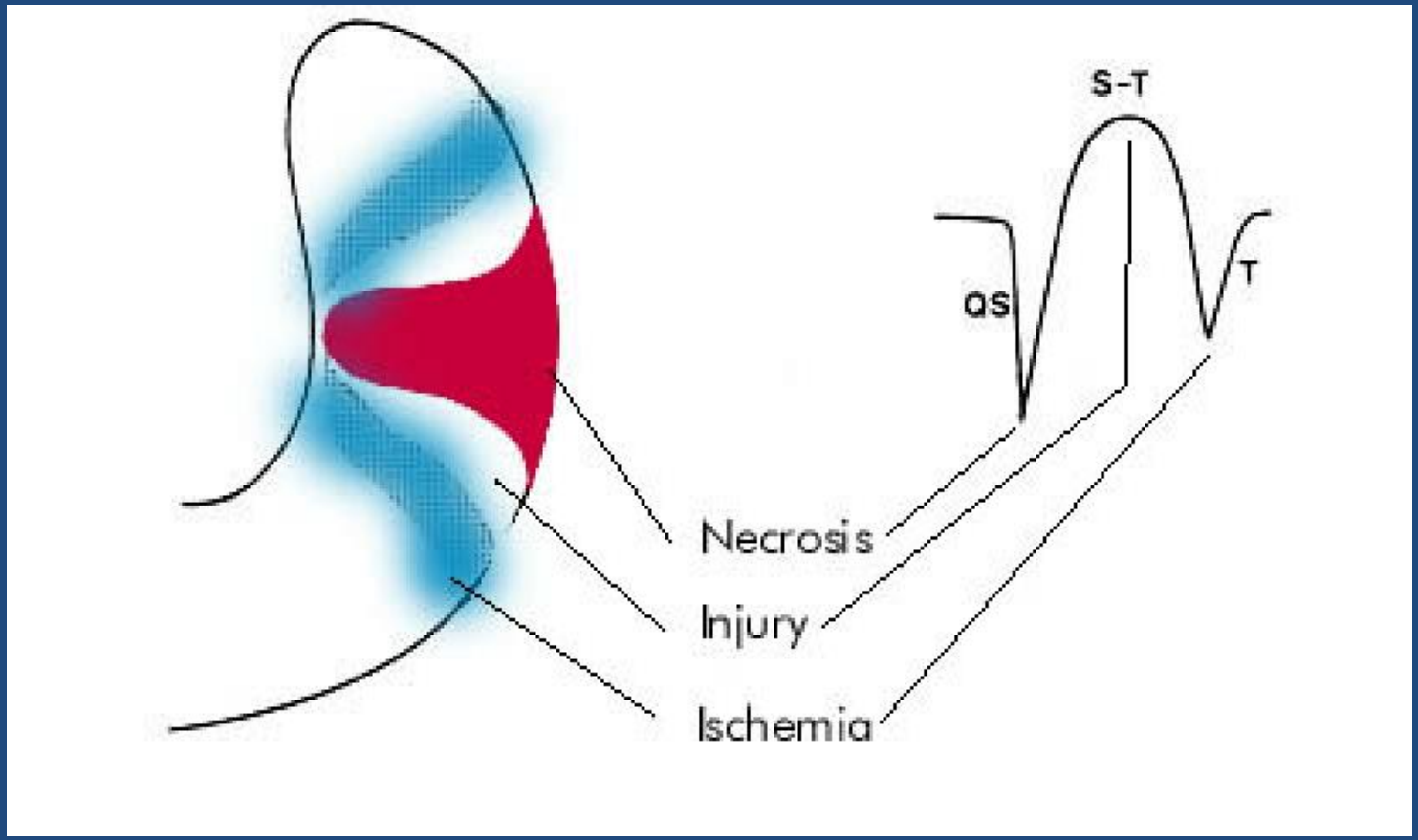
Eje QRS: + 120°

R V1 = 14

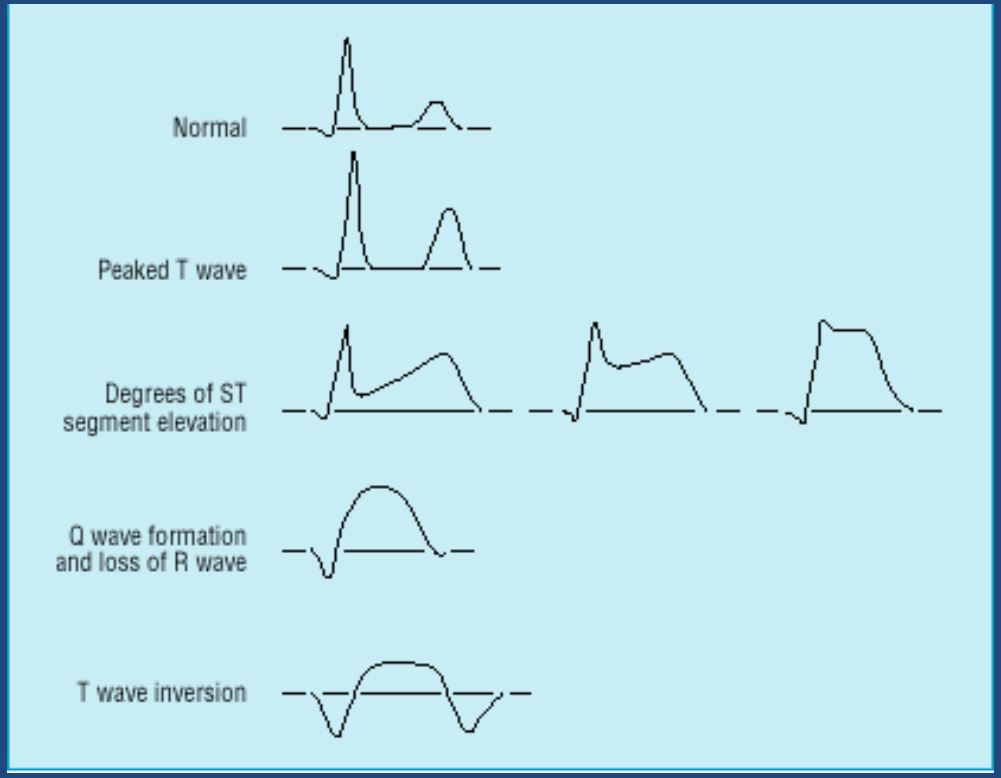
V1 = 14/4

Manifestaciones clínicas de la isquemia miocárdica

- Sindromes coronarios agudos
  - Infarto con SDST
  - Infarto sin SDST o Angina Inestable
- Angina Crónica
- Insuficiencia Cardíaca
