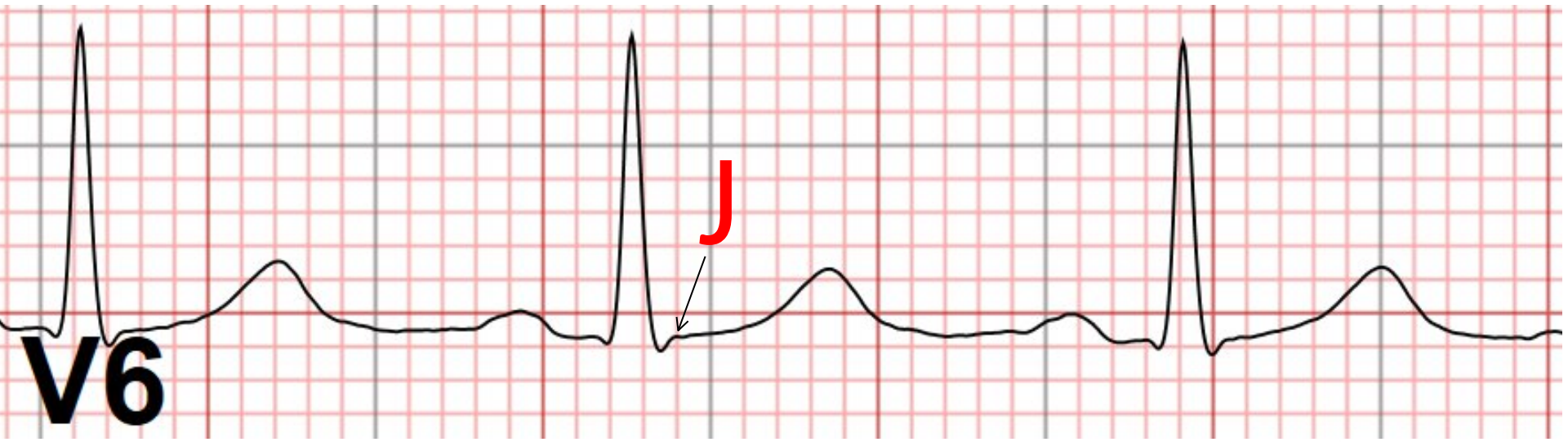
Anomalie di ripolarizzazione nel soggetto giovane: diagnosi differenziali e corretti percorsi diagnostici

G. Bagliani

Scuola di Specializzazione in Malattie Apparato Cardiovascolare
Università Politecnica delle Marche

Clinica di Cardiologia e Aritmologia
Ospedali Riuniti Ancona –
Direttore: Prof. Antonio Dello Russo



