Sociedad Médica de Santiago
Sociedad Chilena de Medicina Interna
150 años al Servicio de la Medicina

IX CURSO MEDICINA INTERNA HOSPITALARIA 2019

Bradicardia y Marcapasos
Aspectos prácticos para el Hospitalista

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Complejo Asistencial Dr. Sótero del Río

Puntos a tratar

- Generación
- Propagación
- Manejo Médico
- Terapia con dispositivos
  - Indicaciones
  - Nociones generales
  - Complicaciones
- Preguntas

Visible Spectrum

Generación del impulso

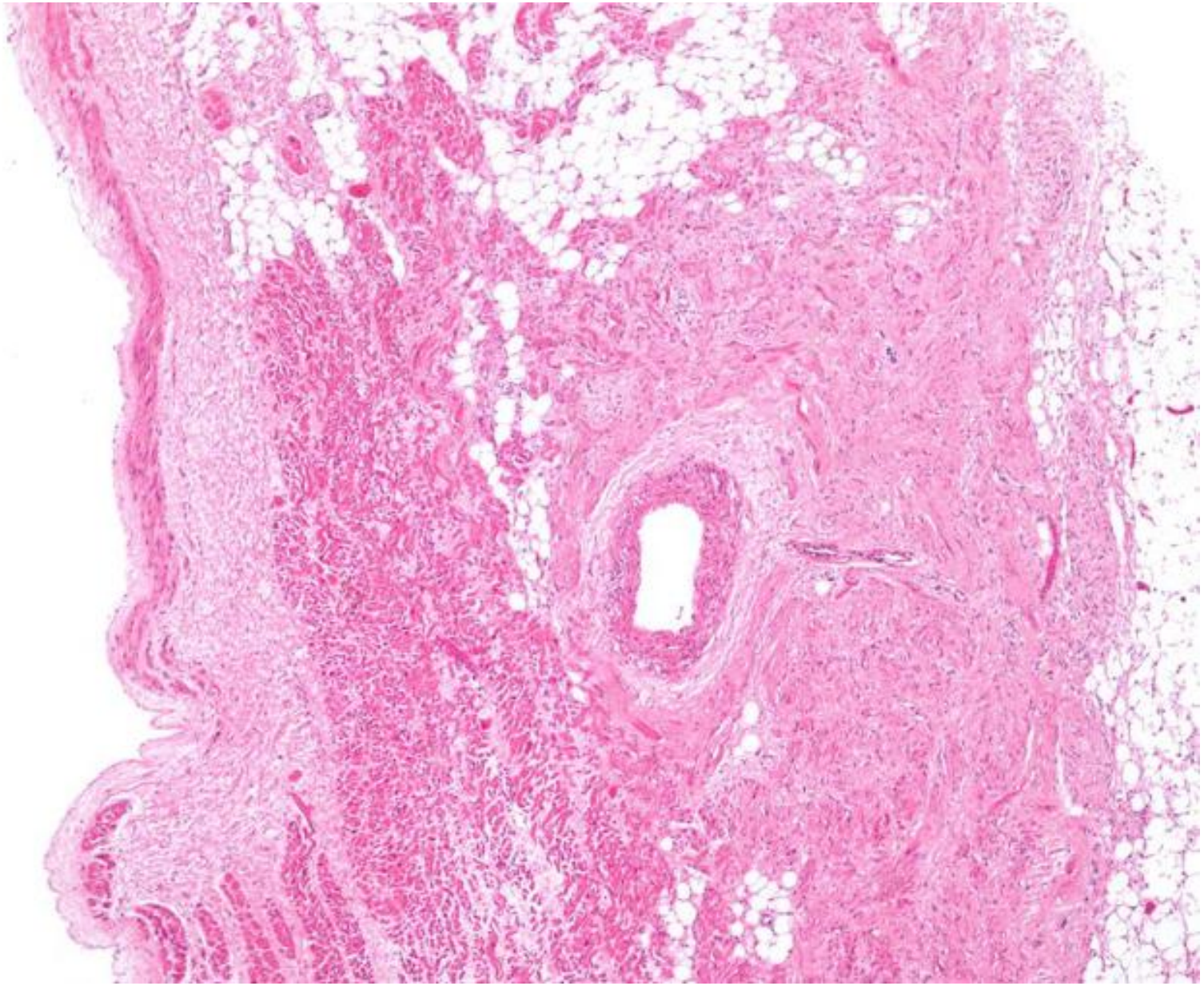


Figure 2: 3D Computer Reconstruction of the Human Heart Sinoatrial Node from Histological and Immunohistochemical Data Demonstrating the Extent of the Sinoatrial Node and Peripheral Pacemaking Tissue

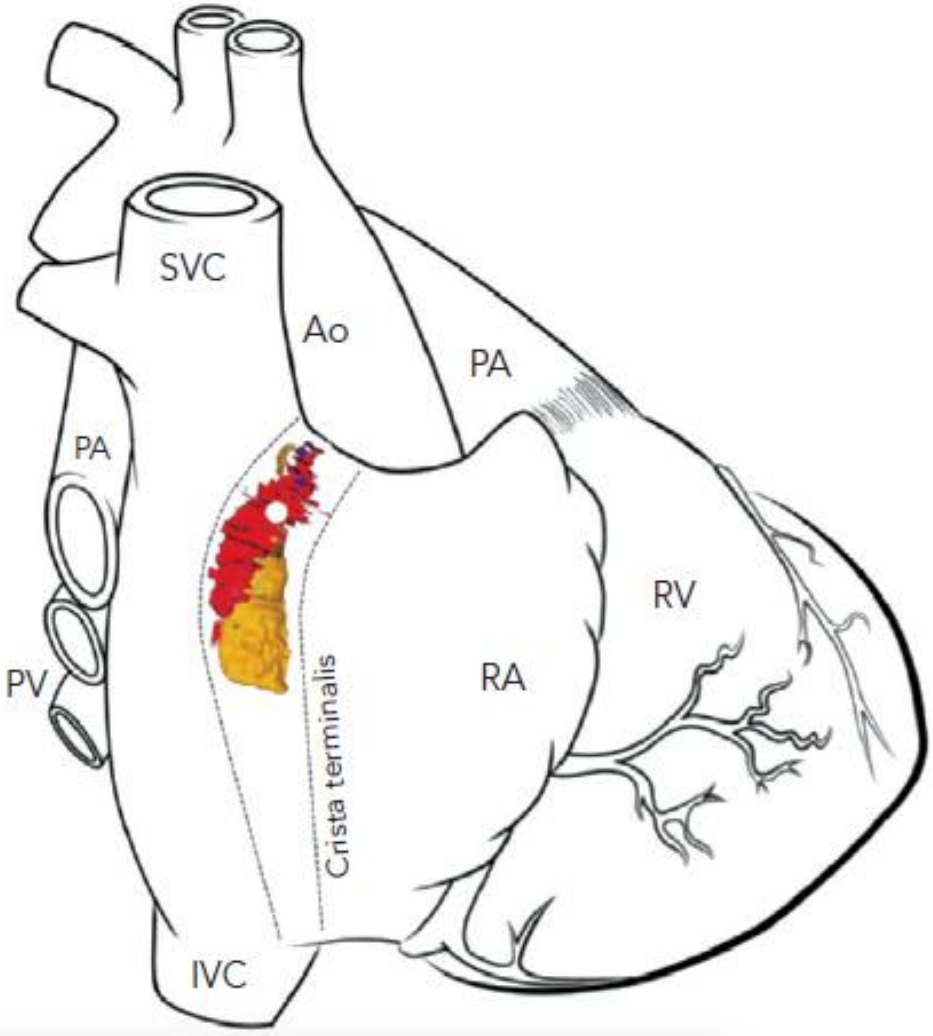
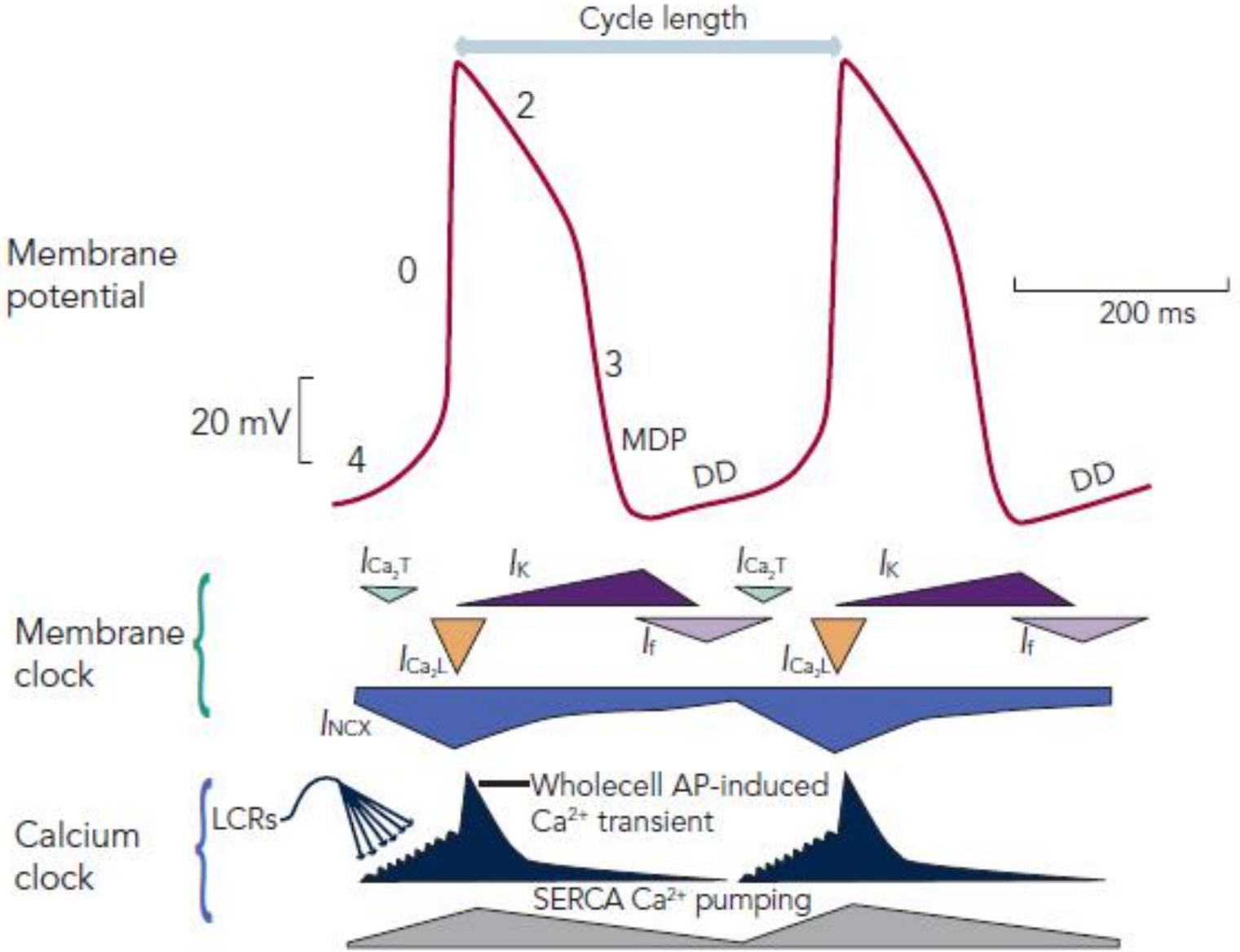
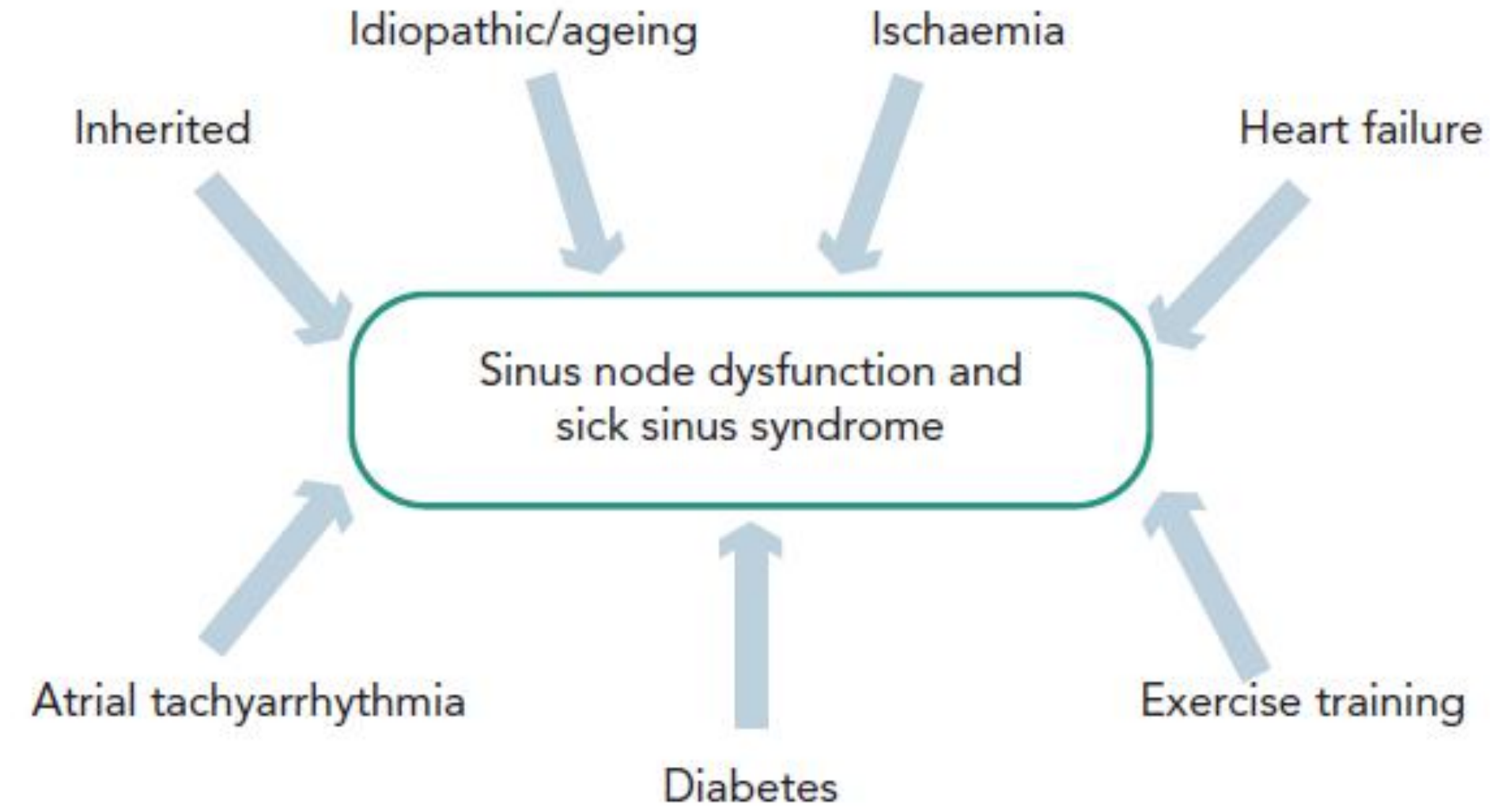
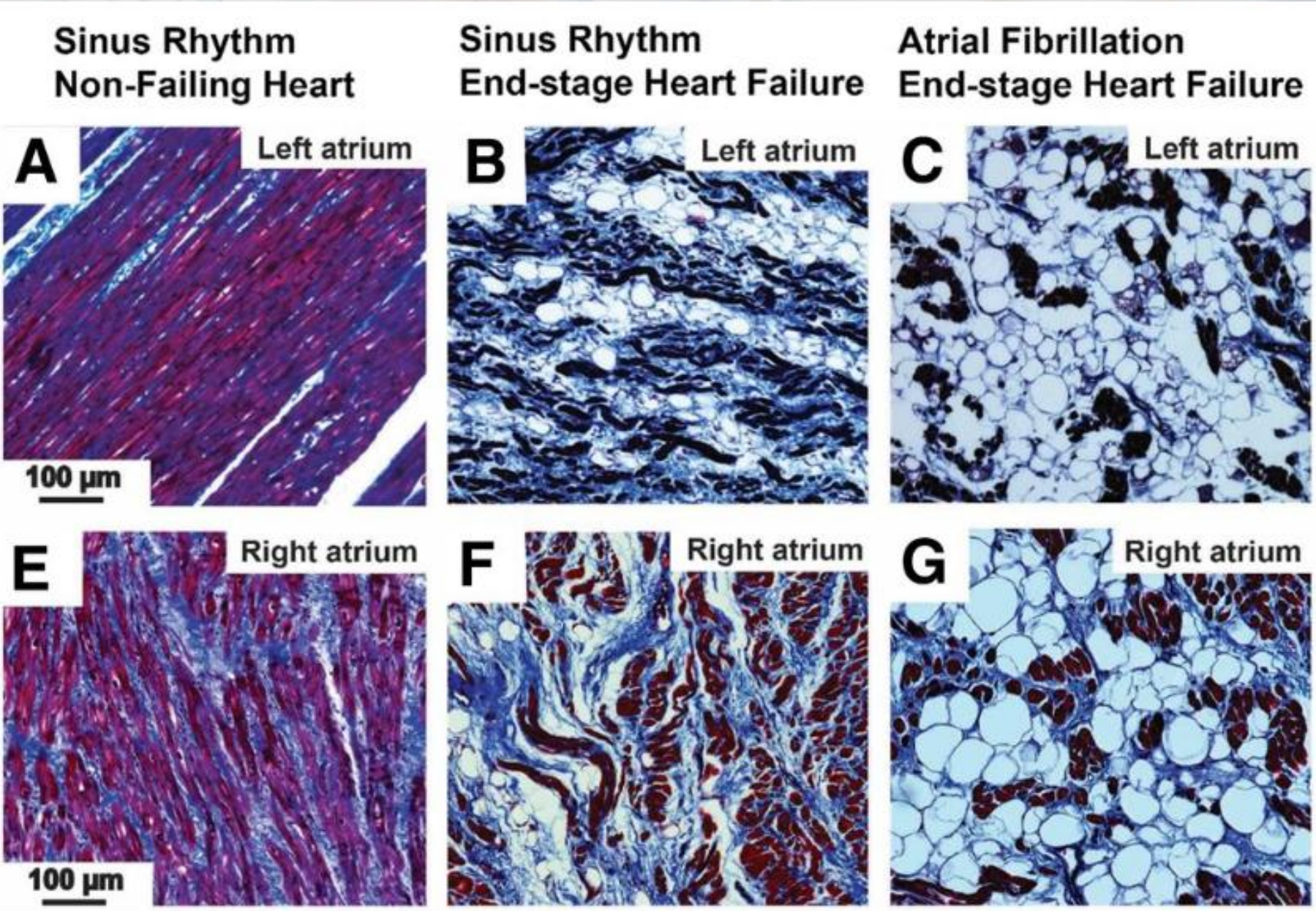


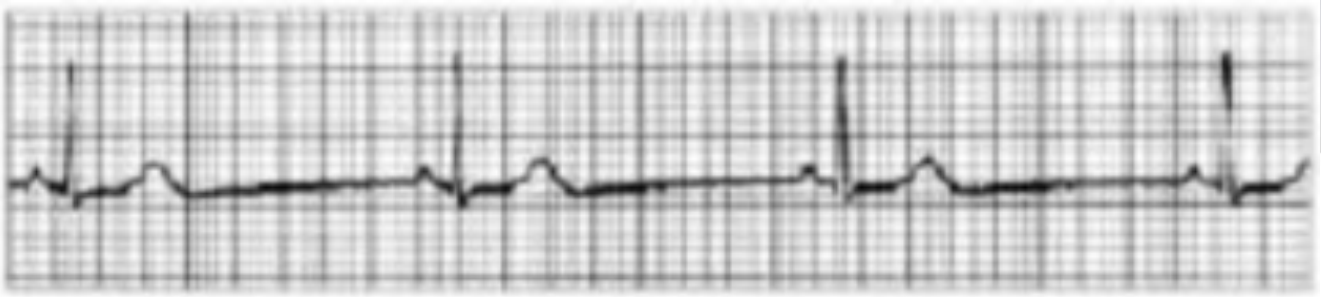
Figure 4: Typical Sinoatrial Node Membrane Action Potentials (Red Trace) and the Timing of Membrane Clock and Ca^{2+} Clock Components