- Muerte Súbita


S-T
QS
T
Necrosis
Injury
Ischemia

Secuencia de cambios ECG en el IAM



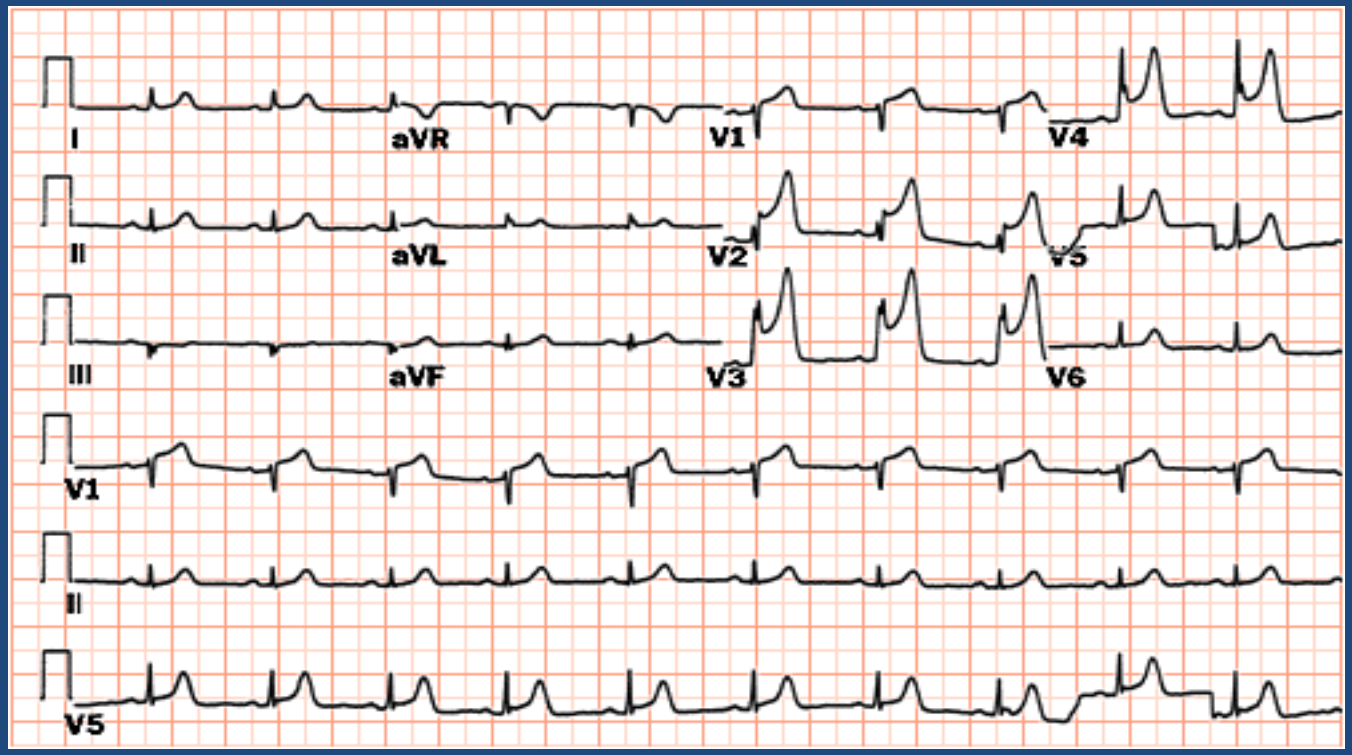
Relación anatómica de las derivaciones

Pared inferior	derivaciones DII, DIII, aVF
Pared anterior	derivaciones V1 a V4
Pared lateral	derivaciones D1, aVL, V5 y V6