Normal Ventricular Repolarization and QT Interval

Ionic Background, Modifiers, and Measurements

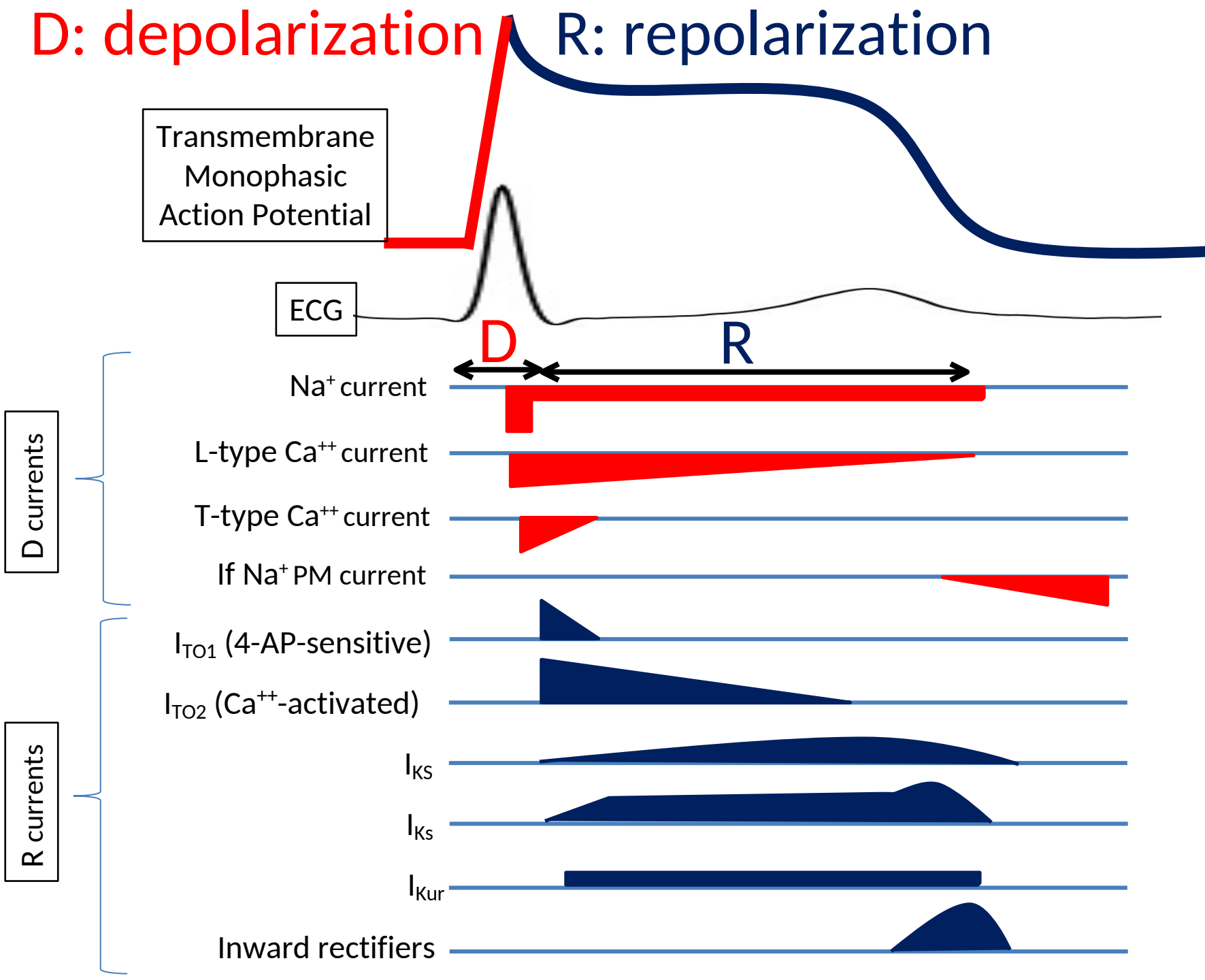
Emanuela T. Locati, MD, PhD[a,*], Giuseppe Bagliani, MD[b,c], Luigi Padeletti, MD[d,e]