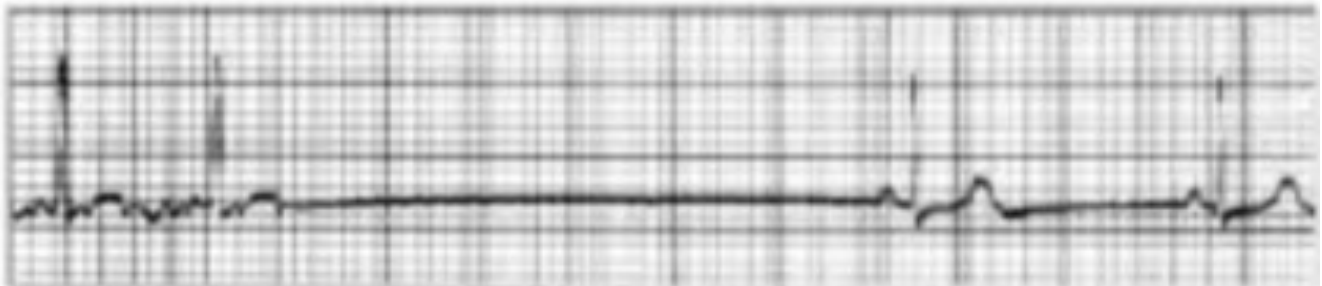



Idiopathic/ageing
Ischaemia
Inherited
Heart failure
Sinus node dysfunction and sick sinus syndrome
Atrial tachyarrhythmia
Exercise training
Diabetes

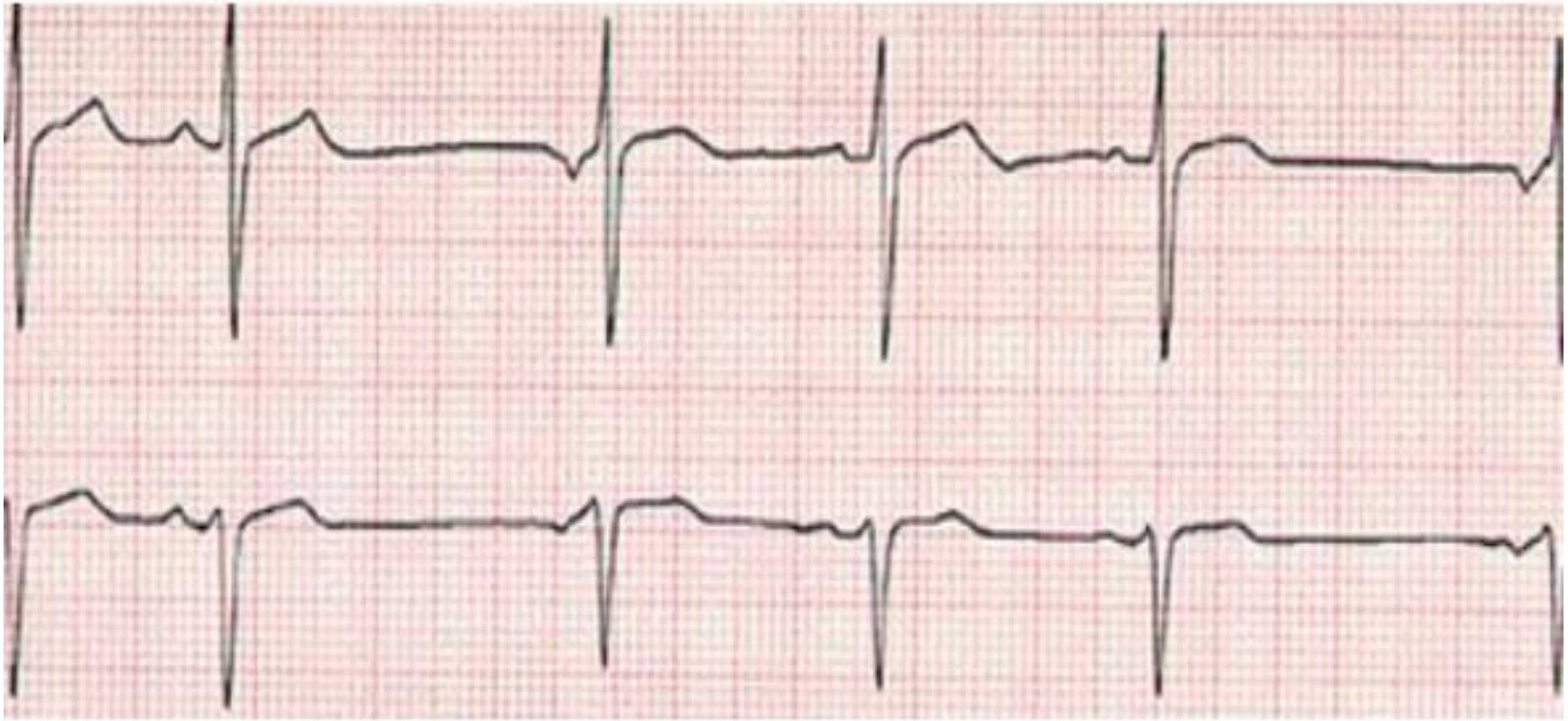

Z
Z
Z
Z
z


Sinus Rhythm
Non-Failing Heart
Sinus Rhythm
End-stage Heart Failure
Atrial Fibrillation
End-stage Heart Failure
A
Left atrium
B
Left atrium
C
Left atrium
100 µm
E
Right atrium
F
Right atrium
G
Right atrium
100 µm





Caso clínico



4. GENERAL EVALUATION OF PATIENTS WITH DOCUMENTED OR SUSPECTED BRADYCARDIA OR CONDUCTION DISORDERS

4.1. History and Physical Examination of Patients With Documented or Suspected Bradycardia or Conduction Disorders

Recommendation for History and Physical Examination in Patients With Documented or Suspected Bradycardia or Conduction Disorders		
COR	**LOE**	**Recommendation**
I	C-EO	1. In patients with suspected bradycardia or conduction disorders a comprehensive history and physical examination should be performed.

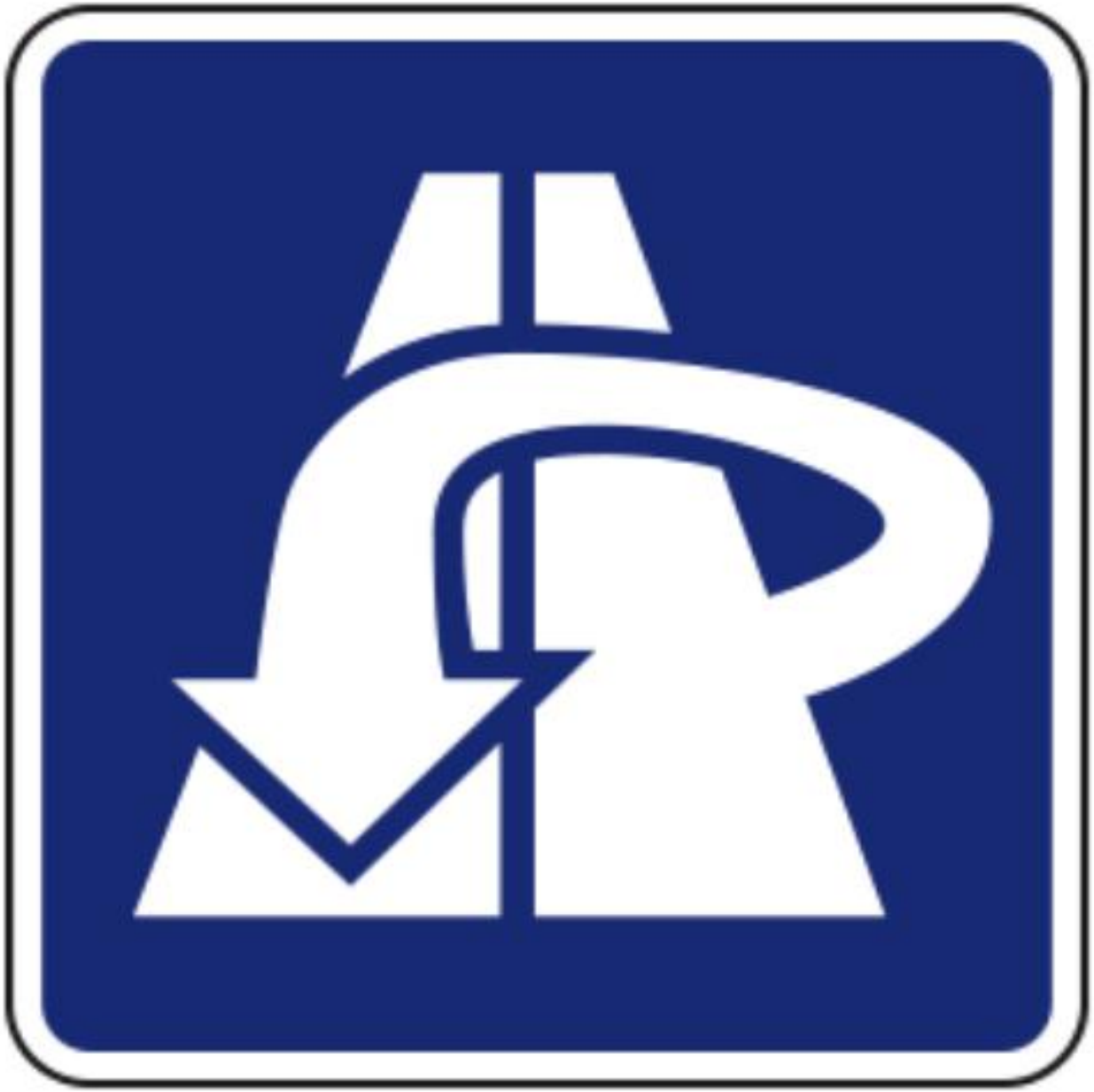


Table 7. Common Potentially Reversible or Treatable Causes of SND[55.3.1-1]

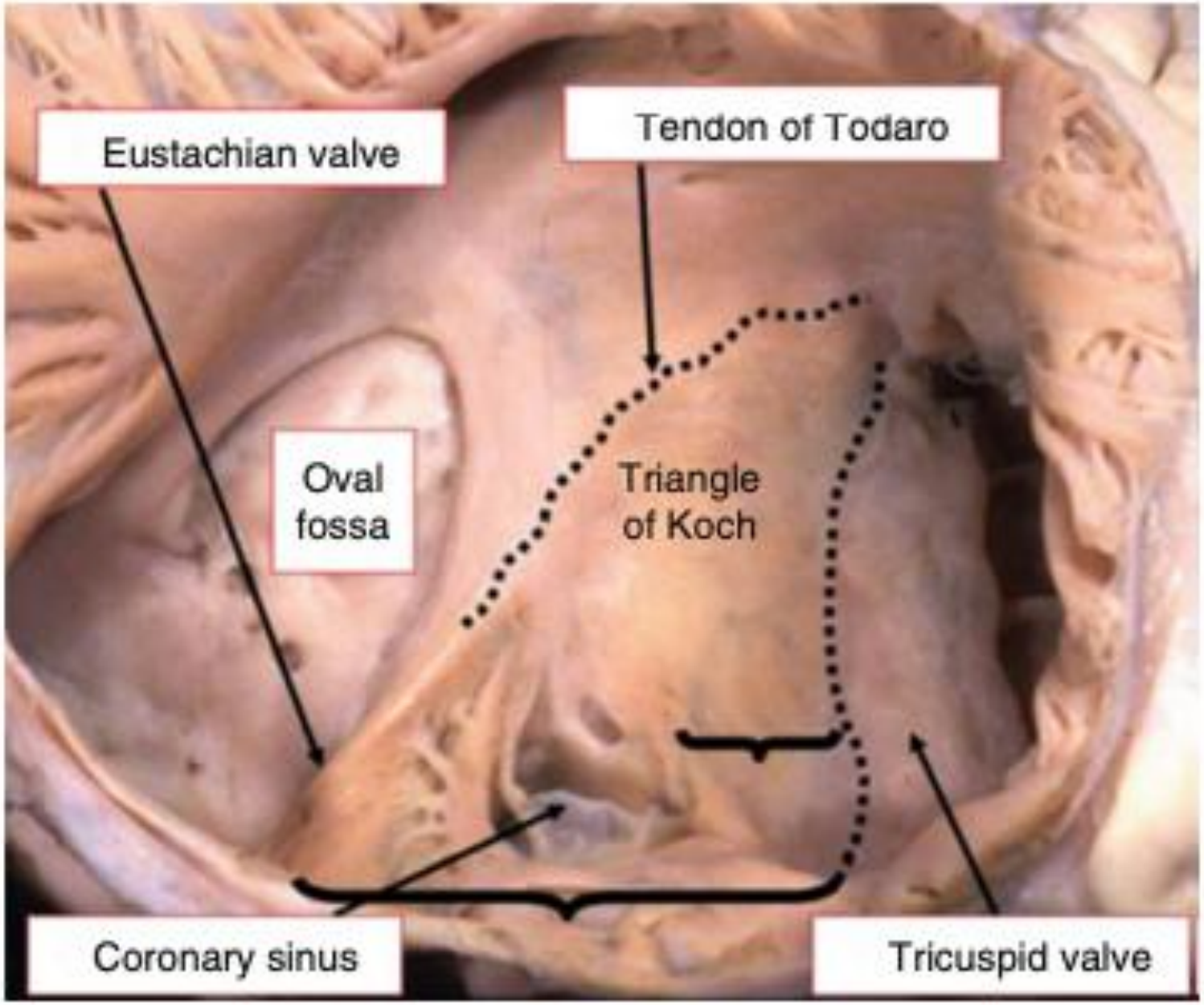
Acute myocardial ischemia or infarction[55.3.1-2-55.3.1-4]
Athletic training[55.3.1-5]
Atrial fibrillation[55.3.1-6]
Cardiac surgery
Valve replacement,[55.3.1-7,55.3.1-8] maze procedure,[55.3.1-7] coronary artery bypass graft[55.3.1-9,55.3.1-10]
Drugs or toxins*
Toluene, organophosphates, tetrodotoxin, cocaine[55.3.1-11]
Electrolyte abnormality
Hyperkalemia,[55.3.1-12] hypokalemia,[55.3.1-13] hypoglycemia[55.3.1-14]
Heart transplant:[55.3.1-15] Acute rejection, chronic rejection, remodeling[55.3.1-16,55.3.1-17]
Hypervagotonia[55.3.1-18,55.3.1-19]
Hypothermia
Therapeutic (post-cardiac arrest cooling[55.3.1-20]) or environmental exposure[55.3.1-21]
Hypothyroidism[55.3.1-22]
Hypovolemic shock[55.3.1-23]
Hypoxemia, hypercarbia, acidosis[55.3.1-24]
Sleep apnea, respiratory insufficiency (suffocation, drowning,[55.3.1-25] stroke,[55.3.1-26] drug overdose)
Infection[55.3.1-27]
Lyme disease,[55.3.1-28] legionella, psittacosis, typhoid fever, typhus, listeria,[55.3.1-29] malaria, leptospirosis, Dengue fever, viral hemorrhagic fevers, Guillain-Barre[55.3.1-30]
Medications*
Beta blockers, non-dihydropyridine calcium channel blockers, digoxin,[55.3.1-31] antiarrhythmic drugs, lithium,[55.3.1-32] methyldopa, risperidone, cisplatin, interferon

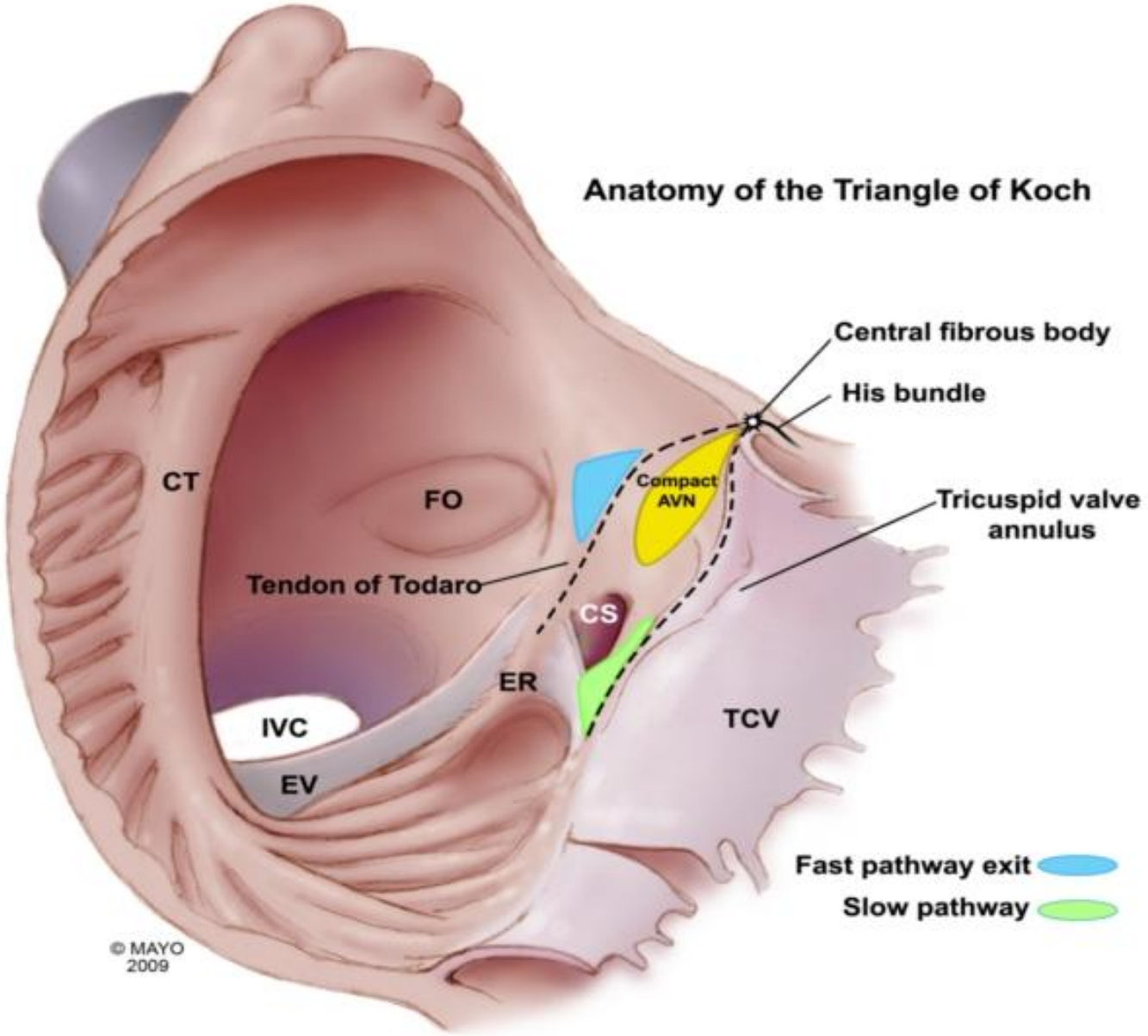
1.- Entren. atlético
2.- Fibrilación auricular
3.- Hipotiroidismo
4.- SAHOS
5.- Drogas
    Litio
    Mdopa, Cloni, Dex
    Risperidona