Derivaciones no estándar

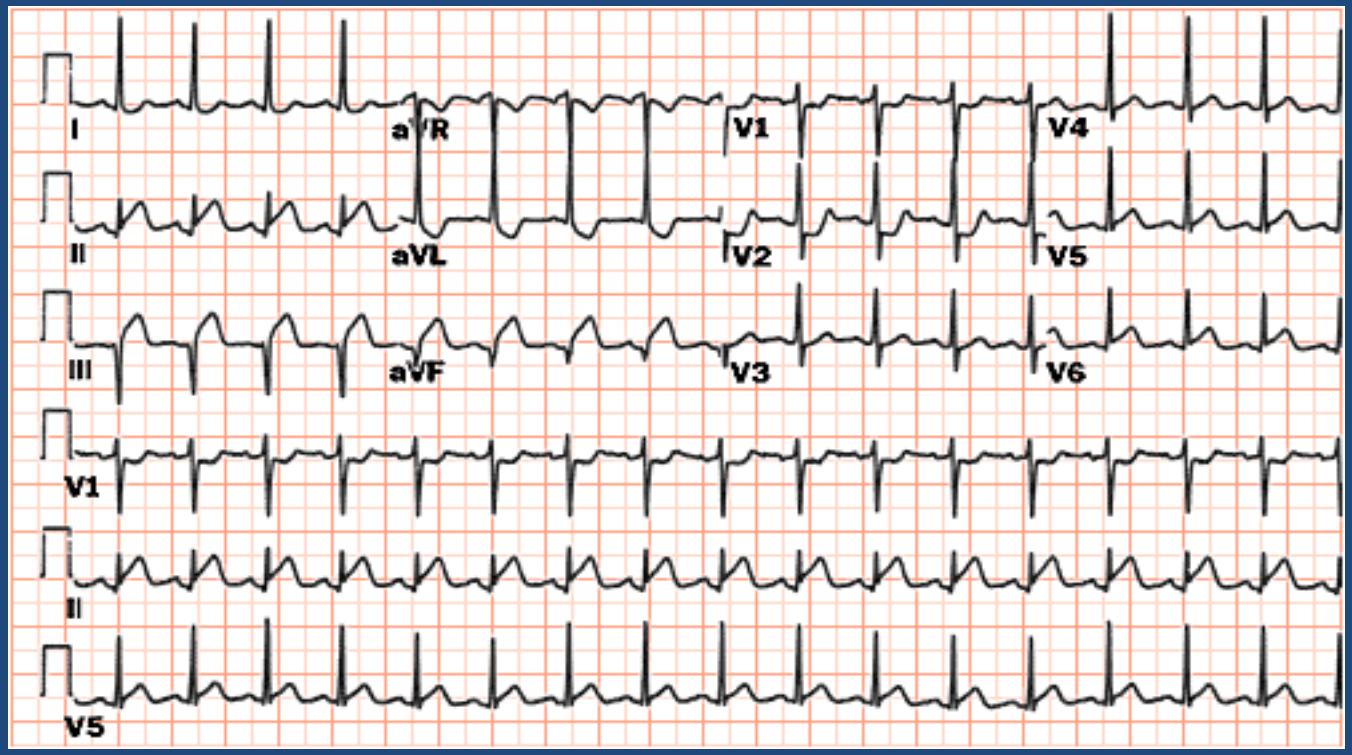
Ventrículo derecho	derivaciones derechas, V1R a V6R
Pared posterior	derivaciones V7 a V9