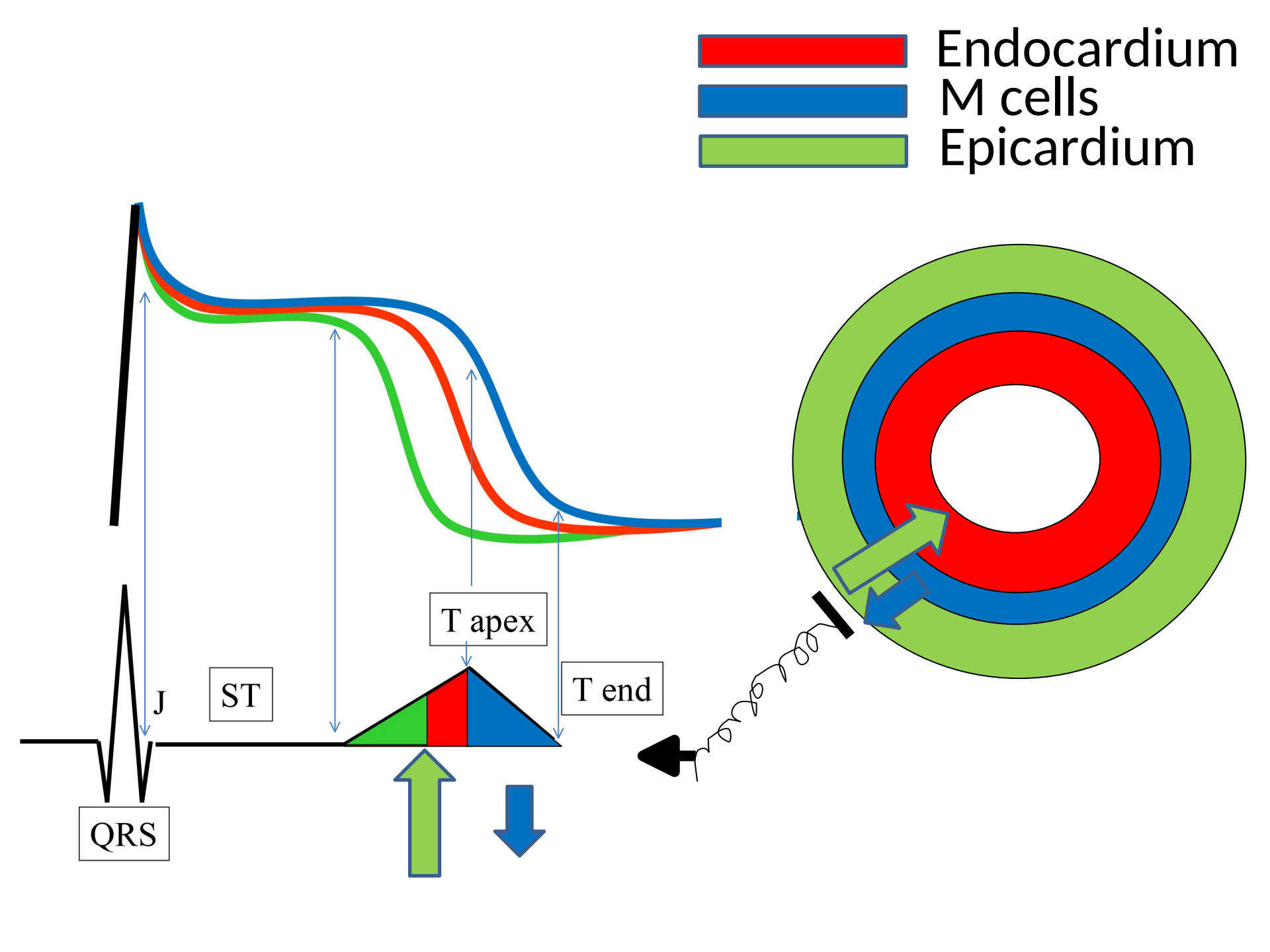
KEYWORDS

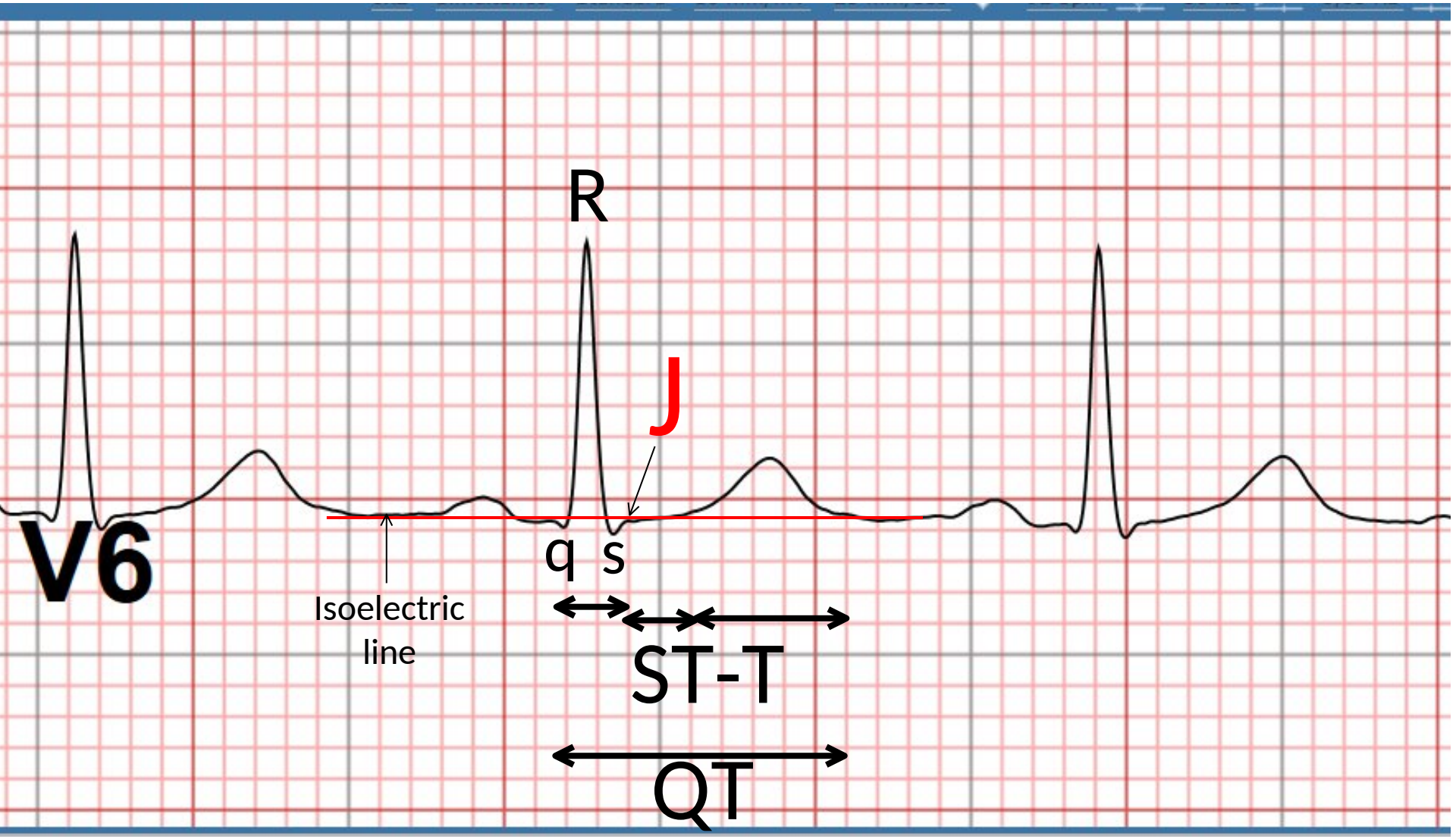
• Ventricular repolarization • QT interval • J point • ST segment • T wave • U wave • Electric memory • T wave alternans