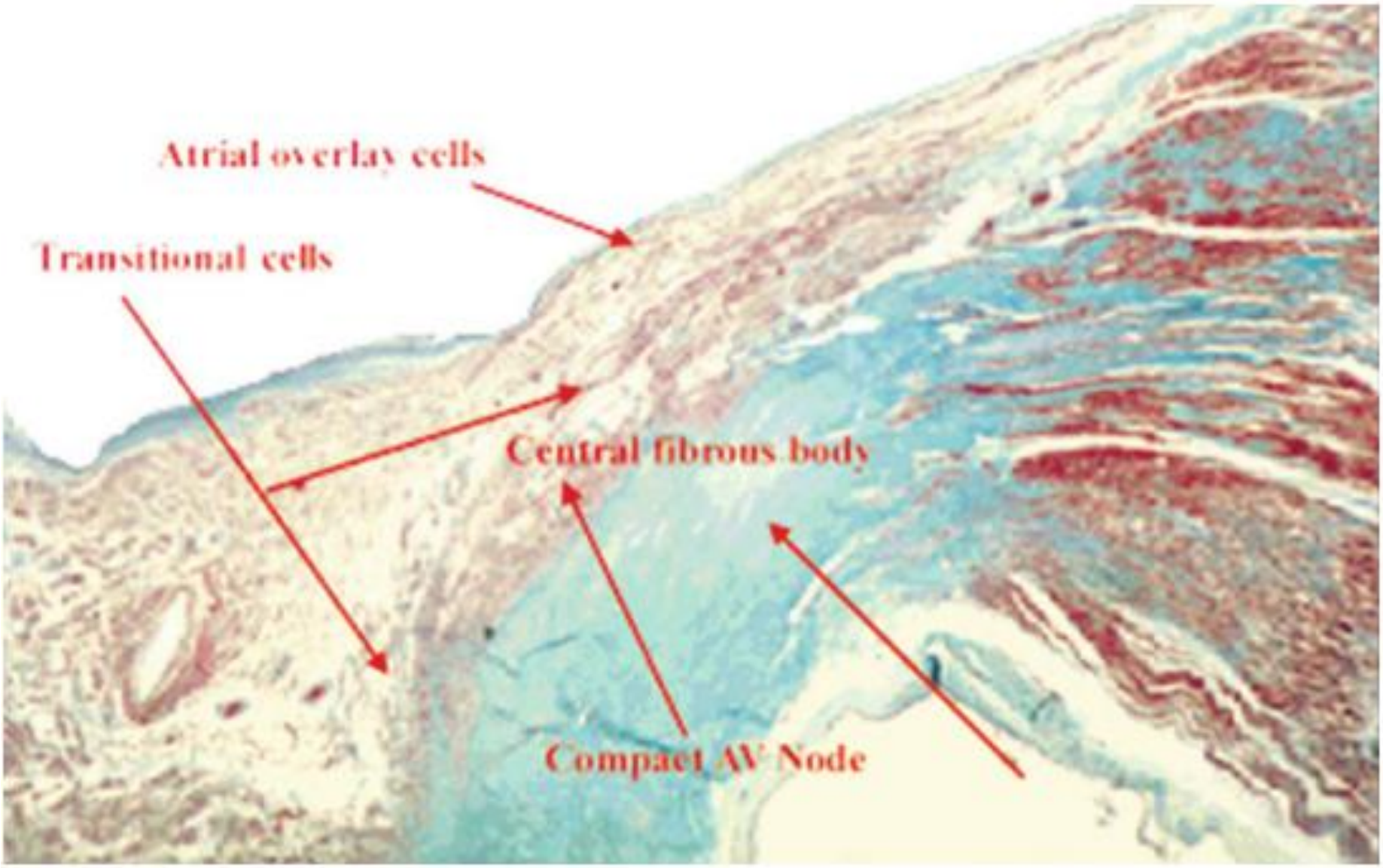
Extrinsic
Autonomic perturbation
Carotid sinus hypersensitivity
Neurally-mediated syncope/presyncope
Physical conditioning
Situational syncope
Cough
Defecation
Glottic stimulation
Medical procedures
Micturition
Vomiting
Sleep (with or without sleep apnea)
Metabolic
Acidosis
Hyperkalemia
Hypokalemia
Hypothermia
Hypothyroidism
Hypoxia

1.- Acidosis
2.- Hiper – Hipokalemia
3.- Hipotermina
4.- Hipoxia
5.- Infarto

Propagación del impulso

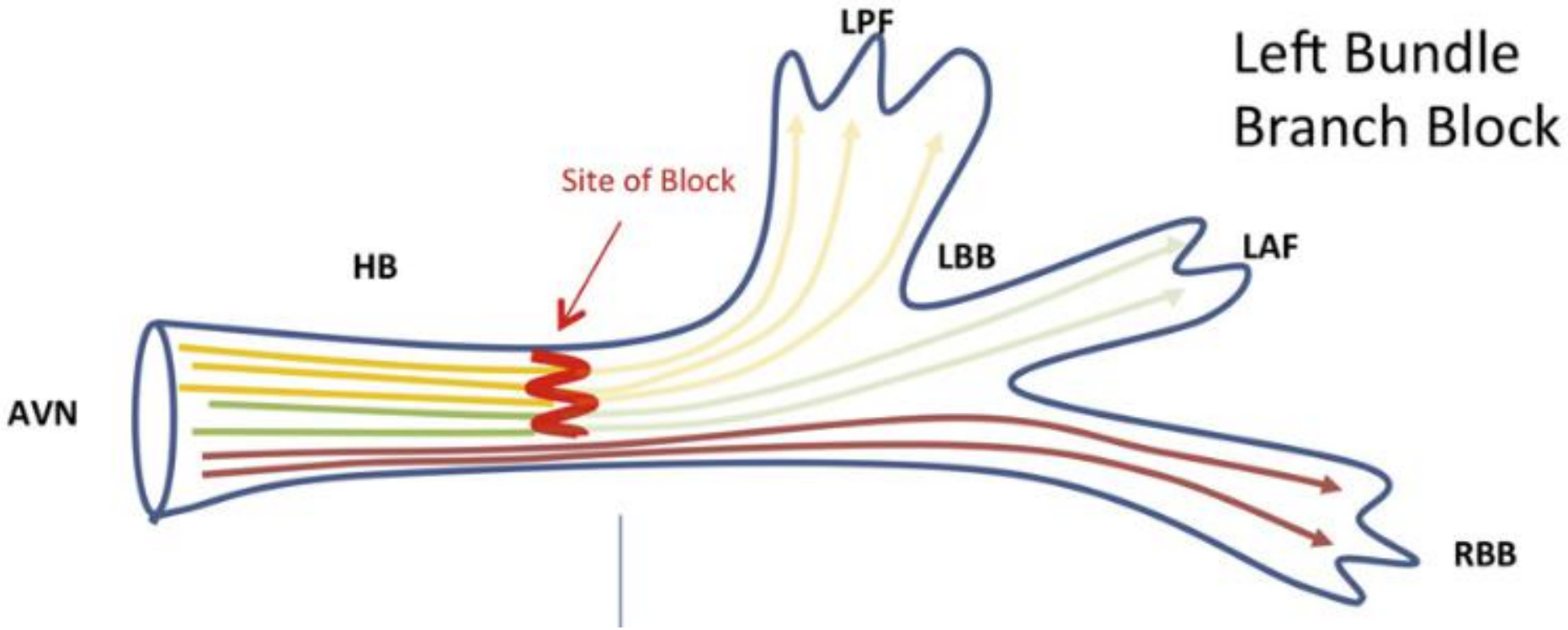

Eustachian valve
Tendon of Todaro
Oval fossa
Triangle of Koch
Coronary sinus
Tricuspid valve

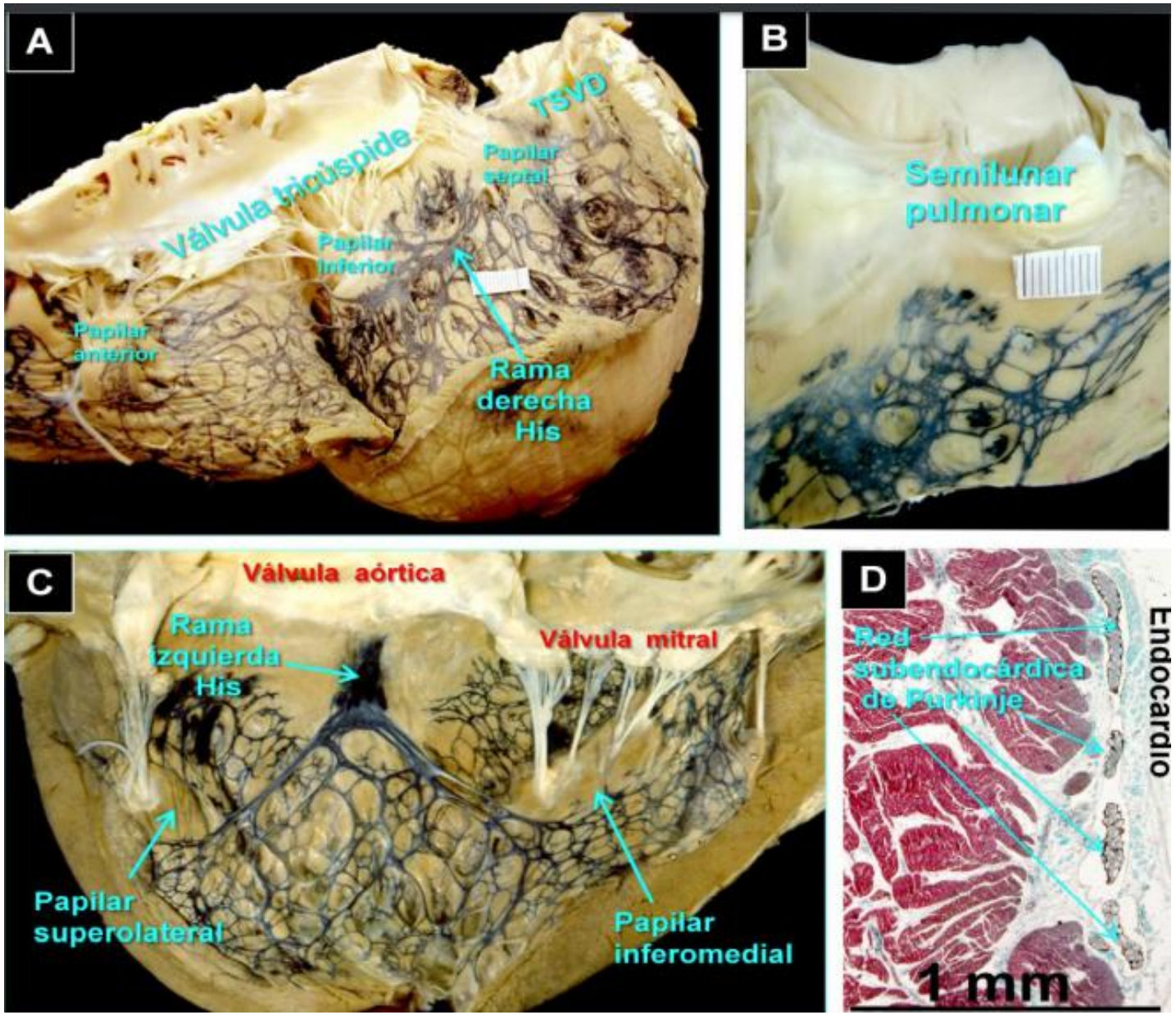

Anatomy of the Triangle of Koch
Central fibrous body
His bundle
Compact AVN
Tricuspid valve annulus
CT
FO
Tendon of Todaro
CS
ER
IVC
EV
TCV
Fast pathway exit
Slow pathway
© MAYO 2009

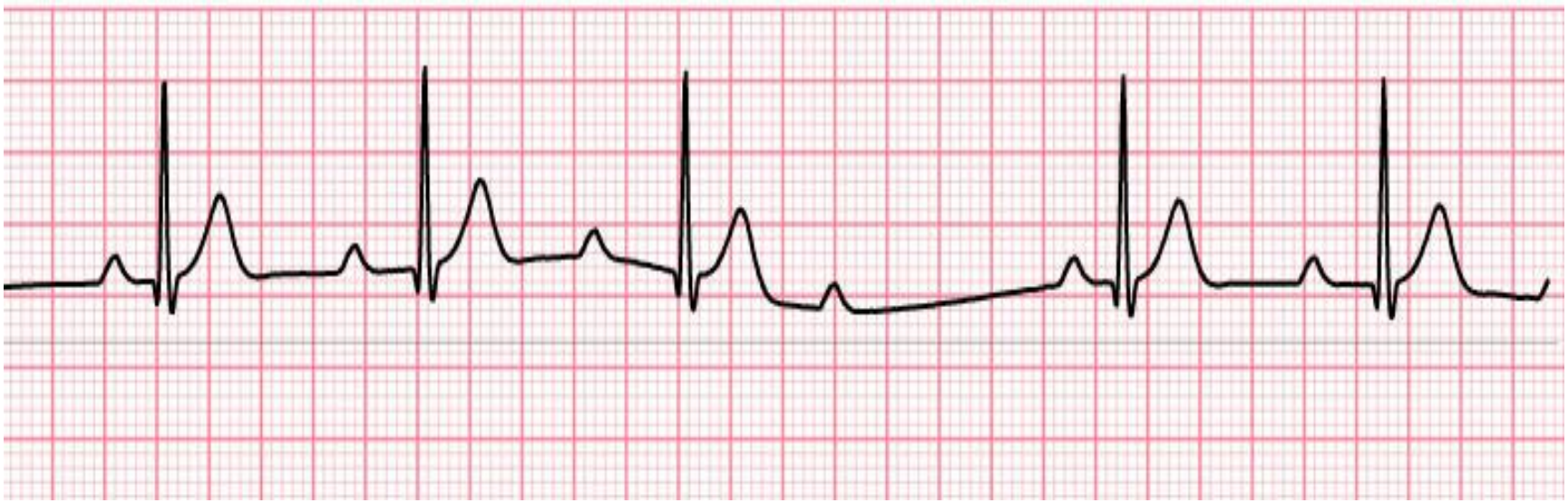

Atrial overlay cells
Transitional cells
Central fibrous body
Compact AV Node

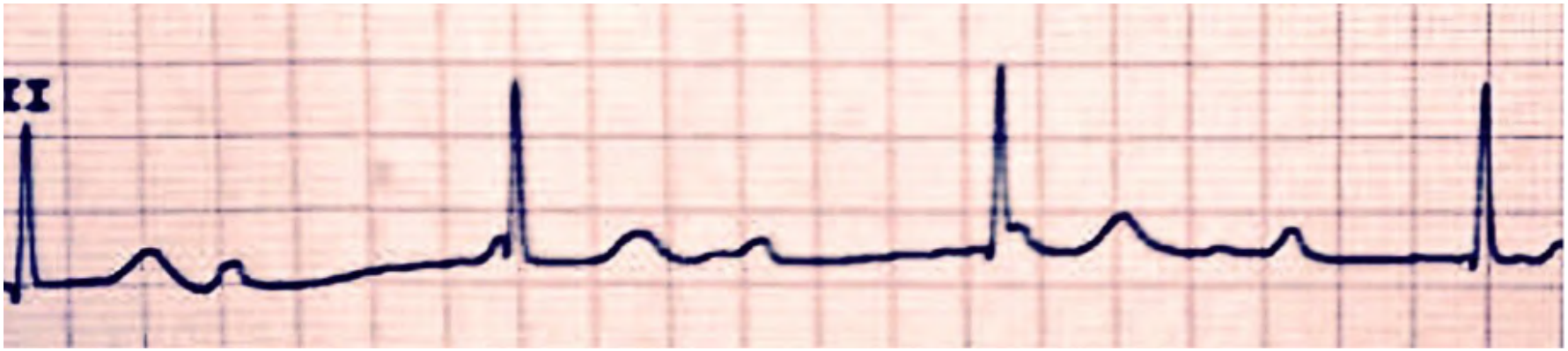
A.E. Teng et al. / Journal of Electrocardiology 49 (2016) 644–648

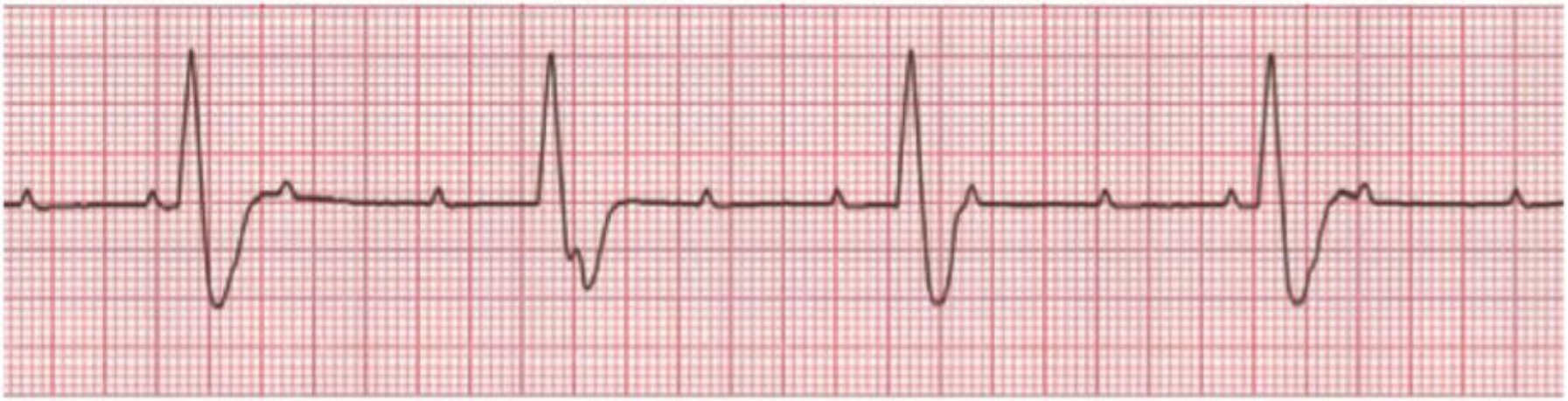
Left Bundle Branch Block




A
Válvula tricúspide
TSVD
Papilar septal
Papilar inferior
Papilar anterior
Rama derecha His
B
Semilunar pulmonar
C
Válvula aórtica
Rama izquierda His
Válvula mitral
Papilar superolateral
Papilar inferomedial
D
Red subendocárdica de Purkinje
Endocardio
1 mm




II

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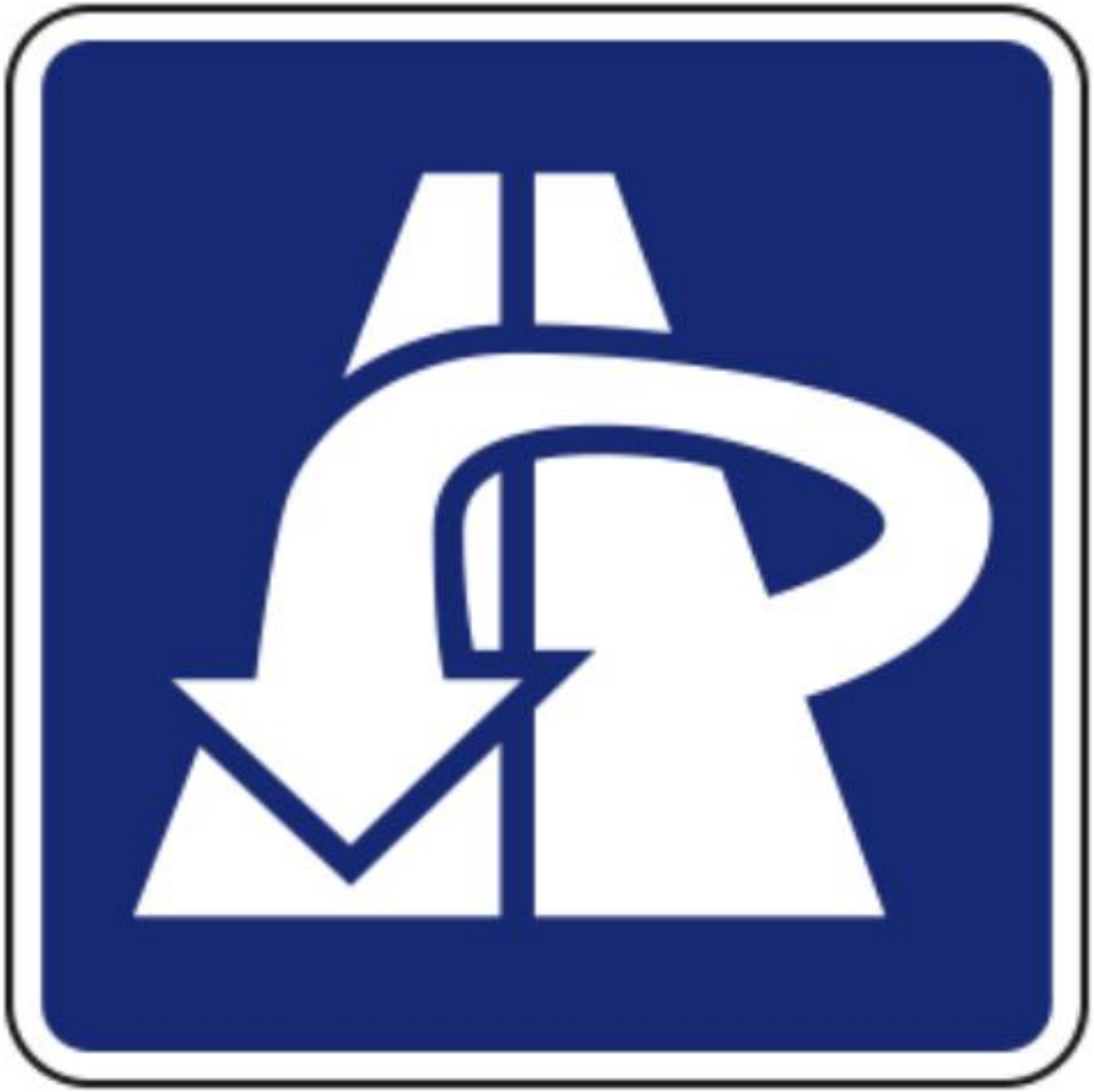


Causas

Table 2: Various causes of atrioventricular block

Type of disorder	Causes
Autonomic	Carotid sinus hypersensitivity, vasovagal
Metabolic and endocrine	Hyperkalemia, hypermagnesemia, hypothyroidism, adrenal insufficiency
Drug induced	Beta blockers, CCBs, adenosine, lithium, digitalis, antiarrhythmics
Infections	Endocarditis, Lyme disease, Chagas disease, TB, toxoplasmosis, syphilis
Heritable and congenital	Congenital heart disease, maternal SLE, myotonic dystrophy, progressive familial heart block
Inflammatory and infiltrative	SLE, scleroderma, mixed connective tissue disorder, rheumatoid arthritis, amyloidosis, sarcoid, hemochromatosis
Neoplasms	Lymphoma, mesothelioma, radiation, catheter ablation
Degenerative	Lev disease, Lenegre's disease
Coronary artery disease	Acute myocardial infarction[1]