IAM anterior. Primera hora evolución



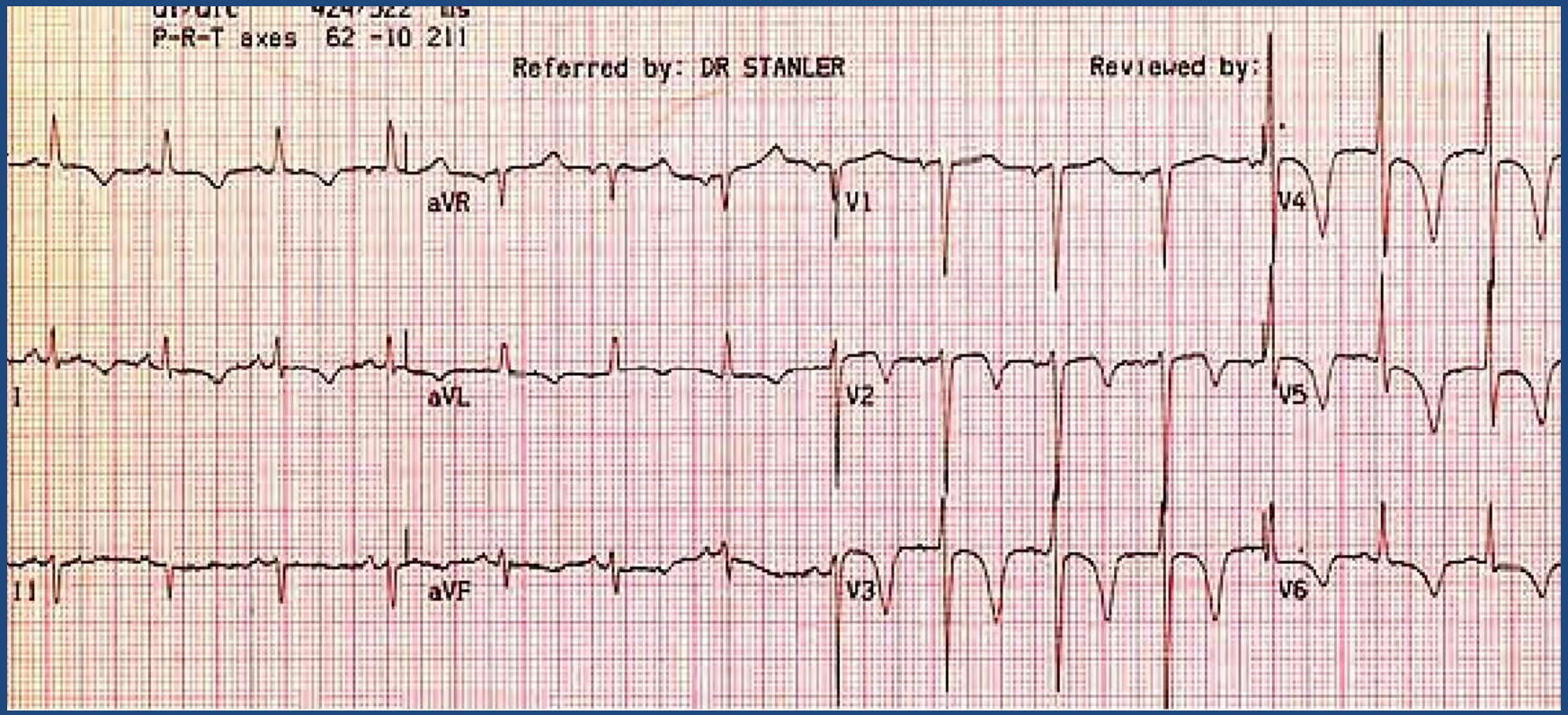
Supradesnivel segmento ST de V1 a V4
Onda T alta de V1 a V4

IAM reciente pared inferior

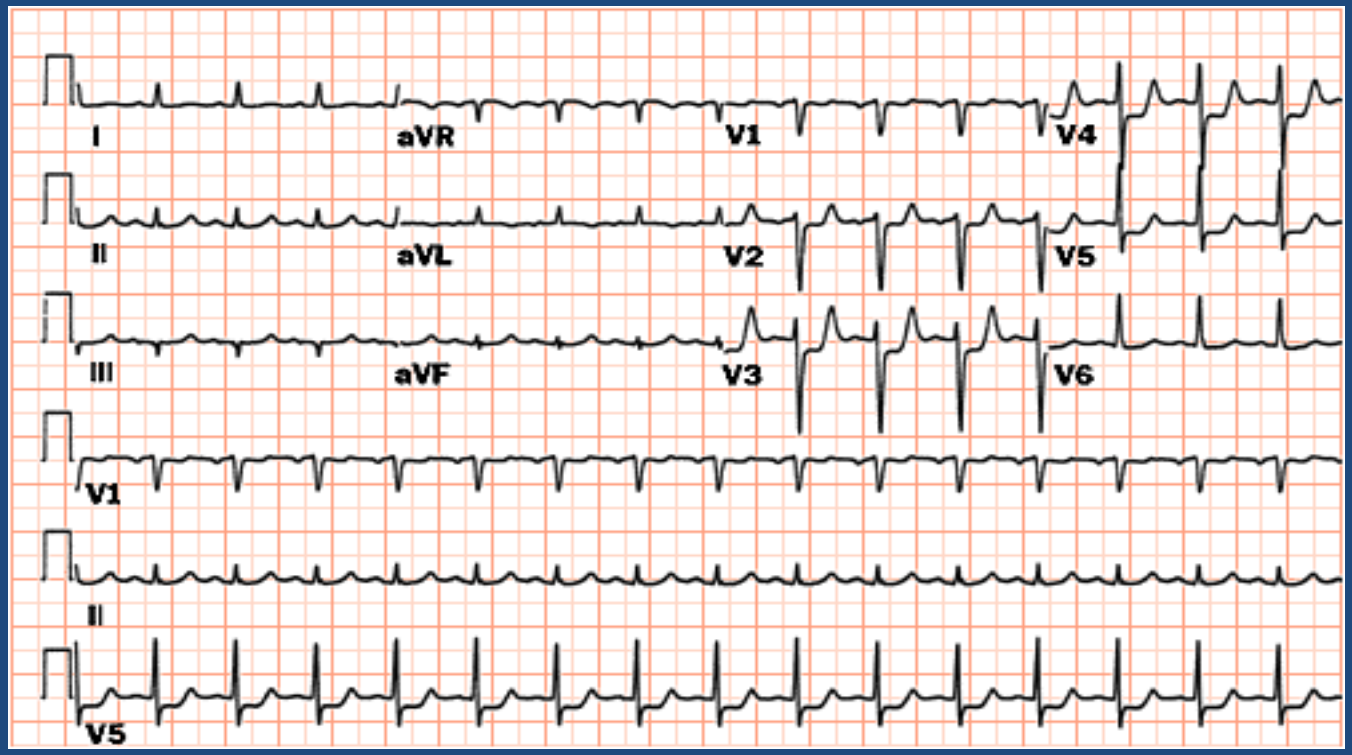


Supradesnivel ST en D2, D3 y AVF
Desnivel ST en V1 y V2

IAM sin SDST


P-R-T axes 62 -10 211
Referred by: DR STANLER
Reviewed by:
aVR
V1
V4
I
aVL
V2
V5
II
aVF
V3
V6