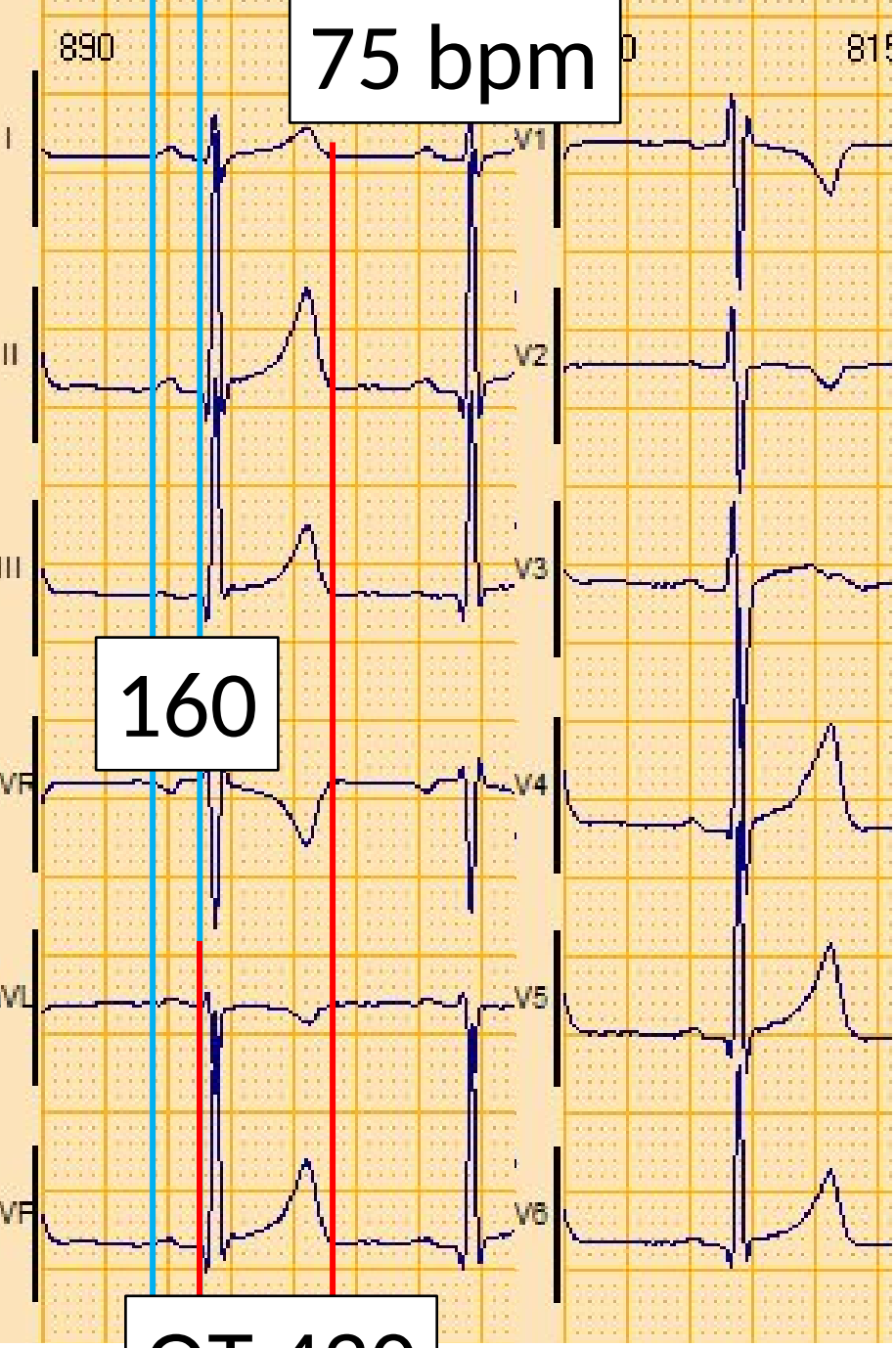
KEY POINTS

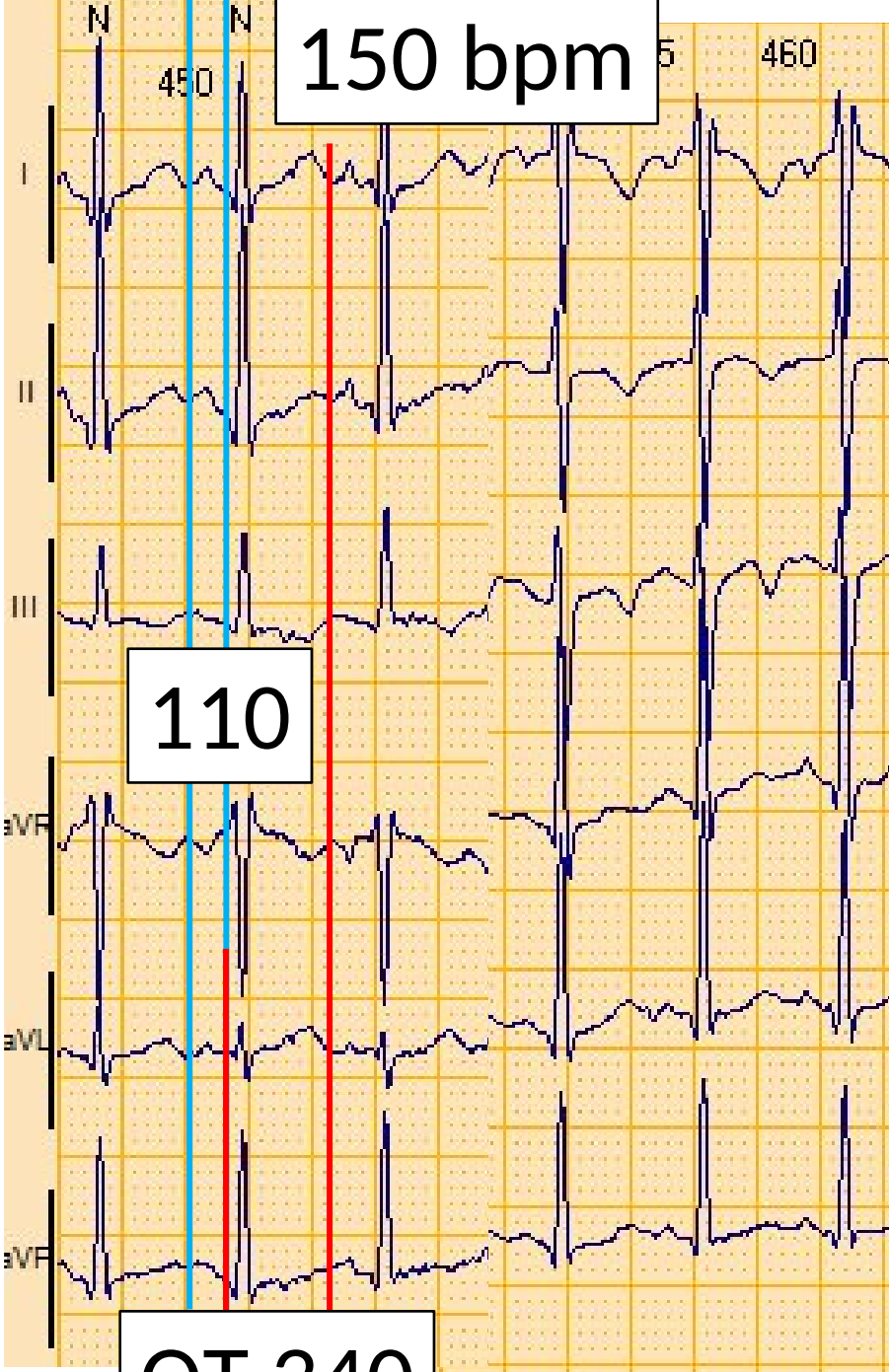
- Ventricular repolarization is a cellular electrophysiological process expressed in the electrocardiogram as the QT interval.
- Intramural differences in the ventricular repolarization are at the base of ST and T waves in the electrocardiogram.
- The QT interval is variable, and many factors affect its duration: heart rate, autonomic nervous activity, age, and gender are the main determinants.
- Many criteria correct the duration of QT interval for heart rate.
- Conditions provoking repolarization abnormalities (QT prolongation) are ionic changes, drugs, cardiac/noncardiac diseases, and genetic background (long QT syndromes).