CCBs: Calcium channel blockers, TB: Tuberculosis, SLE: Systemic lupus erythematosus

Causas

- Infarto Agudo al miocardio
- Hiperkalemia
- Hipotiroidismo
- Endocarditis
- Intoxicación y drogas

Type of disorder	
Autonomic	
Metabolic and endocrin	
Drug induced	
Infections	
Heritable and congenita	ck
Inflammatory and infiltra	coid, hemochromatosis
Neoplasms	
Degenerative	
Coronary artery diseas	

CCBs: Calcium channel blo

Circulation

ACC/AHA/HRS GUIDELINE

2018 ACC/AHA/HRS Guideline on the Evaluation and Management of Patients With Bradycardia and Cardiac Conduction Delay

A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society

Tratamiento médico

Medication	Dosage	Comments
Symptomatic sinus bradycardia or atrioventricular block		
Atropine	0.5–1 mg IV (may be repeated every 3–5 min to a maximum dose of 3 mg)[55.3.2.4-20–55.3.2.4-24]	
Dopamine	5 to 20 mcg/kg/min IV, starting at 5 mcg/kg/min and increasing by 5 mcg/kg/min every 2 min[55.3.2.4-25]	Dosages of >20 mcg/kg/min may result in vasoconstriction or arrhythmias
Isoproterenol	20–60 mcg IV bolus followed doses of 10–20 mcg, or infusion of 1–20 mcg/min based on heart rate response[55.3.2.4-26–55.3.2.4-32]	Monitor for potential development of ischemic chest pain
Epinephrine	2–10 mcg/min IV or 0.1–0.5 mcg/kg/min IV titrated to desired effect[55.3.2.4-17,55.3.2.4-31,55.3.2.4-33]	
Second- or third-degree atrioventricular block associated with acute inferior MI		
Aminophylline	250-mg IV bolus	

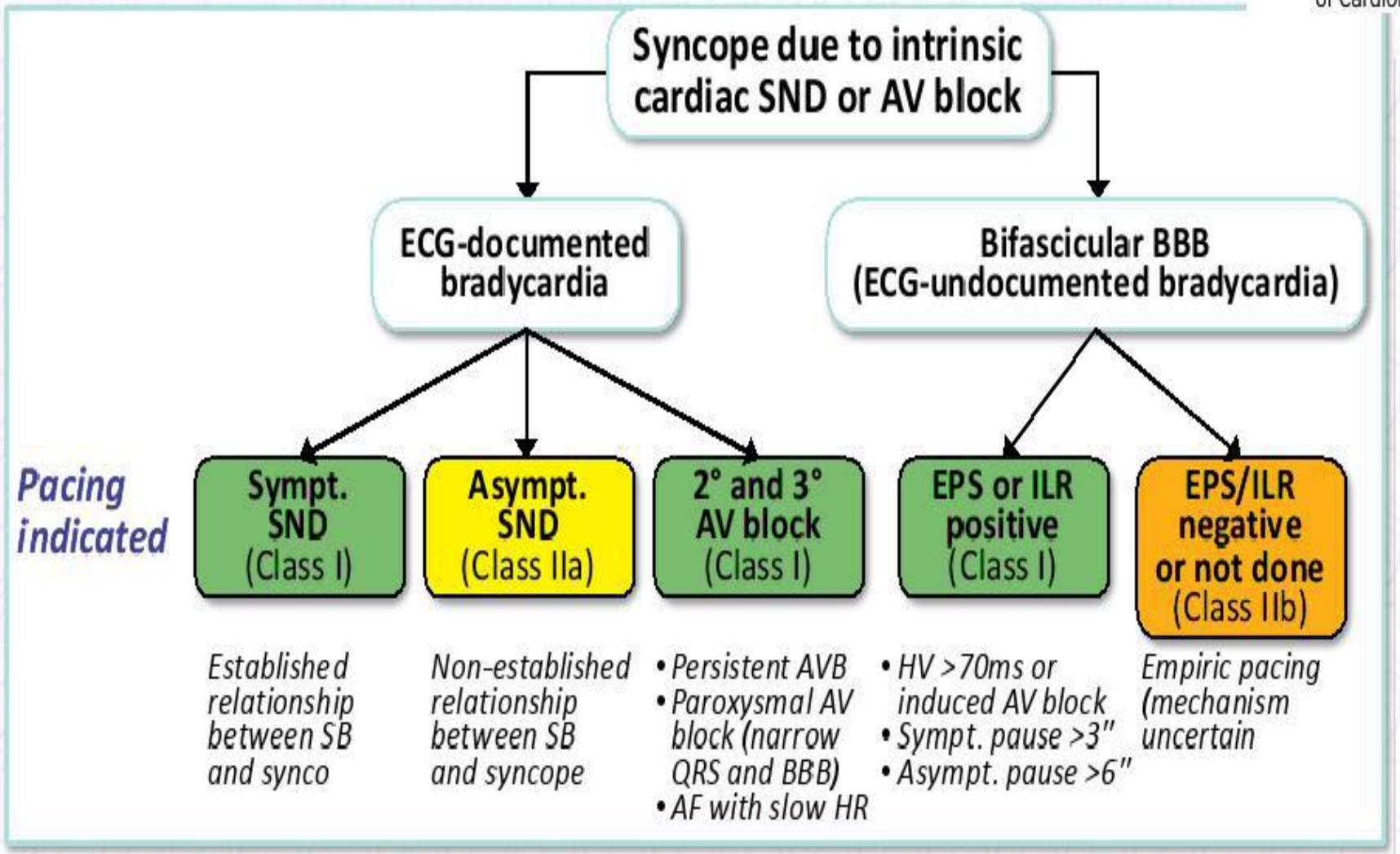
Tratamiento médico

Calcium channel blocker overdose		
10% calcium chloride	1–2 g IV every 10–20 min or an infusion of 0.2–0.4 mL/kg/h[55.3.2.4-34-55.3.2.4-36]	
10% calcium gluconate	3–6 g IV every 10–20 min or an infusion at 0.6–1.2 mL/kg/h[55.3.2.4-34-55.3.2.4-36]	
Beta-blocker or calcium channel blocker overdose		
Glucagon	3–10 mg IV with infusion of 3–5 mg/h[55.3.2.4-37,55.3.2.4-38]	
High dose insulin therapy	IV bolus of 1 unit/kg followed by an infusion of 0.5 units/kg/h.[55.3.2.4-36,55.3.2.4-39,55.3.2.4-40]	Follow glucose and potassium levels
Digoxin overdose		
Digoxin antibody fragment	Dosage is dependent on amount ingested or known digoxin concentration[55.3.2.4-41-55.3.2.4-48]	One vial binds approximately 0.5 mg of digoxin Administer over at least 30 min May be repeated

Terapia con dispositivos

Treatment of syncope: **Cardiac arrhythmias**

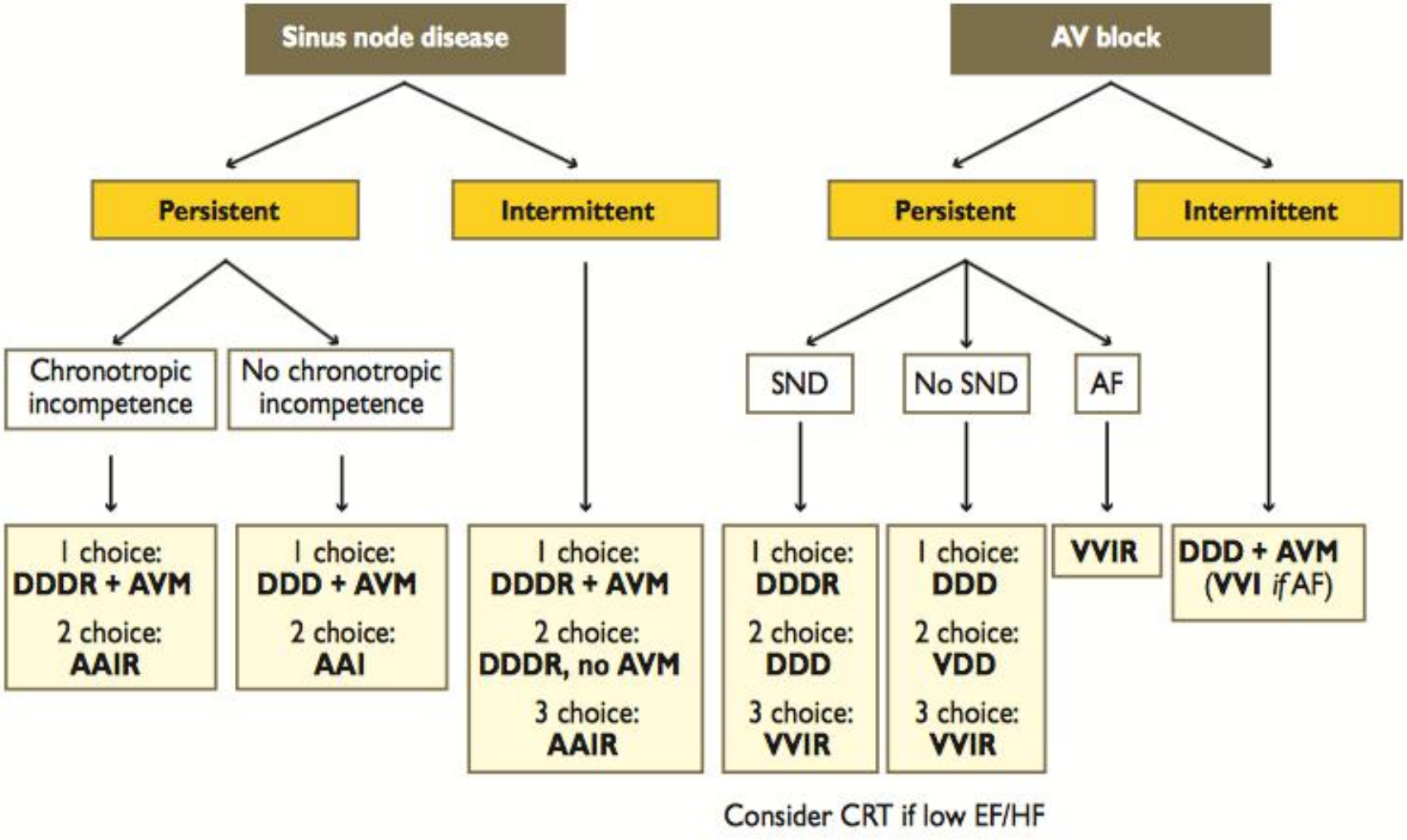
ESC European Society of Cardiology



www.escardio.org/guidelines

2018 ESC Guidelines on Syncope – Michele Brignole & Angel Moya
European Heart Journal 2018;39:1883–1948 - Doi:10.1093/eurheartj/ehy037

Indicaciones



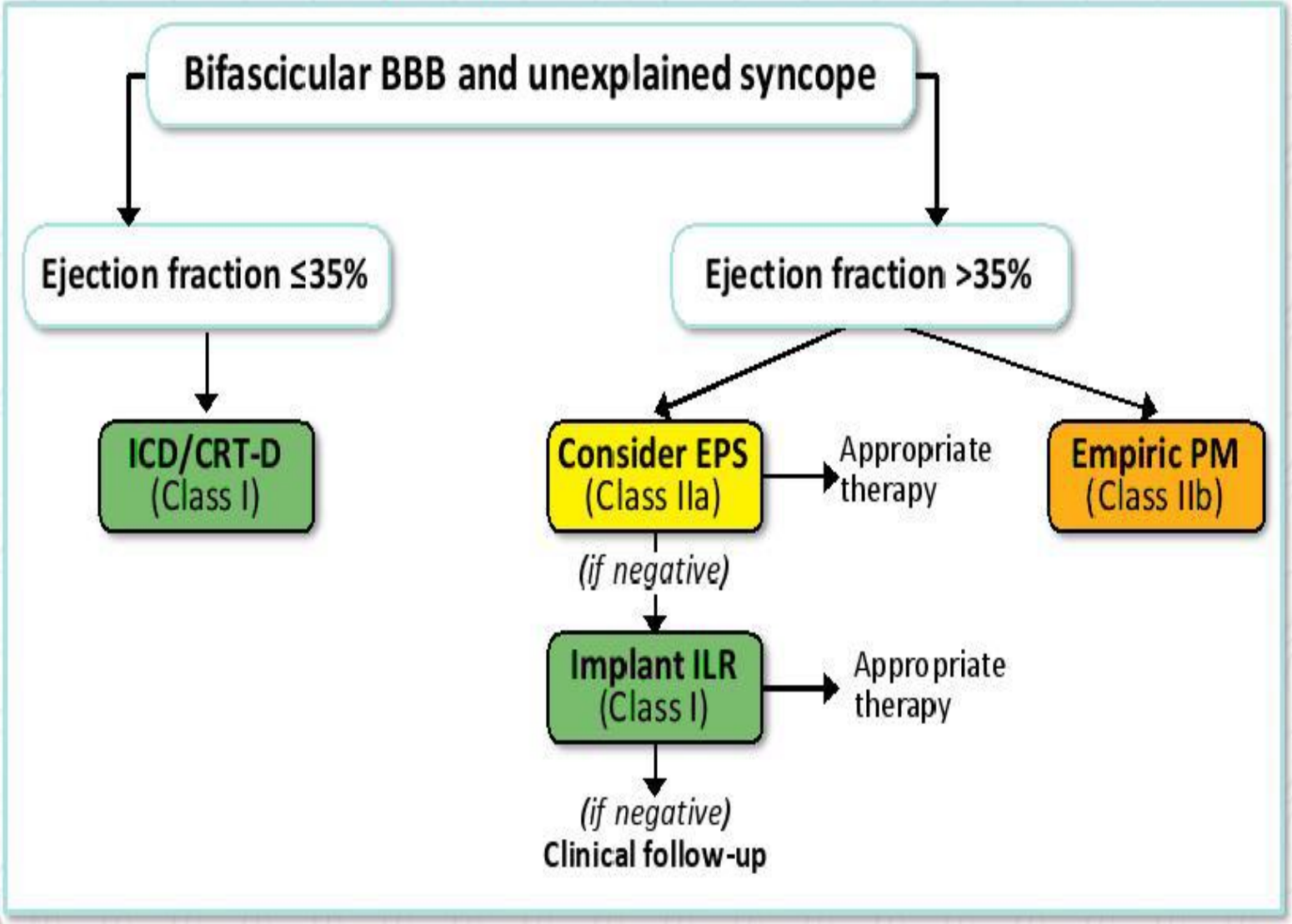
Dual-chamber versus ventricular pacing

Outcome	Dual-chamber benefit over ventricular pacing
All-cause deaths	No benefit
Stroke, embolism	Benefit (in meta-analysis only, not in single trial)
Atrial fibrillation	Benefit
HF, hospitalization for HF	No benefit
Exercise capacity	Benefit
Pacemaker syndrome	Benefit
Functional status	No benefit
Quality of life	Variable
Complications	More complications with dual-chamber