Angina inestable o Infarto no Q



Depresión ST anterior

Alteraciones Electrolíticas

Alteraciones del Potasio

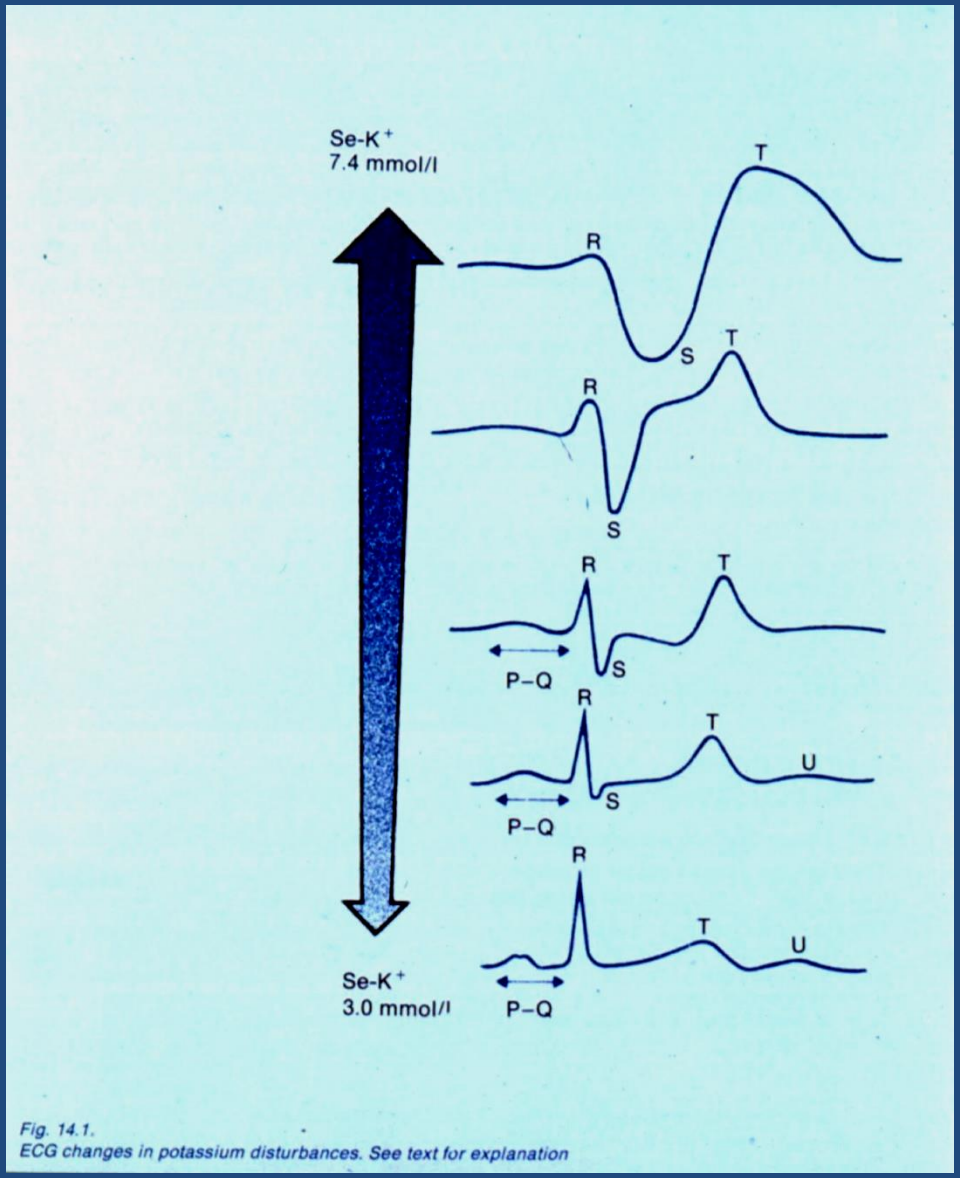
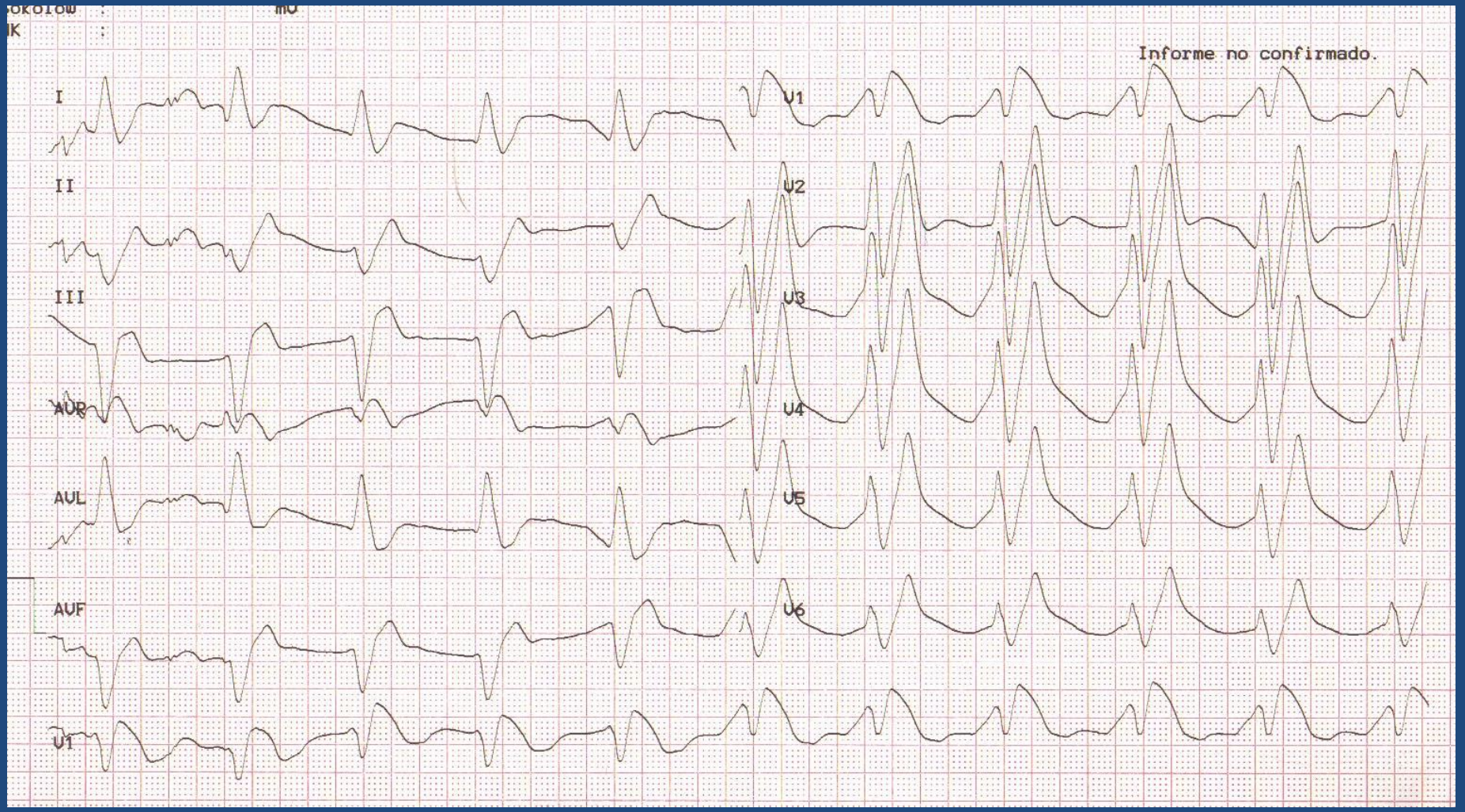
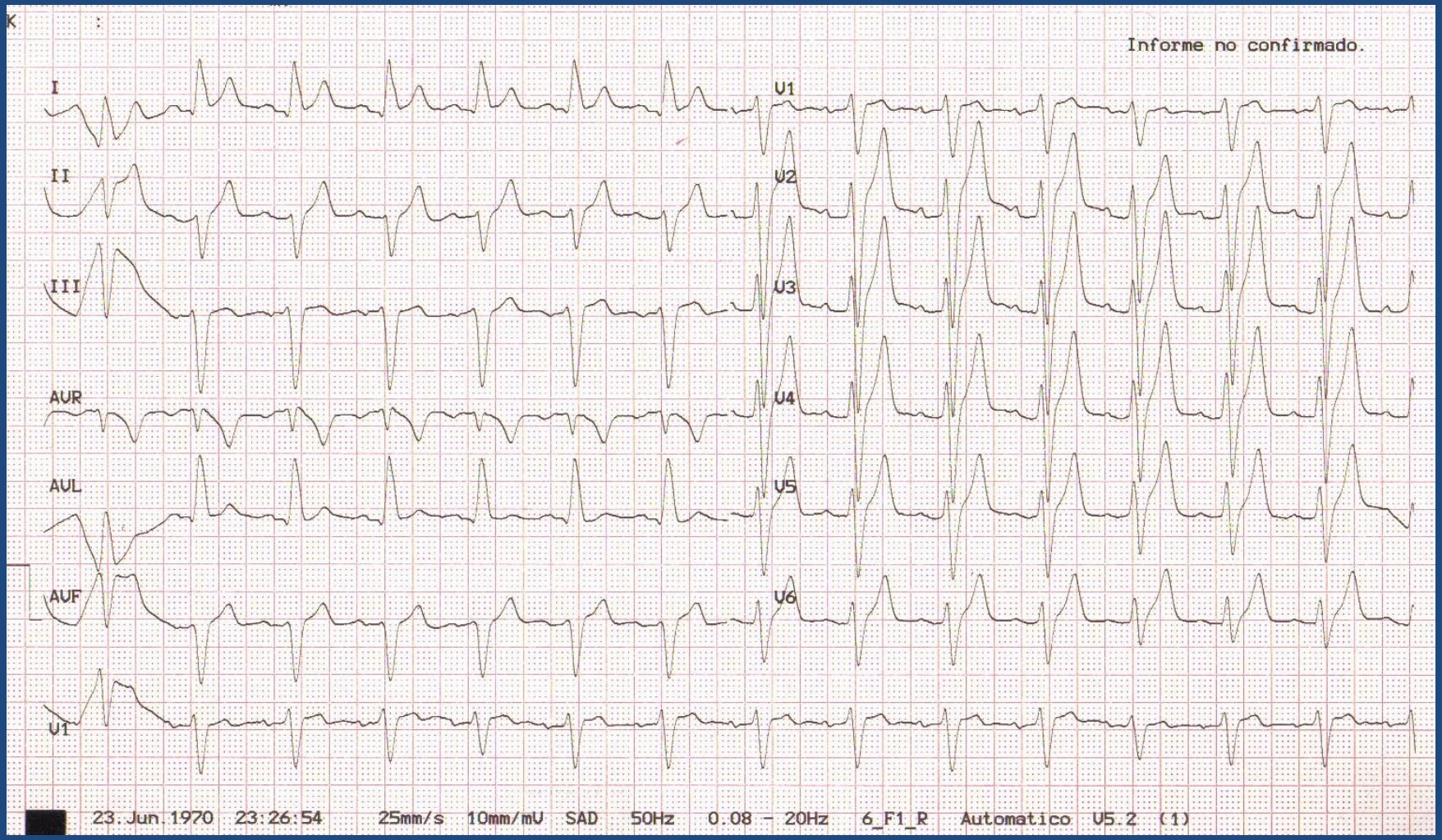