D: depolarization
R: repolarization
Transmembrane Monophasic Action Potential
ECG
D
R
Na+ current
L-type Ca++ current
T-type Ca++ current
If Na+ PM current
D currents
ITO1 (4-AP-sensitive)
ITO2 (Ca++-activated)
IKS
IKs
IKur
Inward rectifiers
R currents


Endocardium
M cells
Epicardium
J
ST
T apex
T end
QRS


R
J
V6
q
s
Isoelectric
line
ST-T
QT

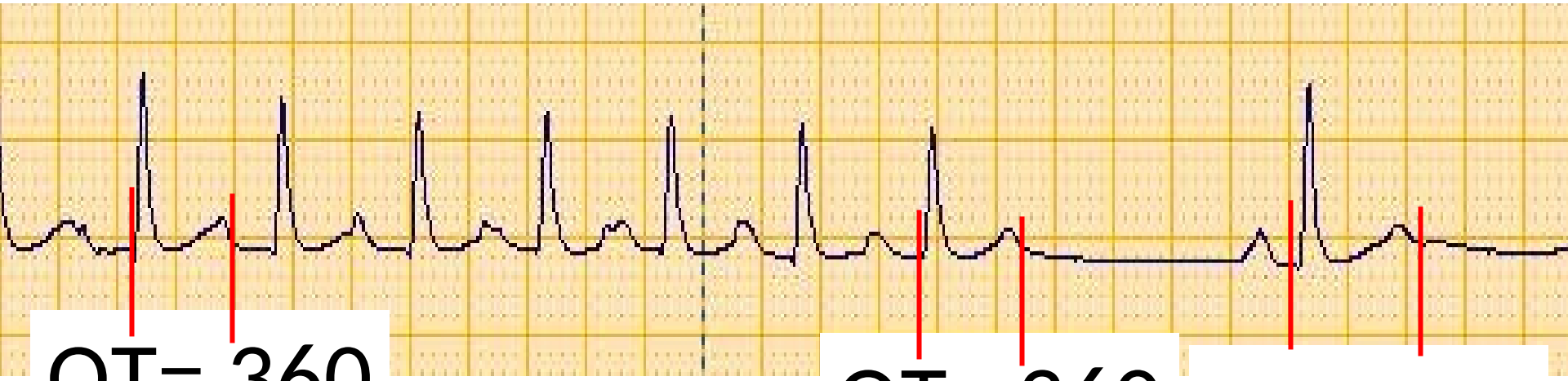

75 bpm
160
QT 420


150 bpm
110
QT 340

Dinamicità della Ripolarizzazione Ventricolare

cità del miocardio di variare la refrattarietà (QT) in base alla freq

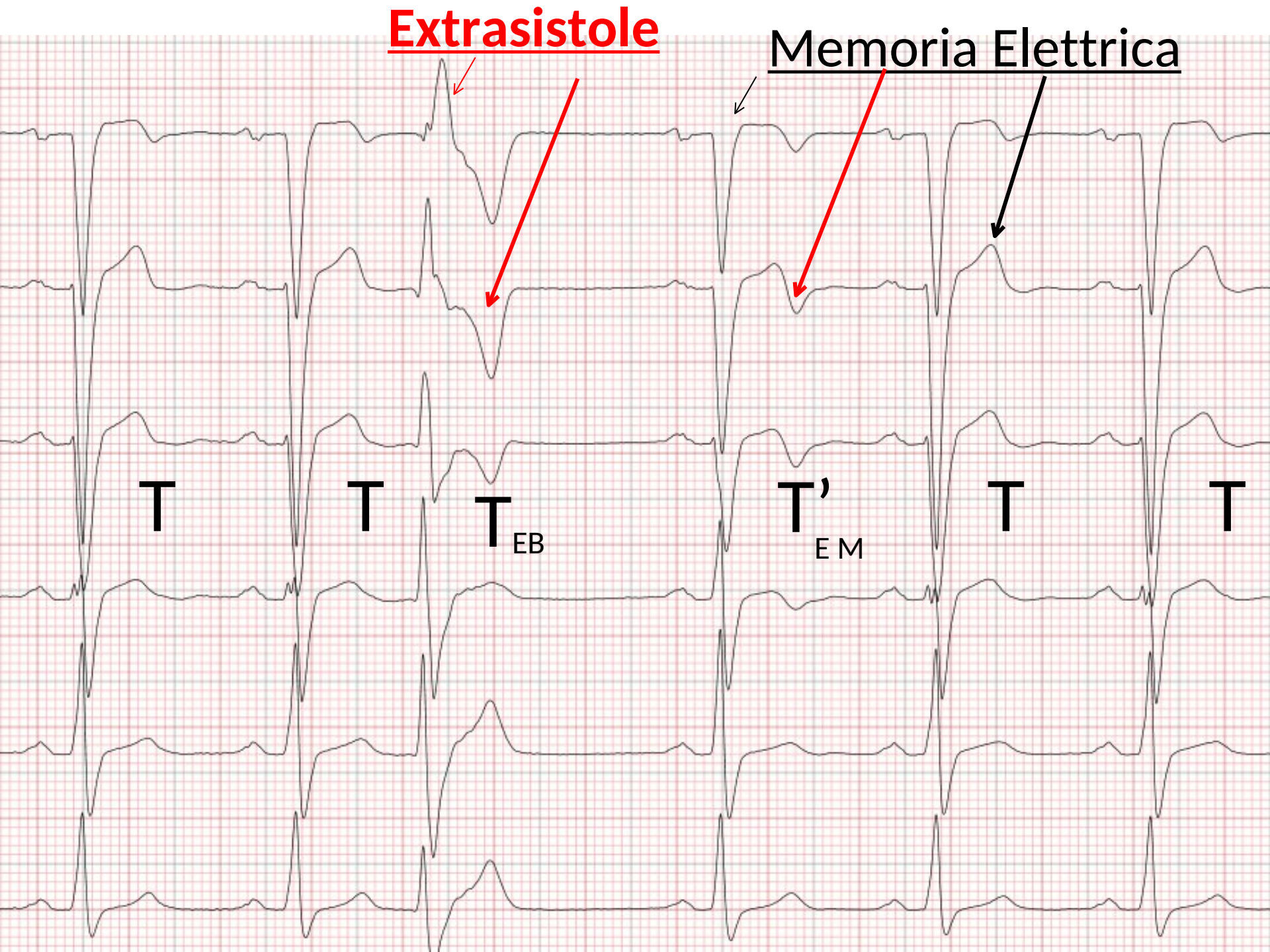