European Heart Journal 2013;34:2281-2329
Europace 2013;15:1070–1118

Treatment of syncope: **Bundle Branch Block**

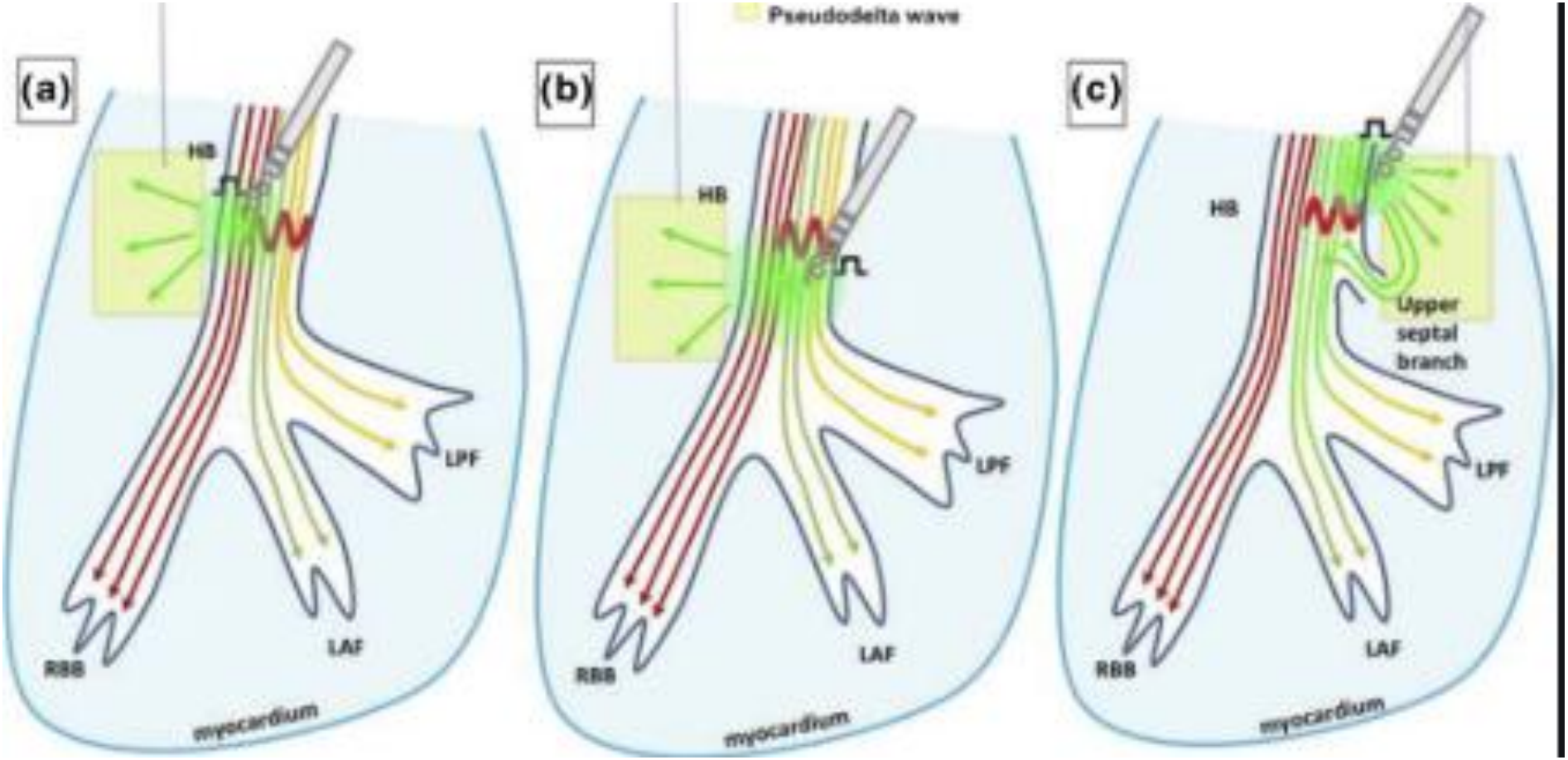
ESC
European Society of Cardiology



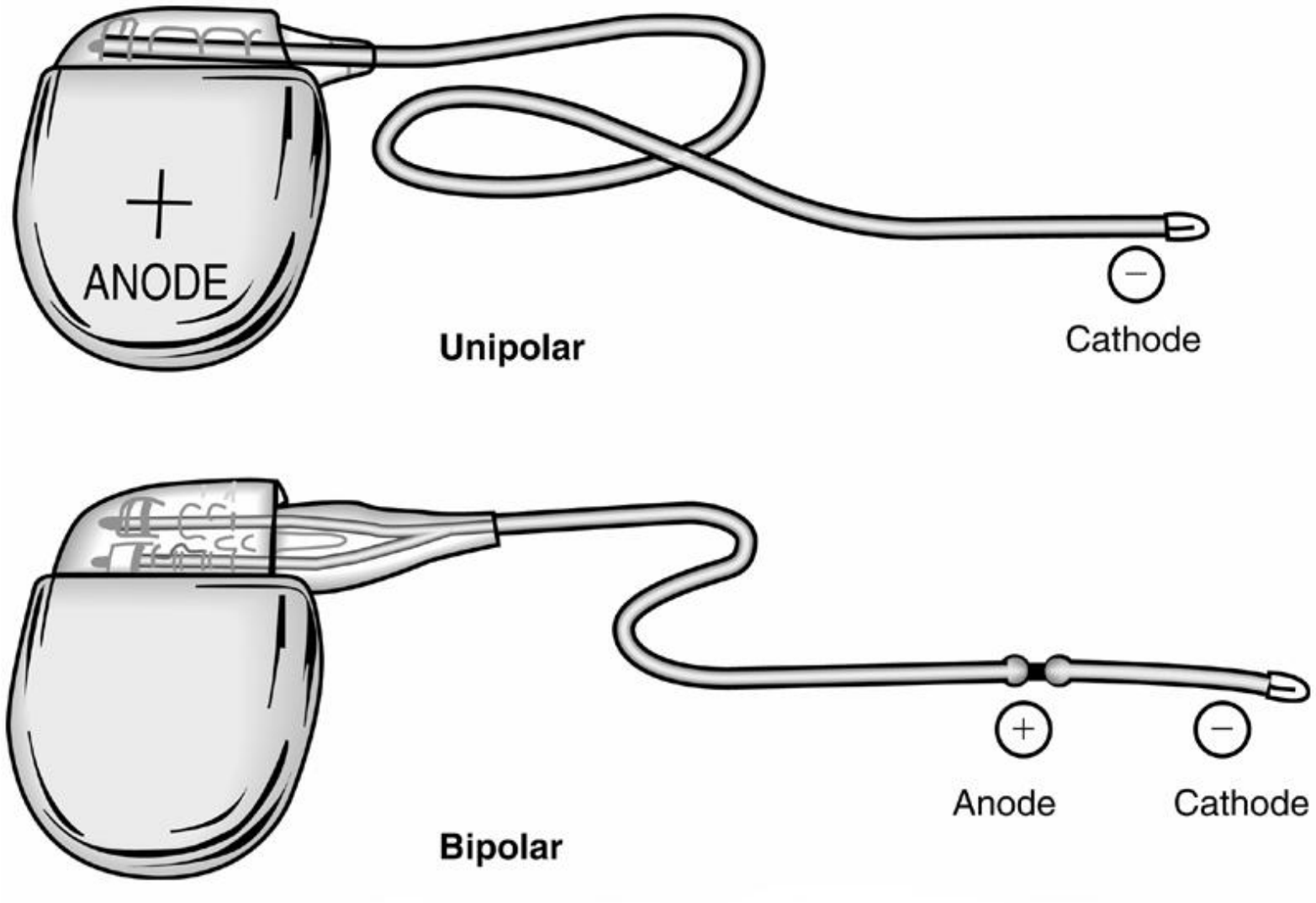
ACC/AHA/HRS GUIDELINE

2018 ACC/AHA/HRS Guideline on the Evaluation and Management of Patients With Bradycardia and Cardiac Conduction Delay

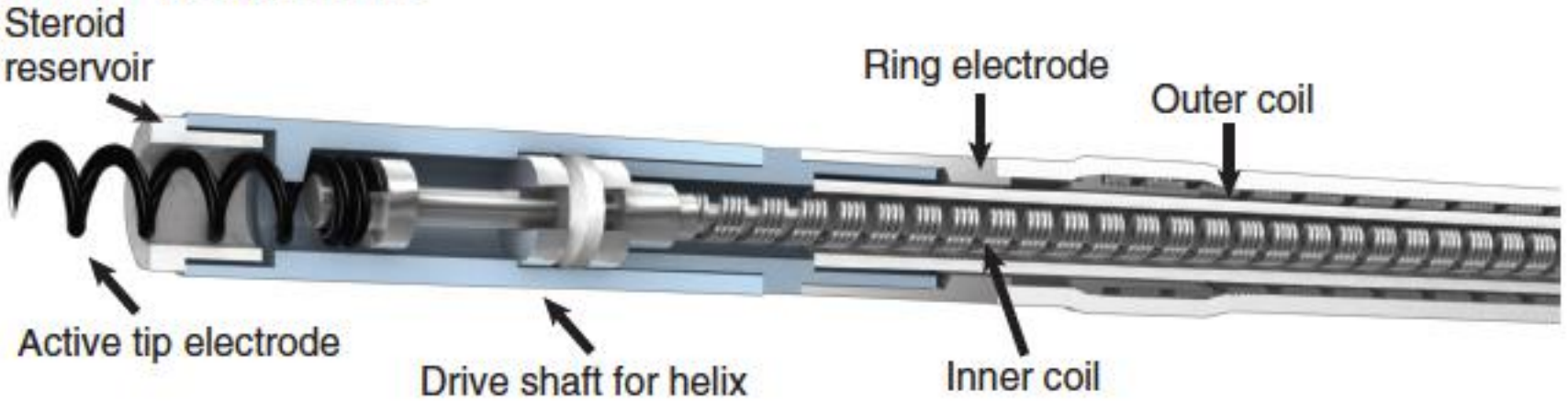
- In patients with a left ventricular ejection fraction between 36% to 50% and atrioventricular block, who have an indication for permanent pacing and are expected to require ventricular pacing >40% of the time, techniques that provide more physiologic ventricular activation (eg, cardiac resynchronization therapy, His bundle pacing) are preferred to right ventricular pacing to prevent heart failure.


(a)
HB
LPF
LAF
RBB
myocardium
(b)
Pseudodelta wave
HB
LPF
LAF
RBB
myocardium
(c)
HB
Upper septal branch
LPF
LAF
RBB
myocardium

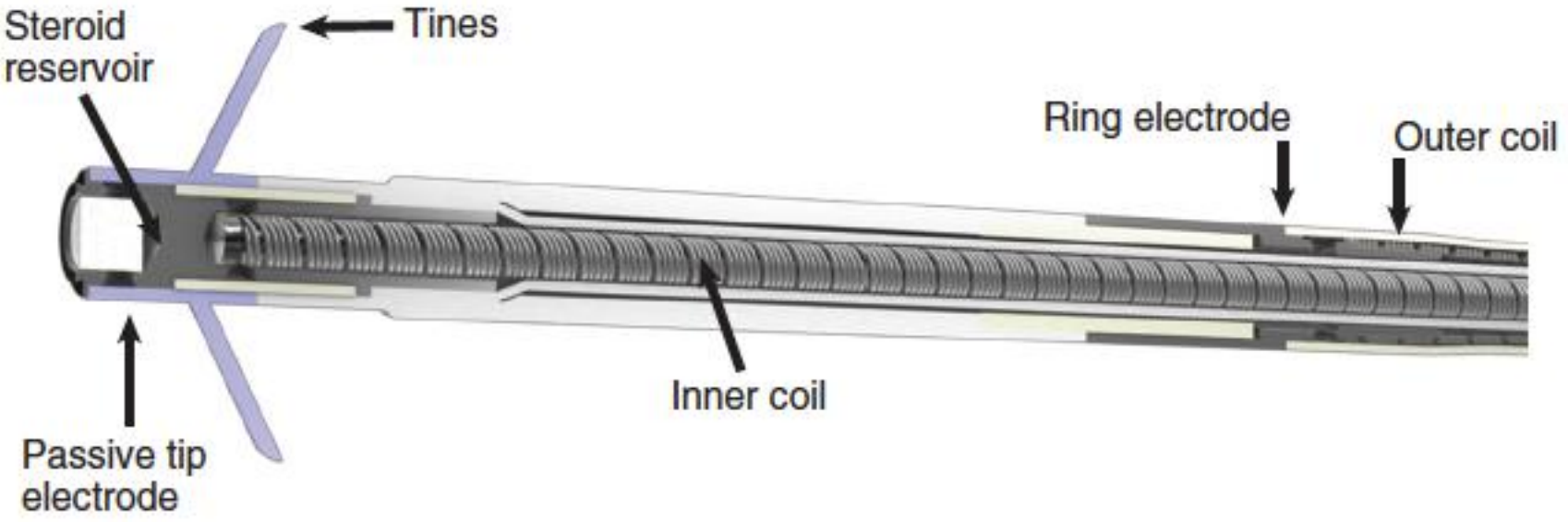
Marcapasos


+
ANODE
Unipolar
Cathode
+
Anode
Cathode
Bipolar

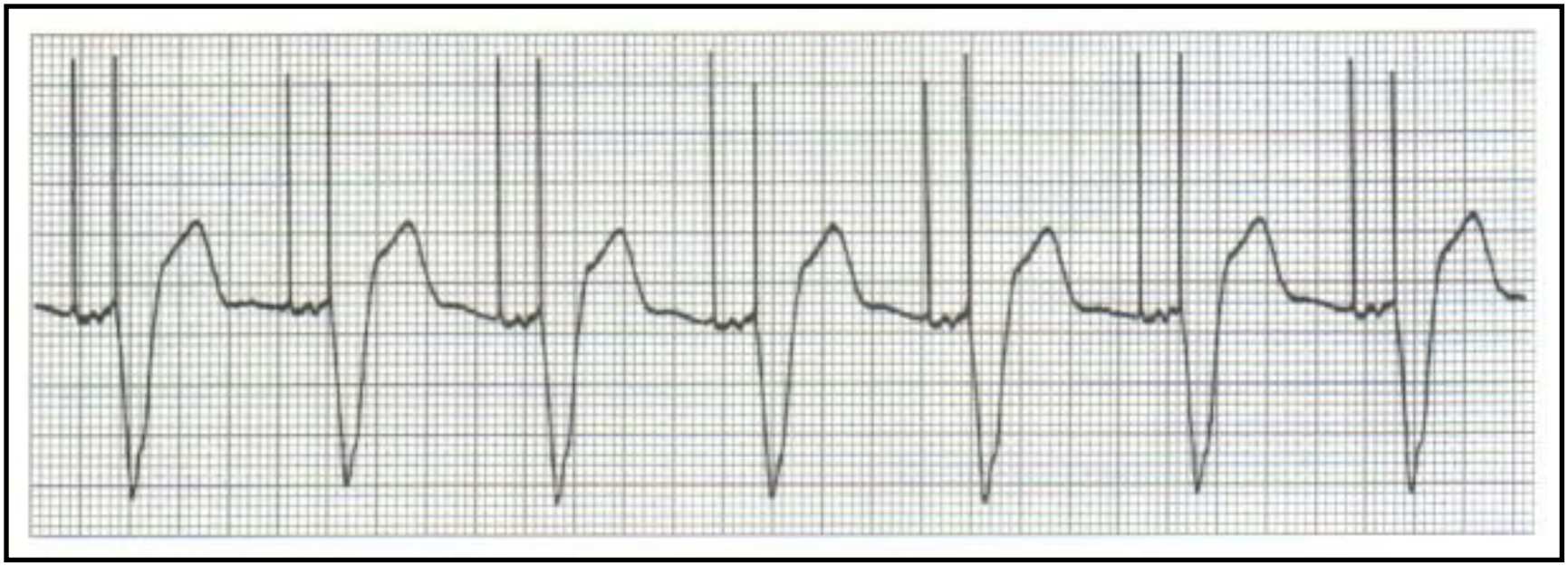
ACTIVE PACING LEAD



PASSIVE PACING LEAD



Captura



	Unipolar	*Bipolar*
VENTAJAS	— Umbrales de estimulación más bajos	— Menos interferencias
	— Menor resistencia en el electrodo indiferente	— Menos inhibición por miopotenciales
	— Mejor análisis de la onda detectada	— Mejor detección de la onda auricular
	— Cables más delgados	— Posibilidad de conversión en unipolar
	— Mejor identificación ECG	
INCONVENIENTES	— Mayor posibilidad de detección de interferencias	— Cables más gruesos y menos flexibles
	— Mayor posibilidad de inhibición por miopotenciales	— Implantación más difícil
	— Posible estimulación muscular	— Fabricación más costosa
		— Identificación del ECG más difícil

Unipolar	*Bipolar*
— Umbrales de estimulación más bajos	— Menos interferencias

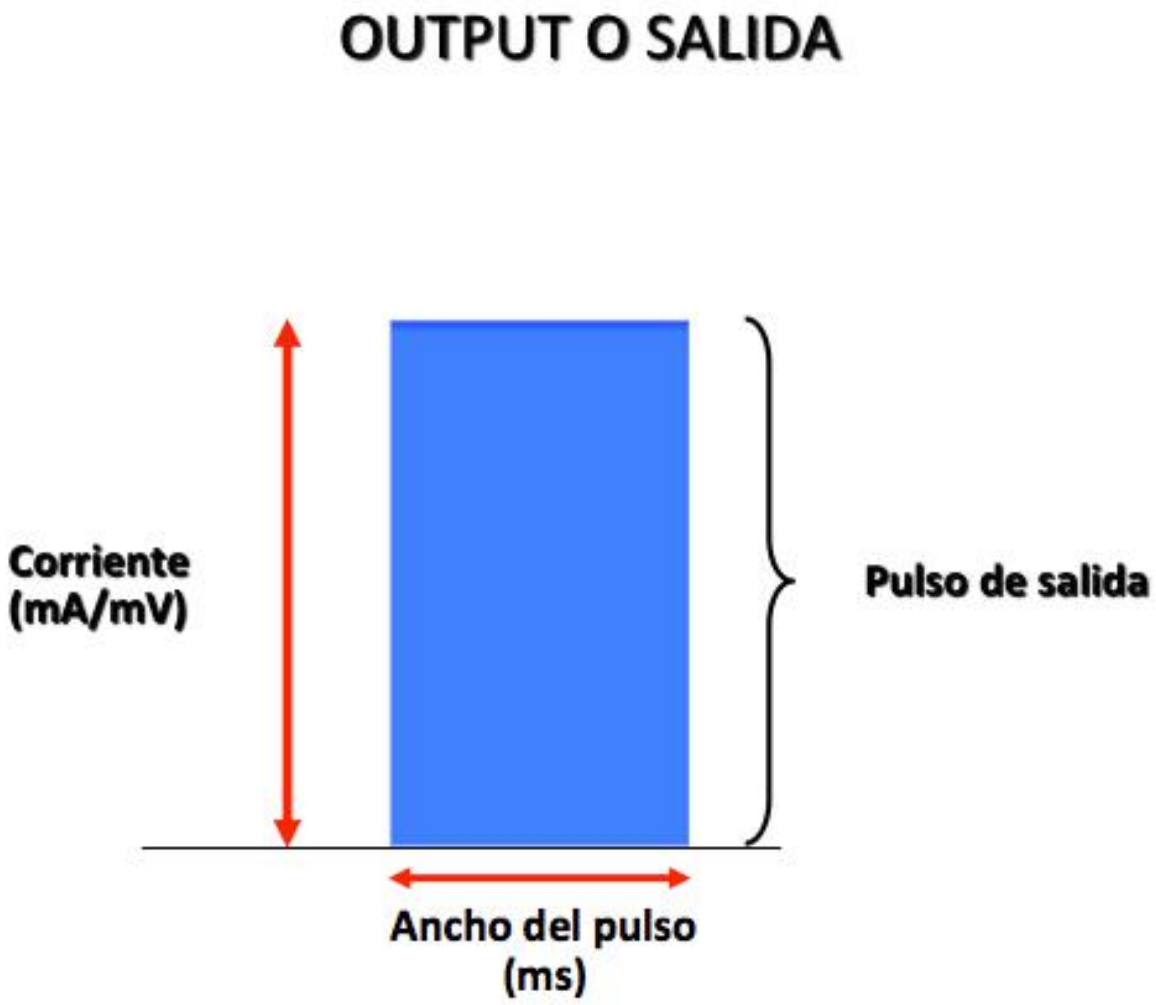
TABLA 1. Características de las dos configuraciones de estimulación

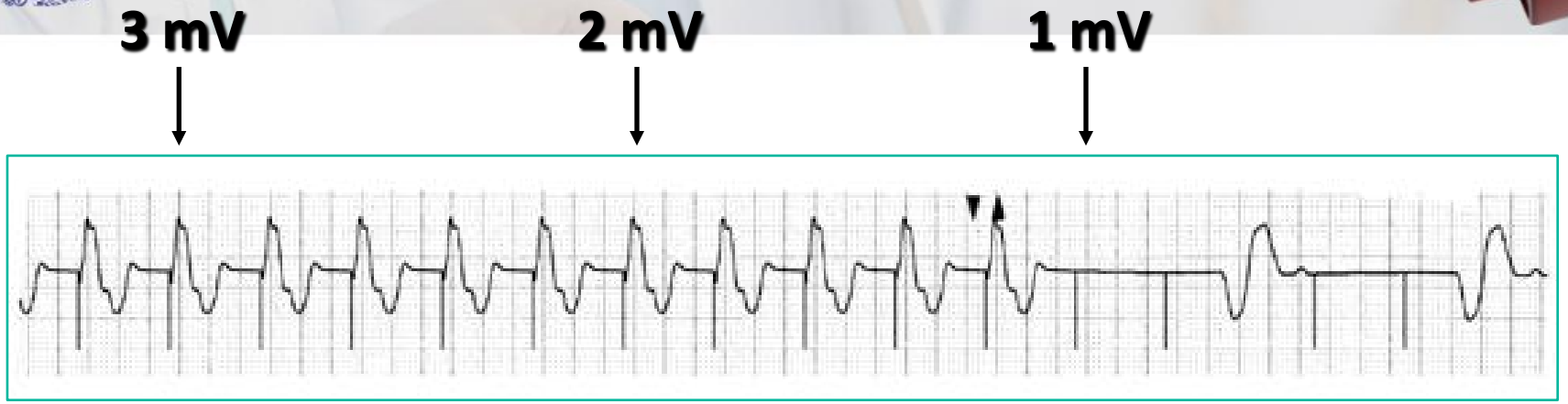
	Espícula	Umbral (V)	Impedancia	Energía
Unipolar	Mayor	Menor	Mayor	Igual
Bipolar	Menor	Mayor	Menor	Igual