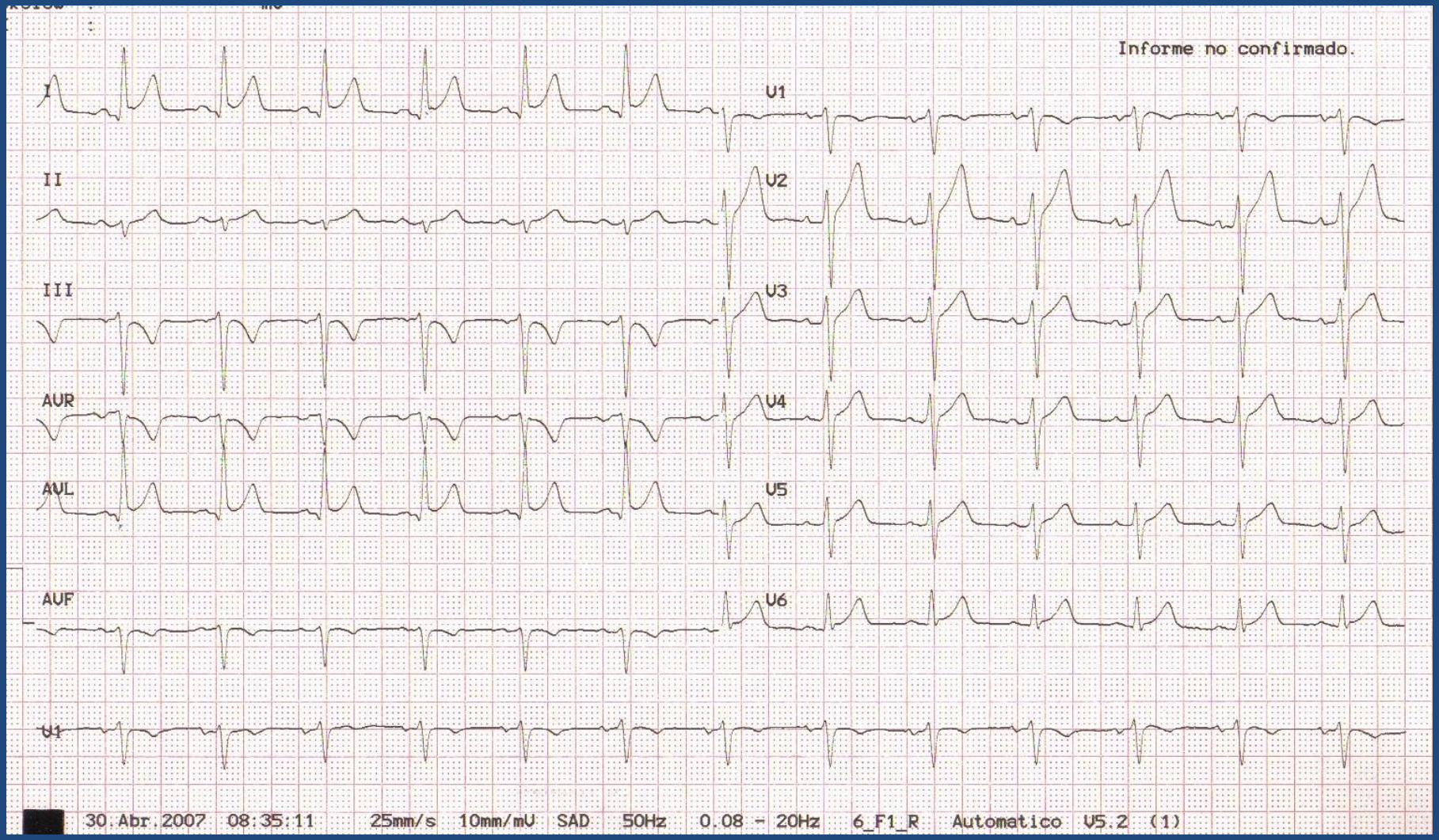
Fig. 14.1.
ECG changes in potassium disturbances. See text for explanation