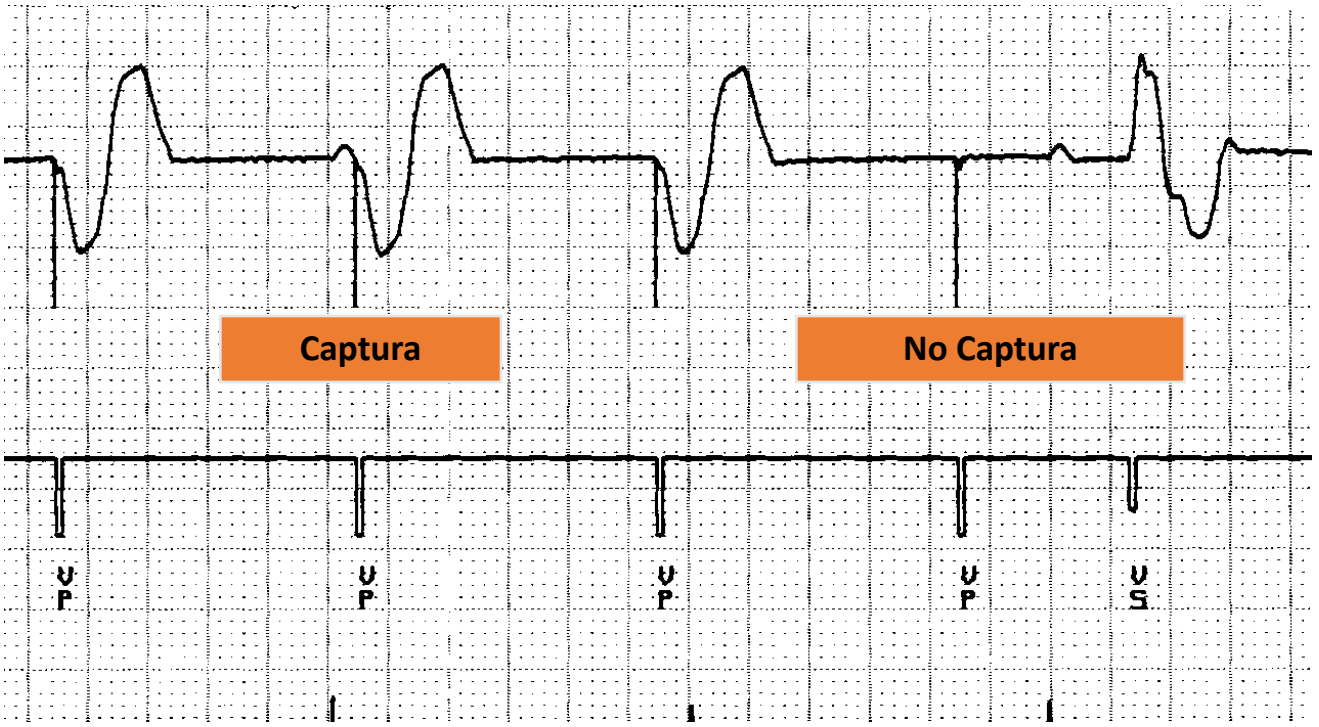
INCO

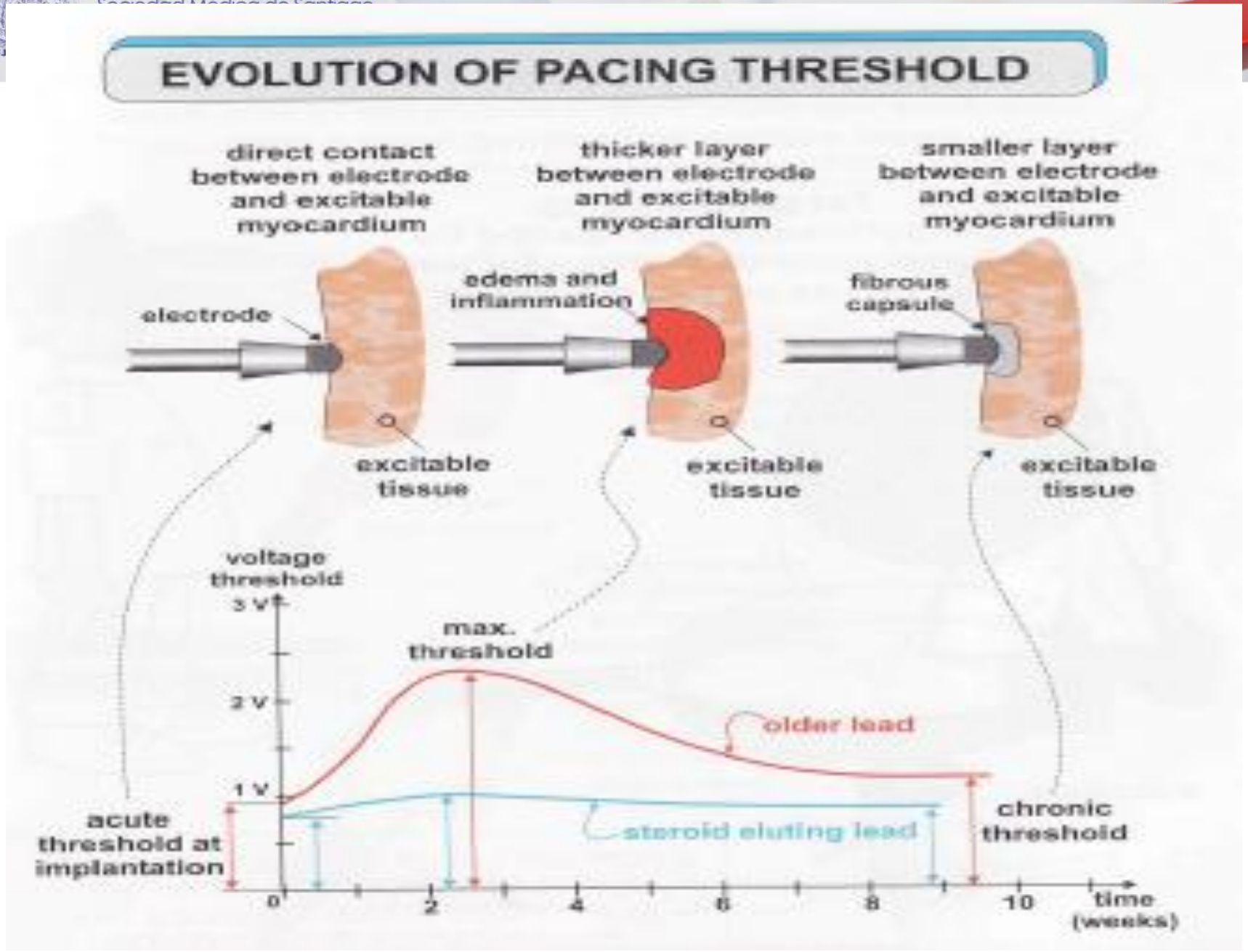
— Identificación del ECG más difícil

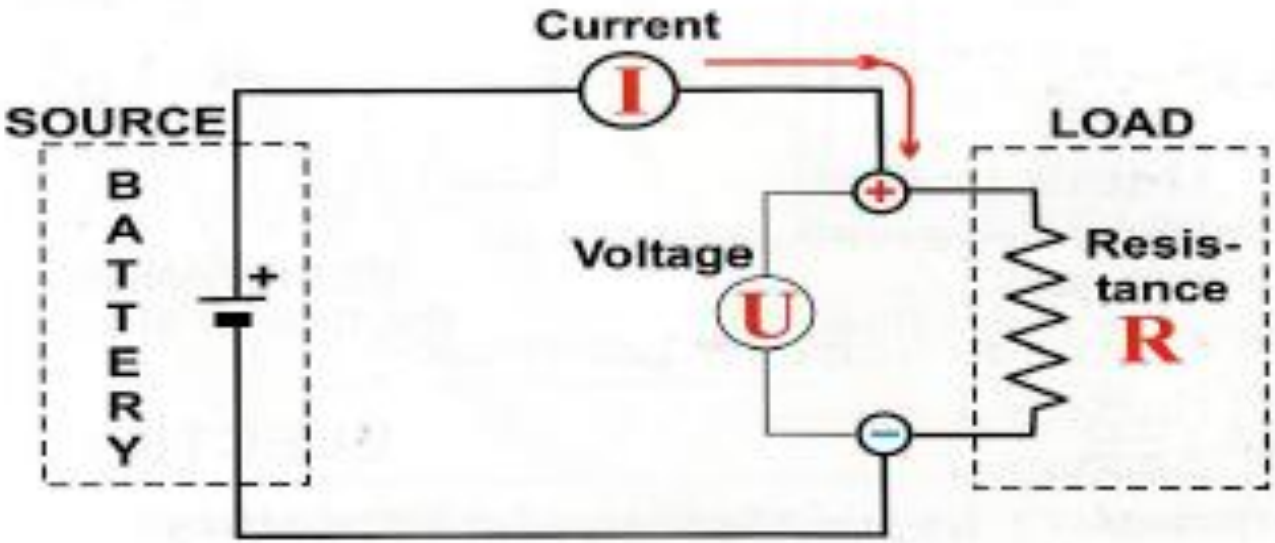
Umbral


OUTPUT O SALIDA
Corriente
(mA/mV)
Pulso de salida
Ancho del pulso
(ms)


3 mV
2 mV
1 mV


Captura
No Captura


EVOLUTION OF PACING THRESHOLD
direct contact between electrode and excitable myocardium
thicker layer between electrode and excitable myocardium
smaller layer between electrode and excitable myocardium
electrode
edema and inflammation
fibrous capsule
excitable tissue
excitable tissue
excitable tissue
voltage threshold
3 V
2 V
1 V
max. threshold
older lead
steroid eluting lead
acute threshold at implantation
chronic threshold
0
2
4
6
8
10
time (weeks)



U = voltage (in volt V)

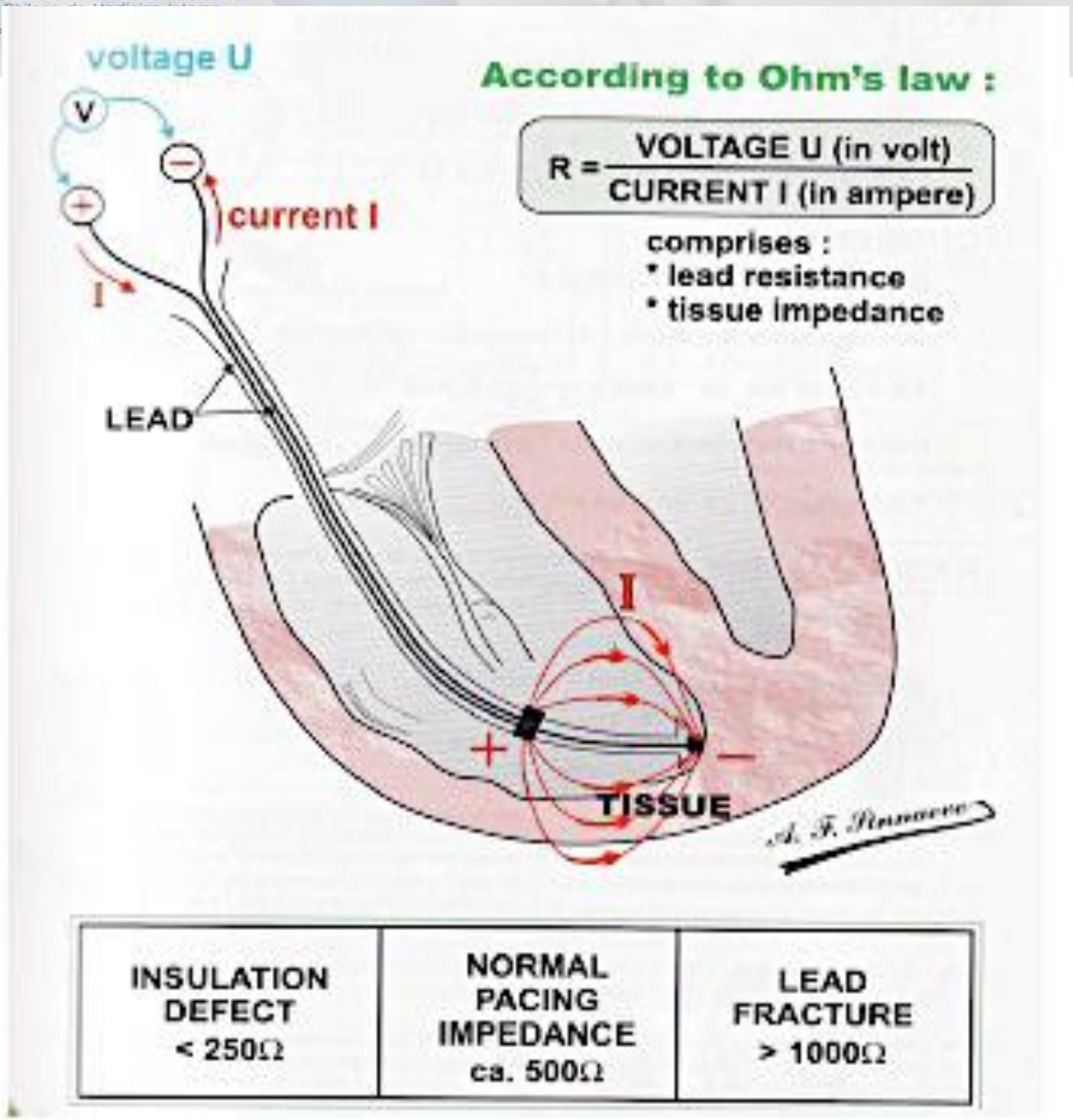
I = current (in ampere A)

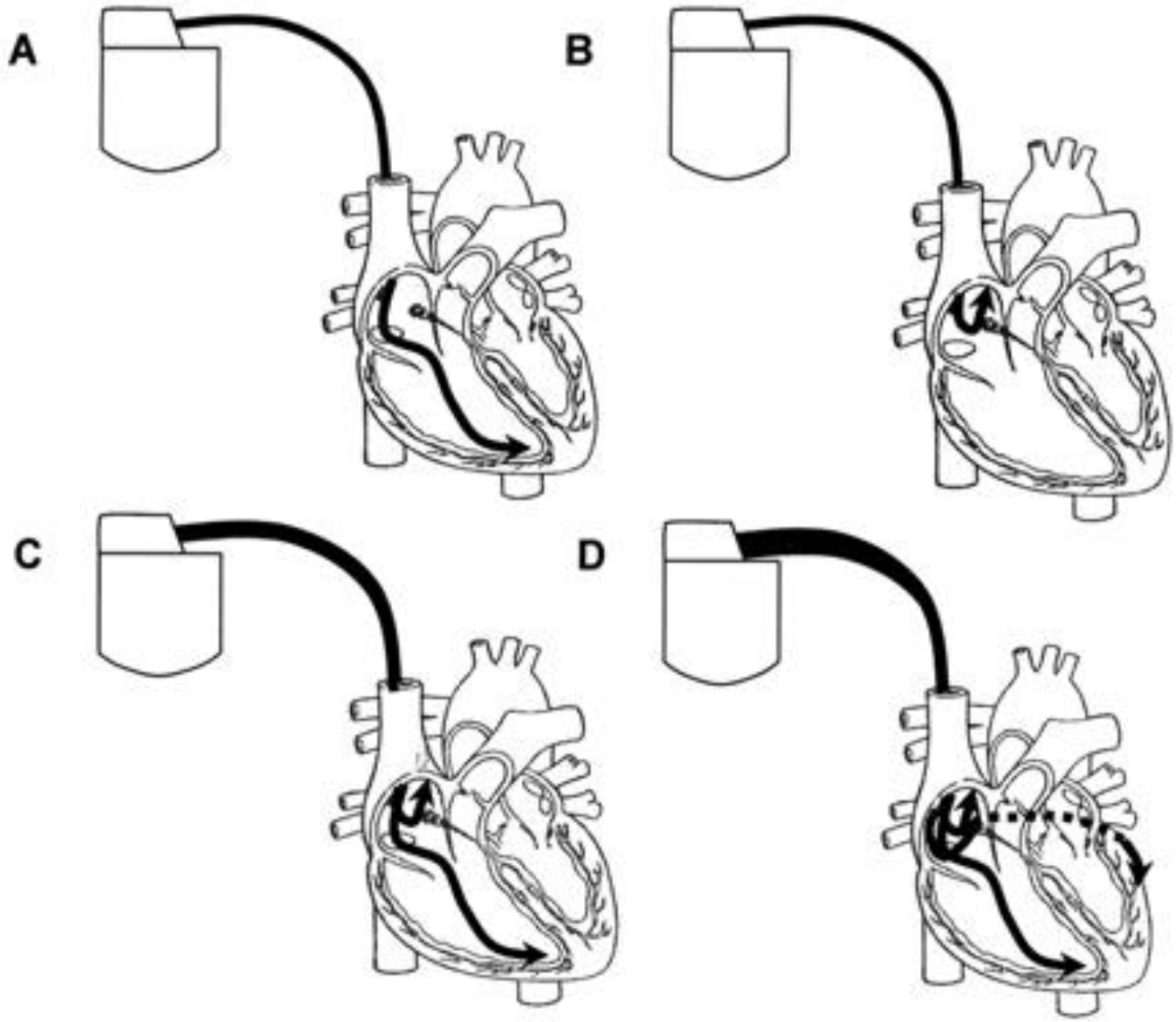
R = resistance (in ohm Ω)

Voltage

Current

Resistance


voltage U
V
current I
I
LEAD
According to Ohm's law :
R = VOLTAGE U (in volt) / CURRENT I (in ampere)
comprises :
* lead resistance
* tissue impedance
I
+
–
TISSUE
INSULATION DEFECT < 250Ω
NORMAL PACING IMPEDANCE ca. 500Ω
LEAD FRACTURE > 1000Ω

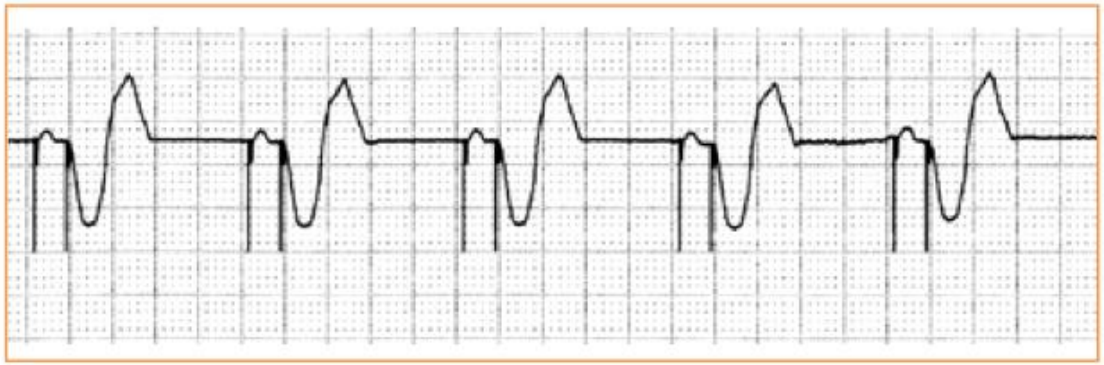

A
B
C
D

Asincrónico

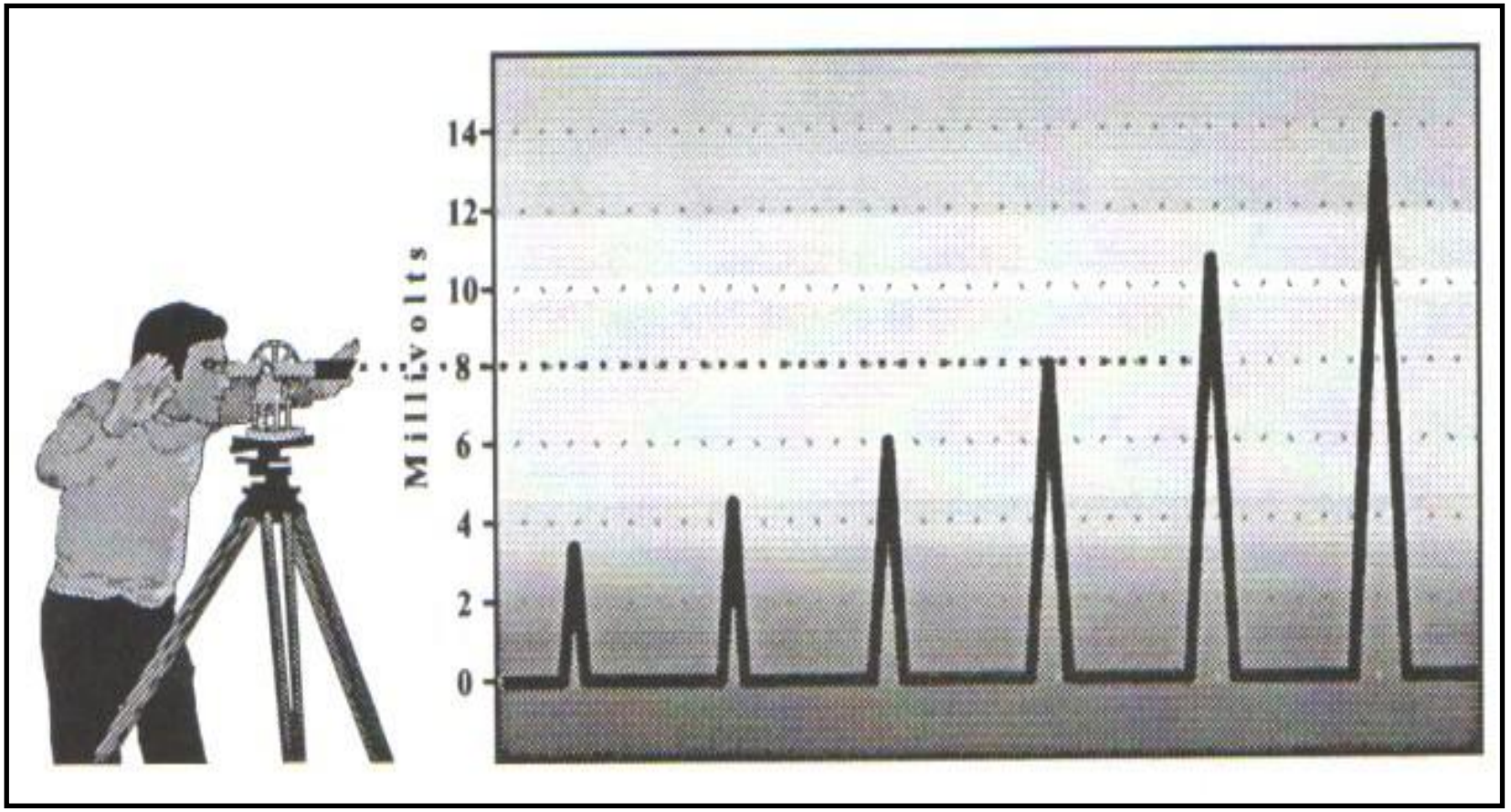
AOO

VOO

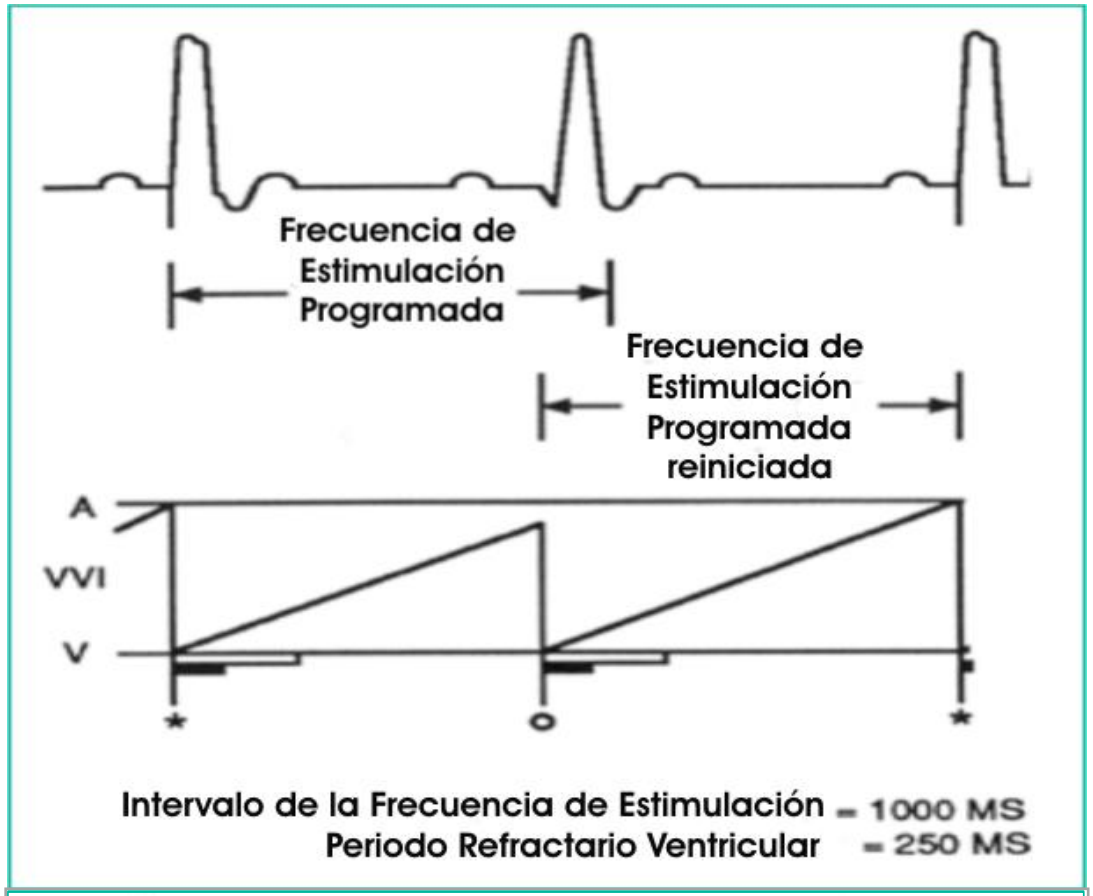
DOO



Sensibilidad



Demanda


Frecuencia de
Estimulación
Programada
Frecuencia de
Estimulación
Programada
reiniciada
A
VVI
V
Intervalo de la Frecuencia de Estimulación = 1000 MS
Periodo Refractario Ventricular = 250 MS