- K^+ 9,2 mEq/L

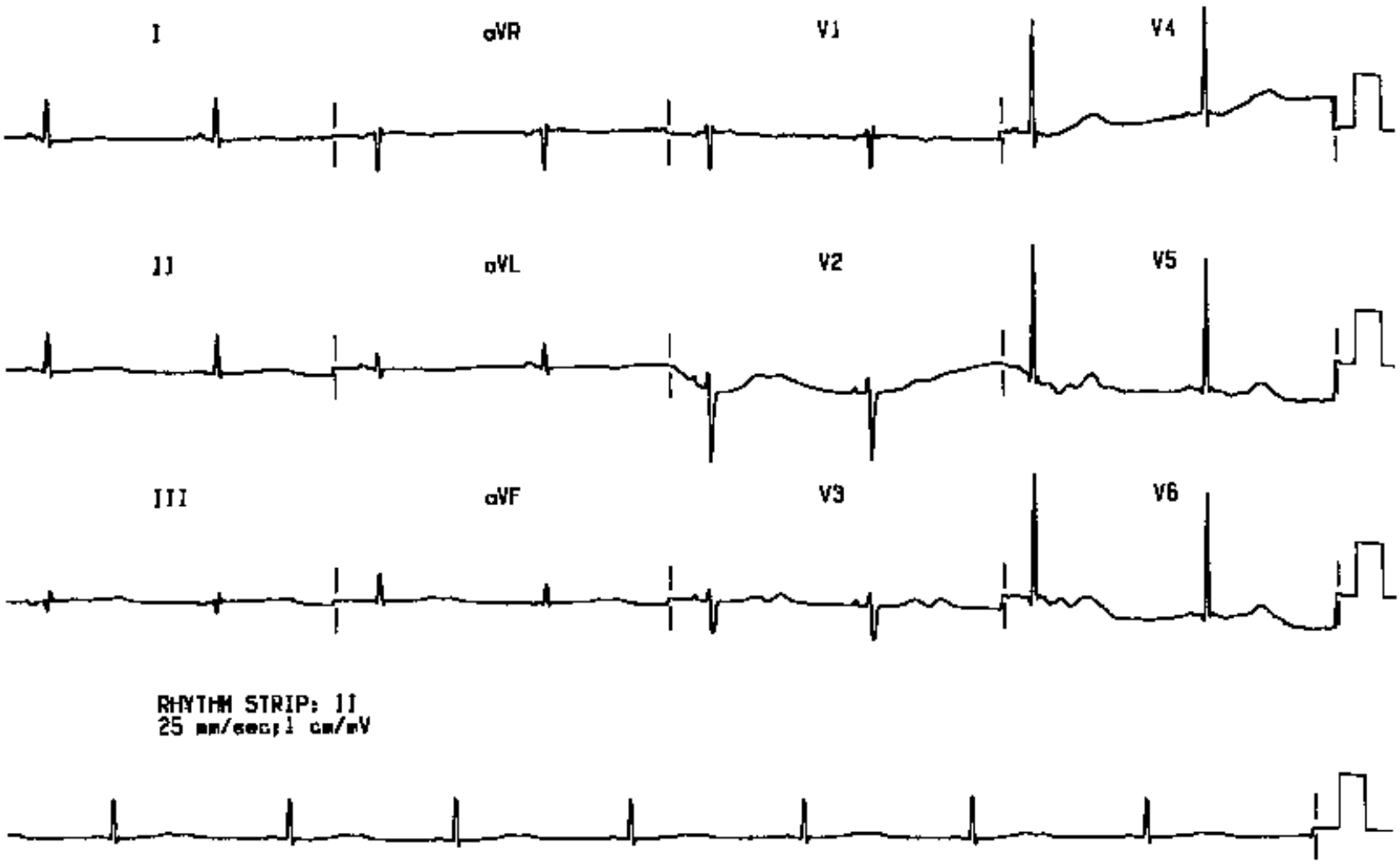

Informe no confirmado.
I
II
III
AVR
AVL
AVF
V1
V1
V2
V3
V4
V5
V6
23.Jun.1970 23:26:54 25mm/s 10mm/mV SAD 50Hz 0.08 - 20Hz 6_F1_R Automatico V5.2 (1)

- K^+ 6,4 mEq/L


Informe no confirmado.
I
II
III
AUR
AUL
AUF
V1
V2
V3
V4
V5
V6
V1
30.Abr.2007 08:35:11 25mm/s 10mm/mV SAD 50Hz 0.08 - 20Hz 6_F1_R Automatico V5.2 (1)

- K^+ 4,8 mEq/L

Mujer de 22 años, con vómitos profusos, K^+ 2.3 mEq/l




Muchas gracias