Código genérico para estimulación antibradicardia

I	II	III	IV	V
Cámara estimulada	Cámara sensada	Respuesta al sensado	Modulación de frecuencia	Estimulación multisitio
O = Ninguna	O = Ninguna	O = No	O = No	O = No
A = Aurícula	A = Aurícula	T = Estimula	R = Modulación de frecuencia	A = Aurícula
V = Ventrículo	V = Ventrículo	I = Inhibe		V = Ventrículo
D = Ambas (A+V)	D = Ambas (A+V)	D = Ambas (T+I)		D = En ambas (A+V)

Modificado de Bernstein AD. et al. The revised NASPE/BPEG generic code for antibradycardia, adaptive-rate, and multisite pacing. North American Society of Pacing and Electrophysiology/British Pacing and Electrophysiology Group. Pacing Clin Electrophysiol 2002 [1].

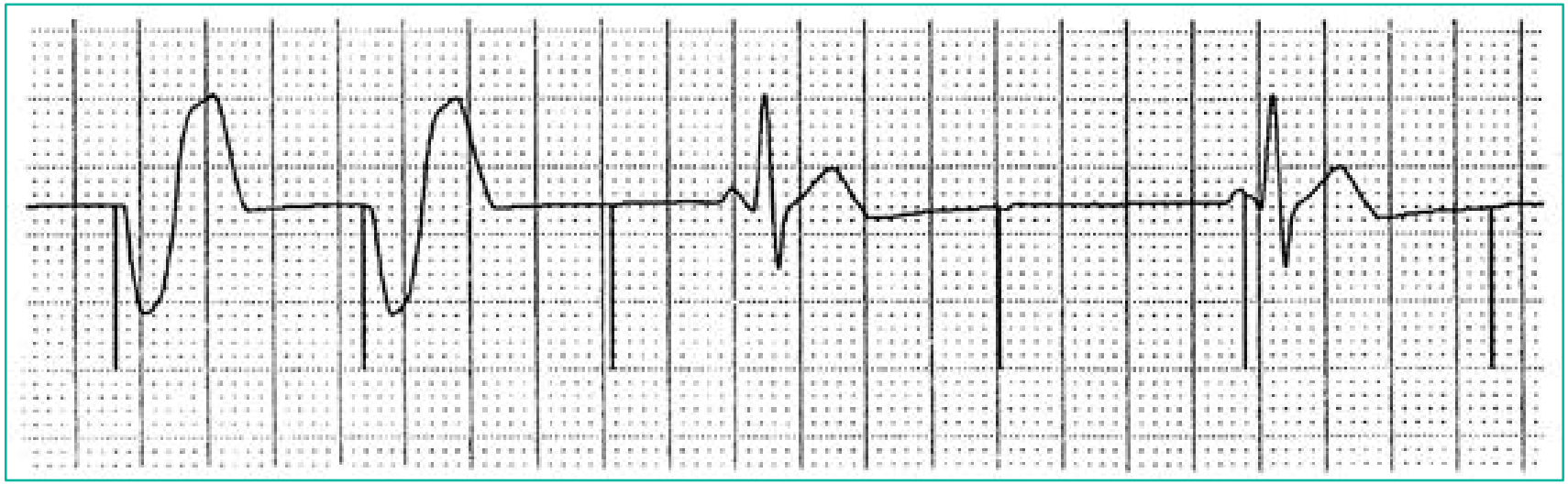
VOO en MCP
Apaga terapia en DAI

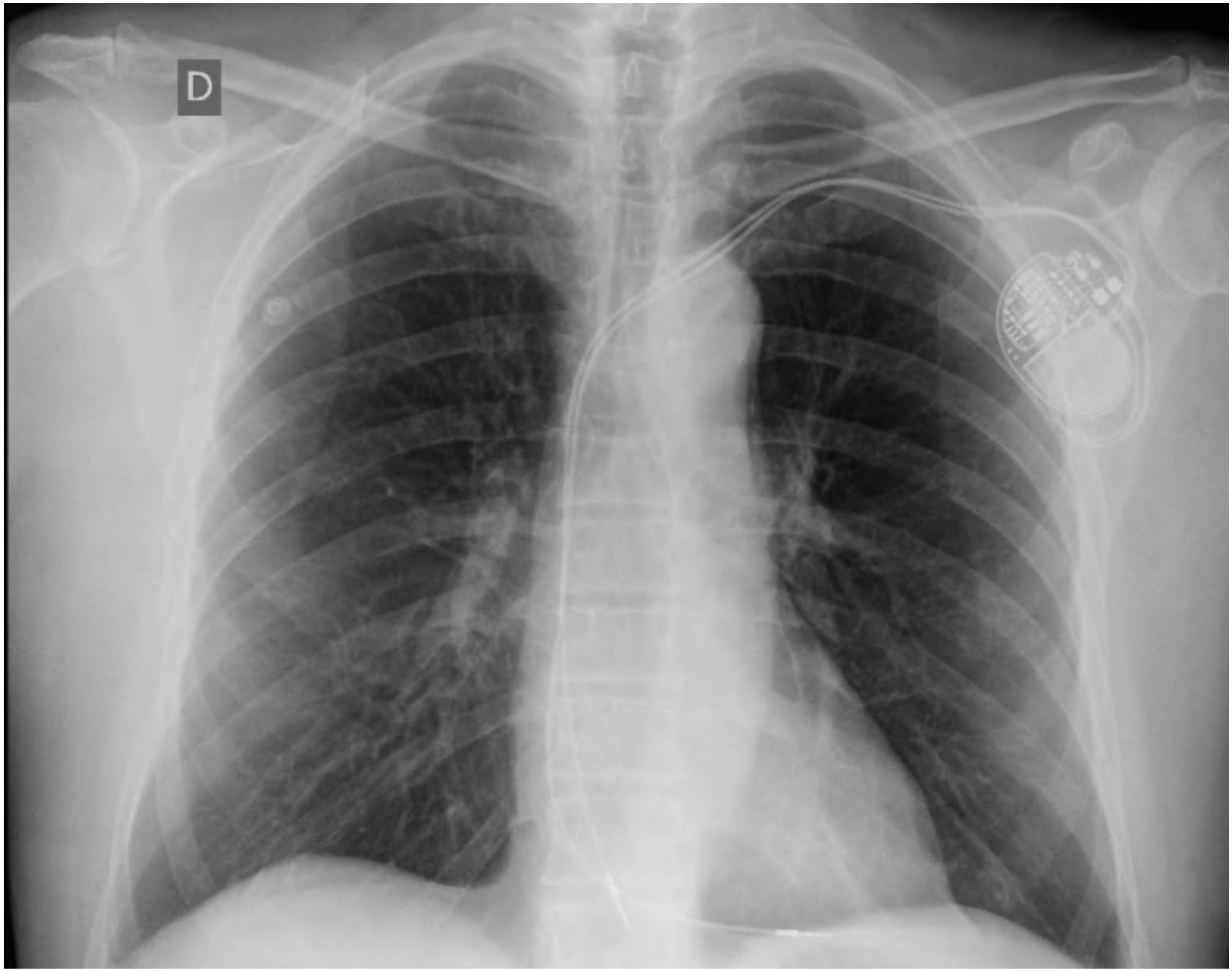
Problemas asociados a MCP

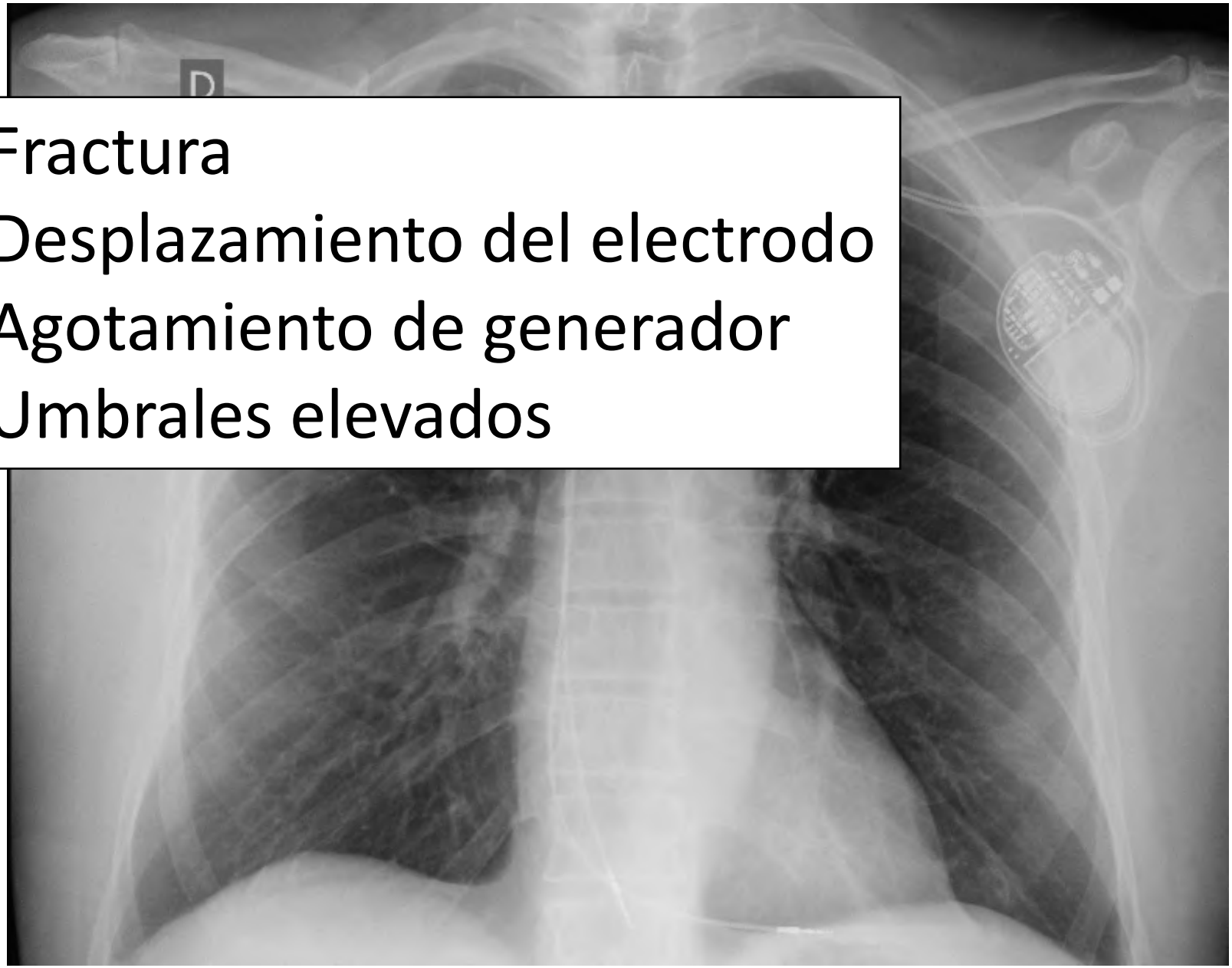

MUCHO.
MUCHO.
MUCHO.

Funcionamiento

Falla de captura

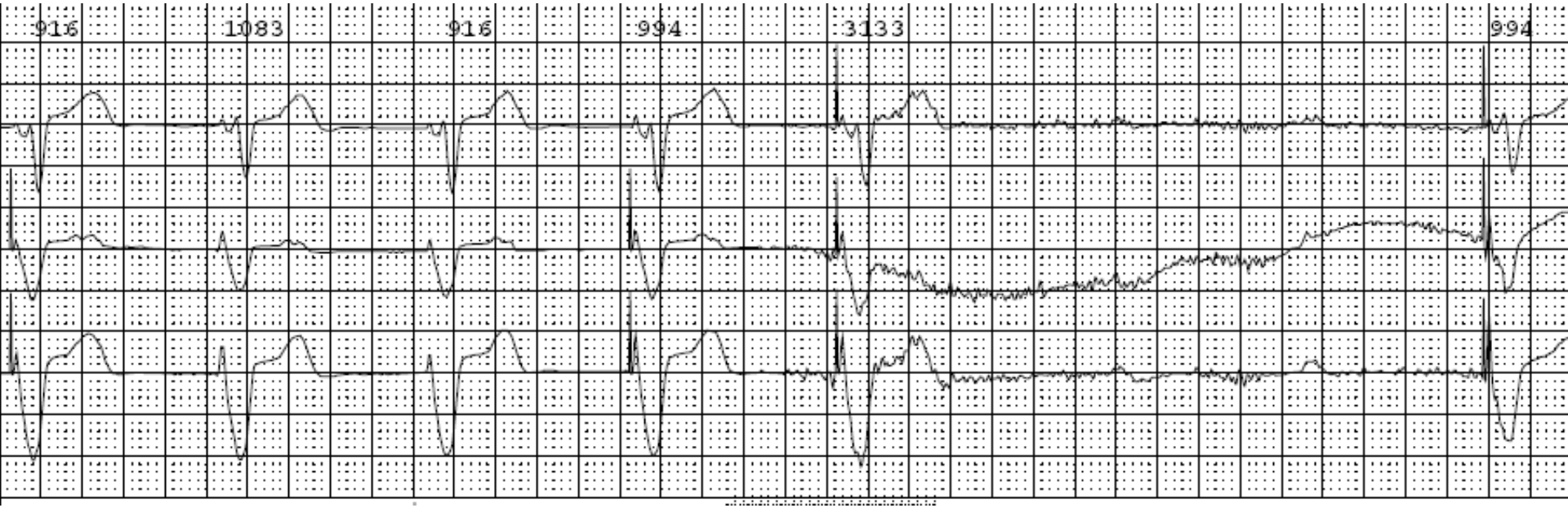



D

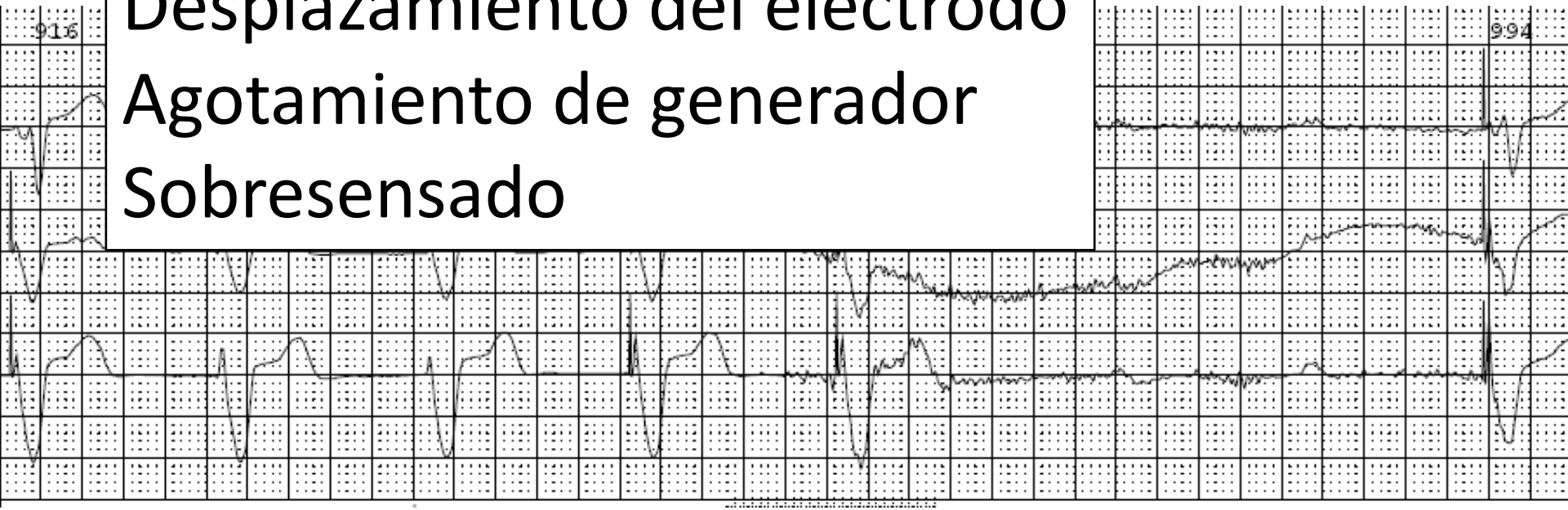


Fractura
Desplazamiento del electrodo
Agotamiento de generador
Umbrales elevados

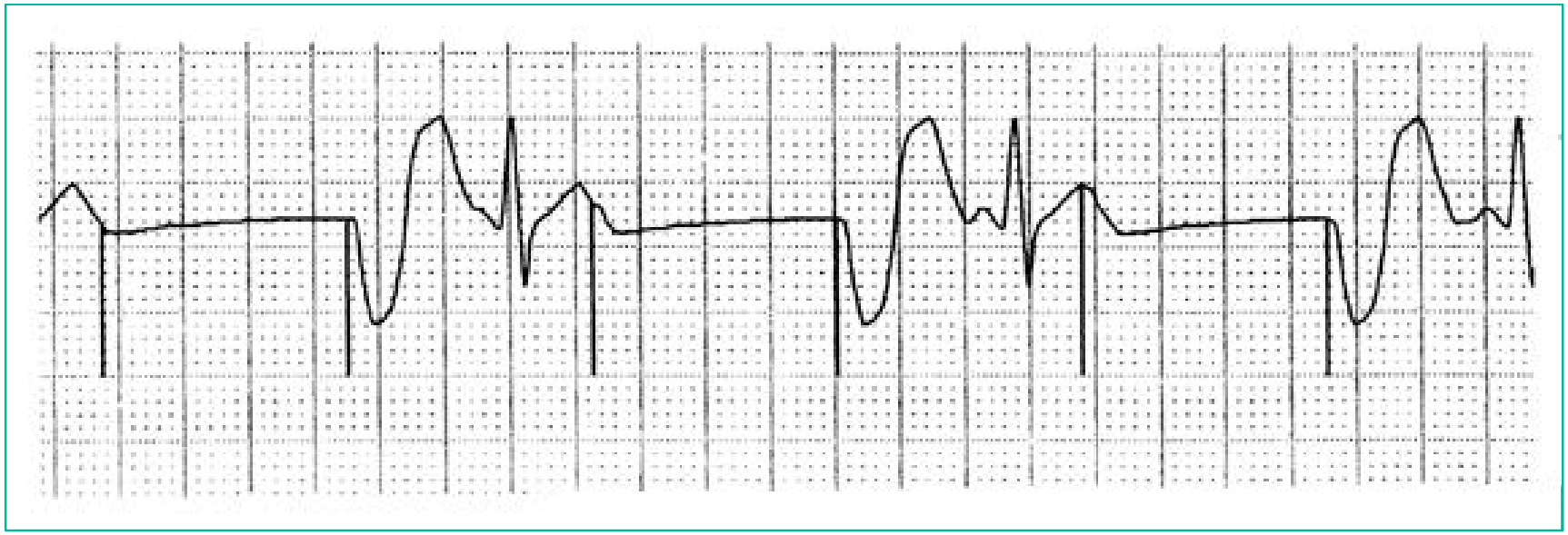
Falla de salida


916
1083
916
994
3133
994

Fractura
Desplazamiento del electrodo
Agotamiento de generador
Sobresensado

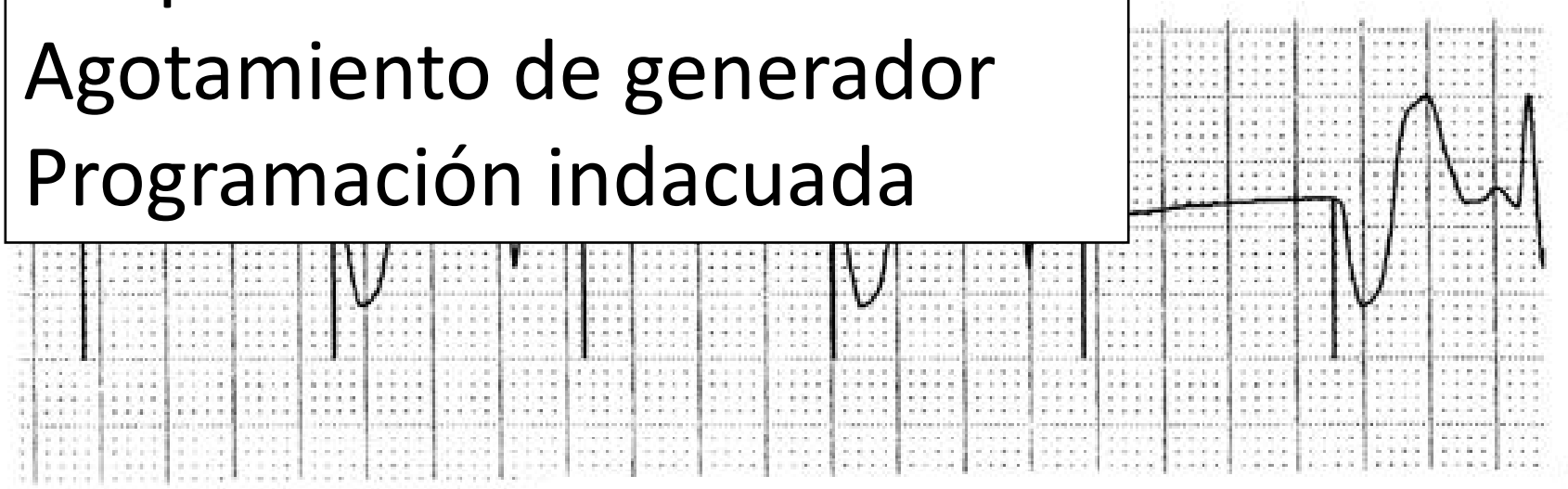


Subsensibilidad

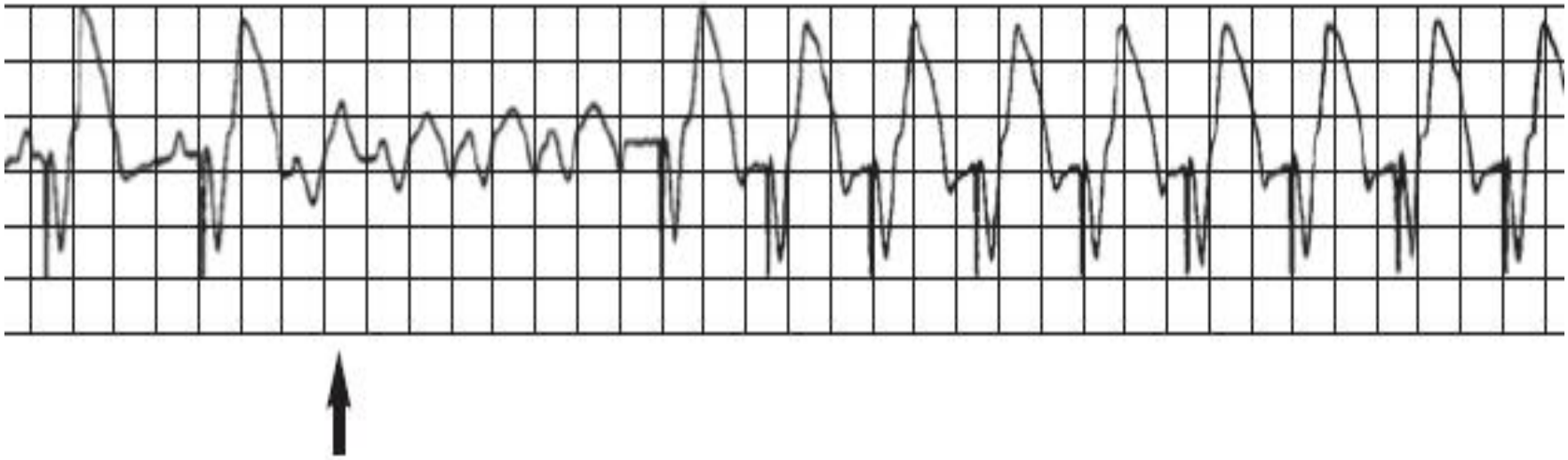


Subsensibilidad

Fractura
Desplazamiento del electrodo
Agotamiento de generador
Programación indacuada



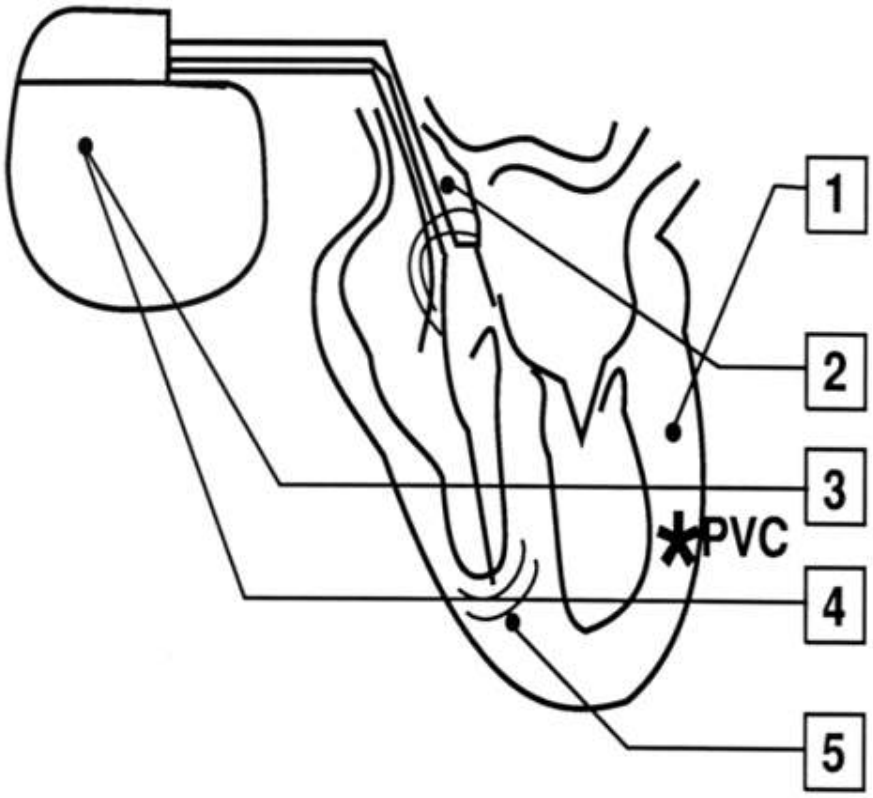
TMP



TPM

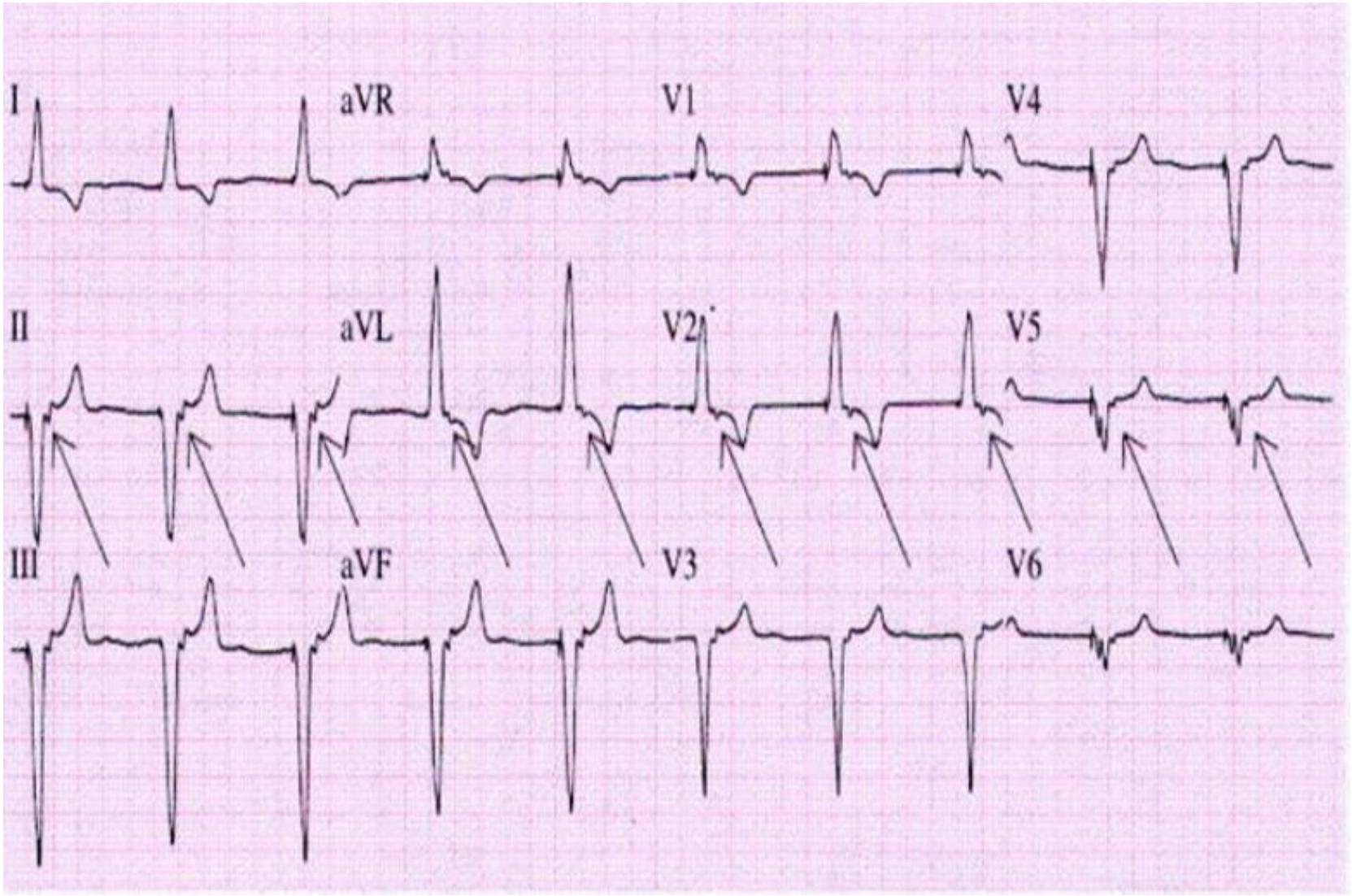
- Ocurre en MP bicamerales :
  - Tracking de una taquiarritmia auricular, FA o flutter atrial.
  - Conducción AV retrógrada (endless loop tachycardia).

Conducción Retrógrada

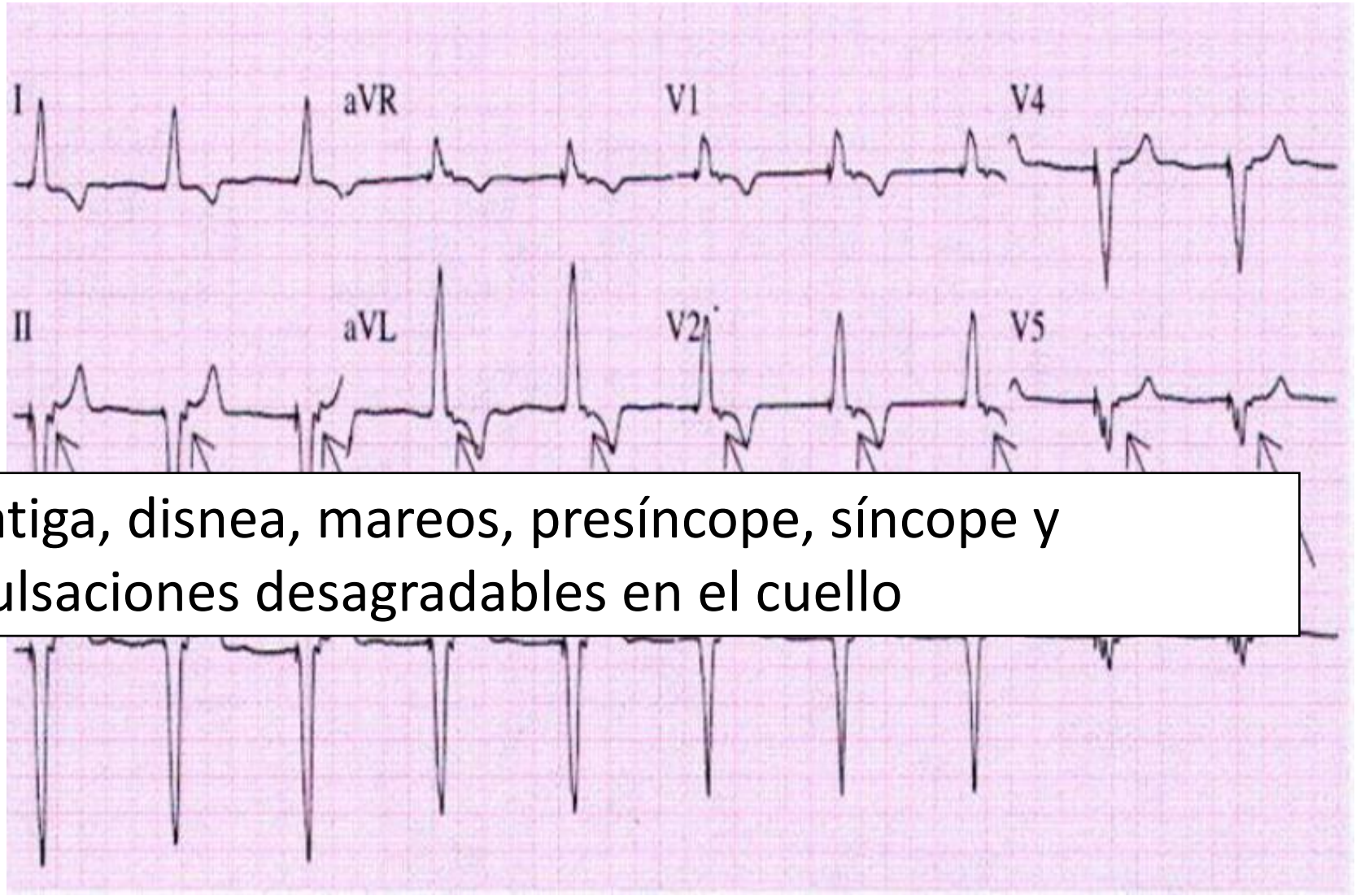


1. Pérdida del sincronismo AV debido a un extrasístole ventricular (EV)
2. Activación del sensado retrógrado
3. Intérvalo A-V iniciado
4. Prolongación del intervalo A-V
5. Estimulación ventricular sincronizada a las ondas P retrógradas

Sd. MCP

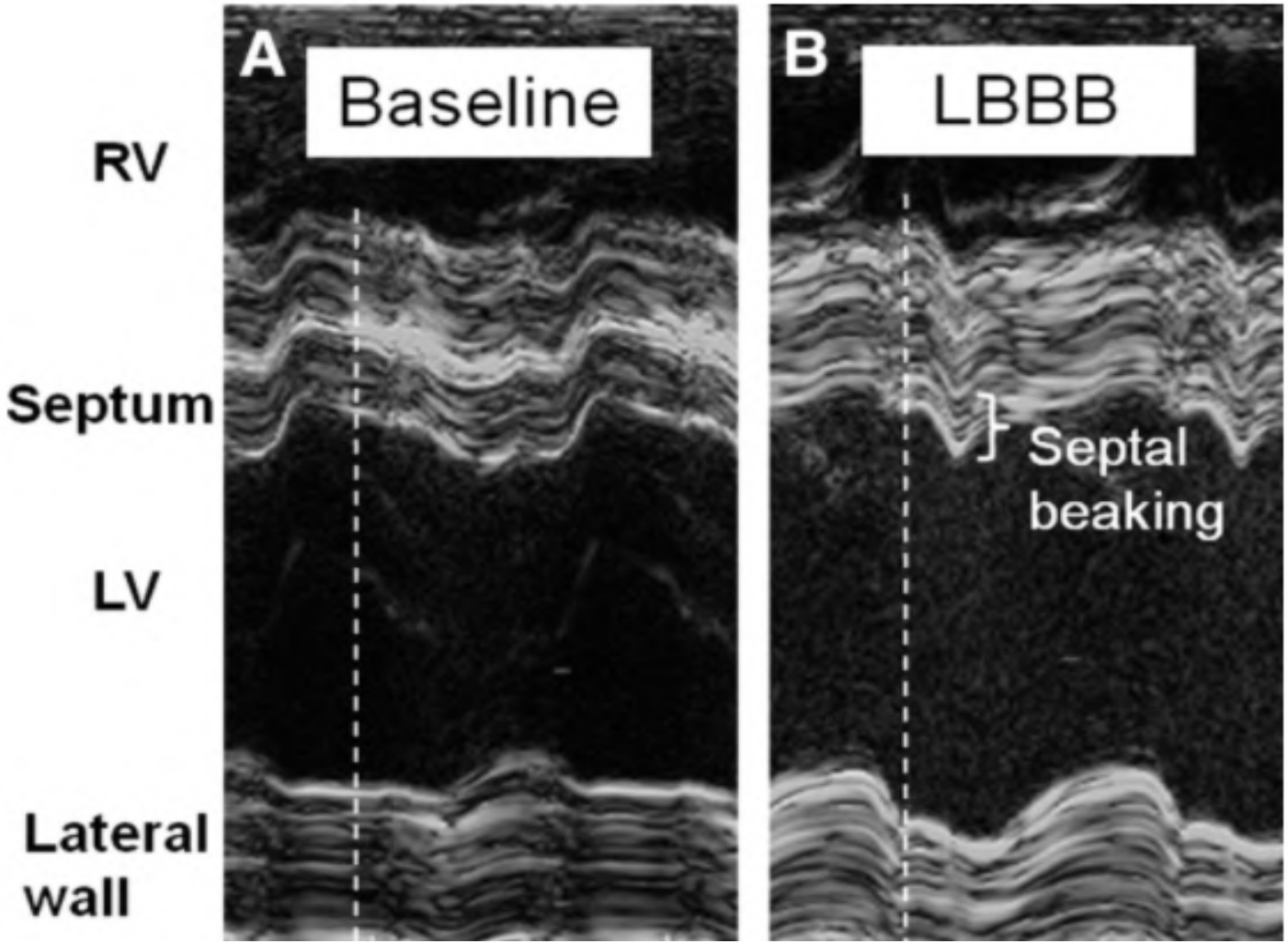


Sd. MCP



Fatiga, disnea, mareos, presíncope, síncope y pulsaciones desagradables en el cuello

Miocardiopatía por MCP



Miocardiopatía por MCP

- RCTs con estimulación crónica aVD (independientes de la sincronía AV):

→ Aumento de incidencia FA

→ Aumento de incidencia de **ICC/Hospitalización por ICC**

→ Aumento incidencia de **Disfunción Sistólica VI**

Nielsen JC, Circulation 1998; 97:987-995

Nielsen JC, JACC 2003;42:614-623

Sweeney MO, Circulation 2003; 23:2932-2937

- Estimulación aVD durante terapia con ICD:

→Tendencia a mayor riesgo de arritmias ventriculares y M°CV

Steinberg JS, J Cardiovasc Electrophysiol.2005;16:359-365

DAVID Trial. JAMA 2002;288:3115-3123

FIN

Muchas gracias!