QT= 560

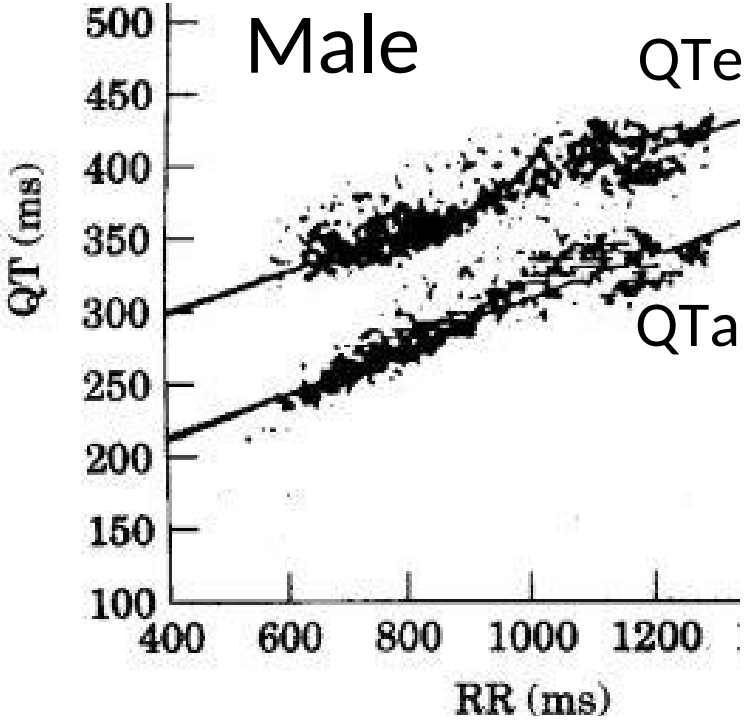


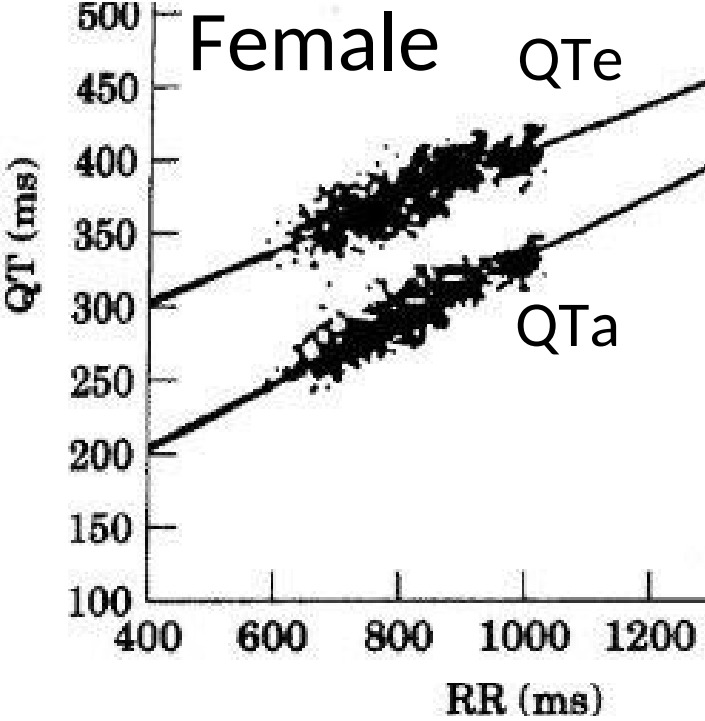
QT= 360

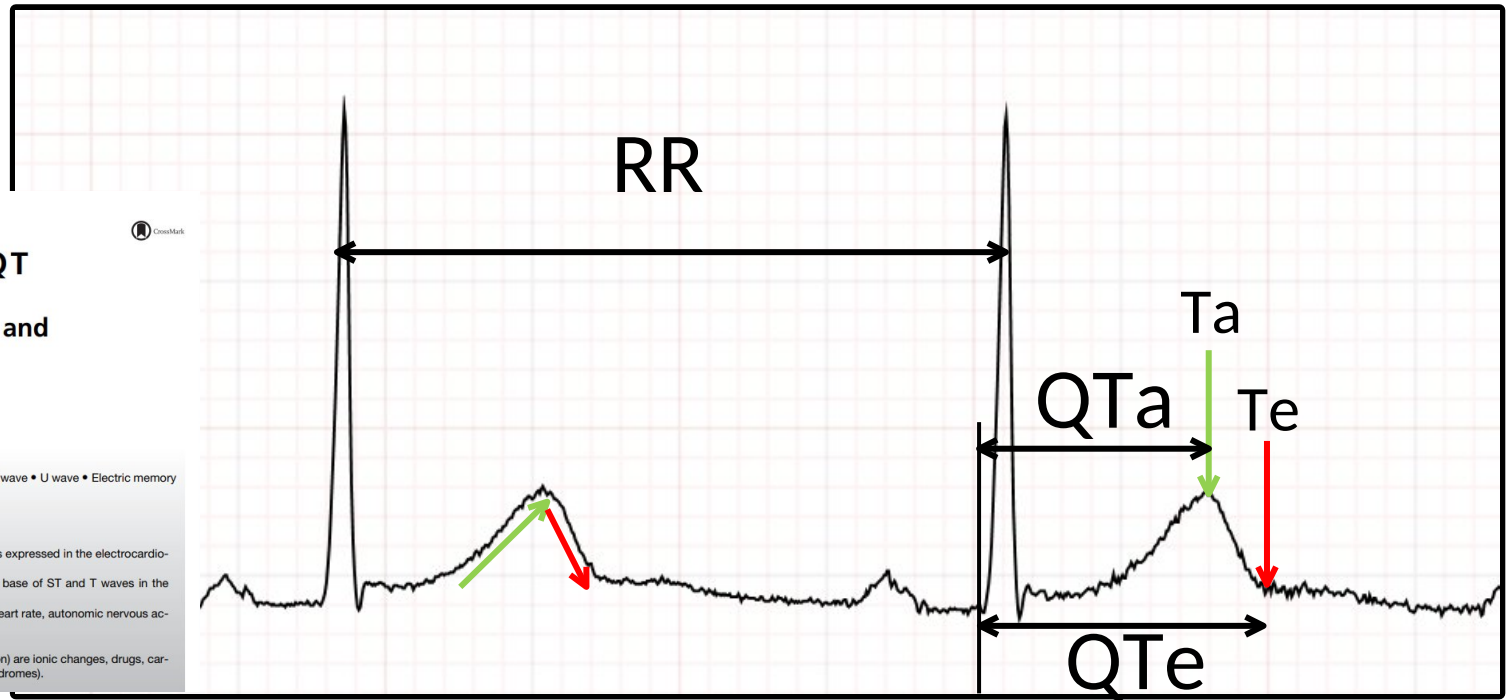
QT= 360

QT= 440


Extrasistole
Memoria Elettrica
T
T
T EB
T' E M
T
T







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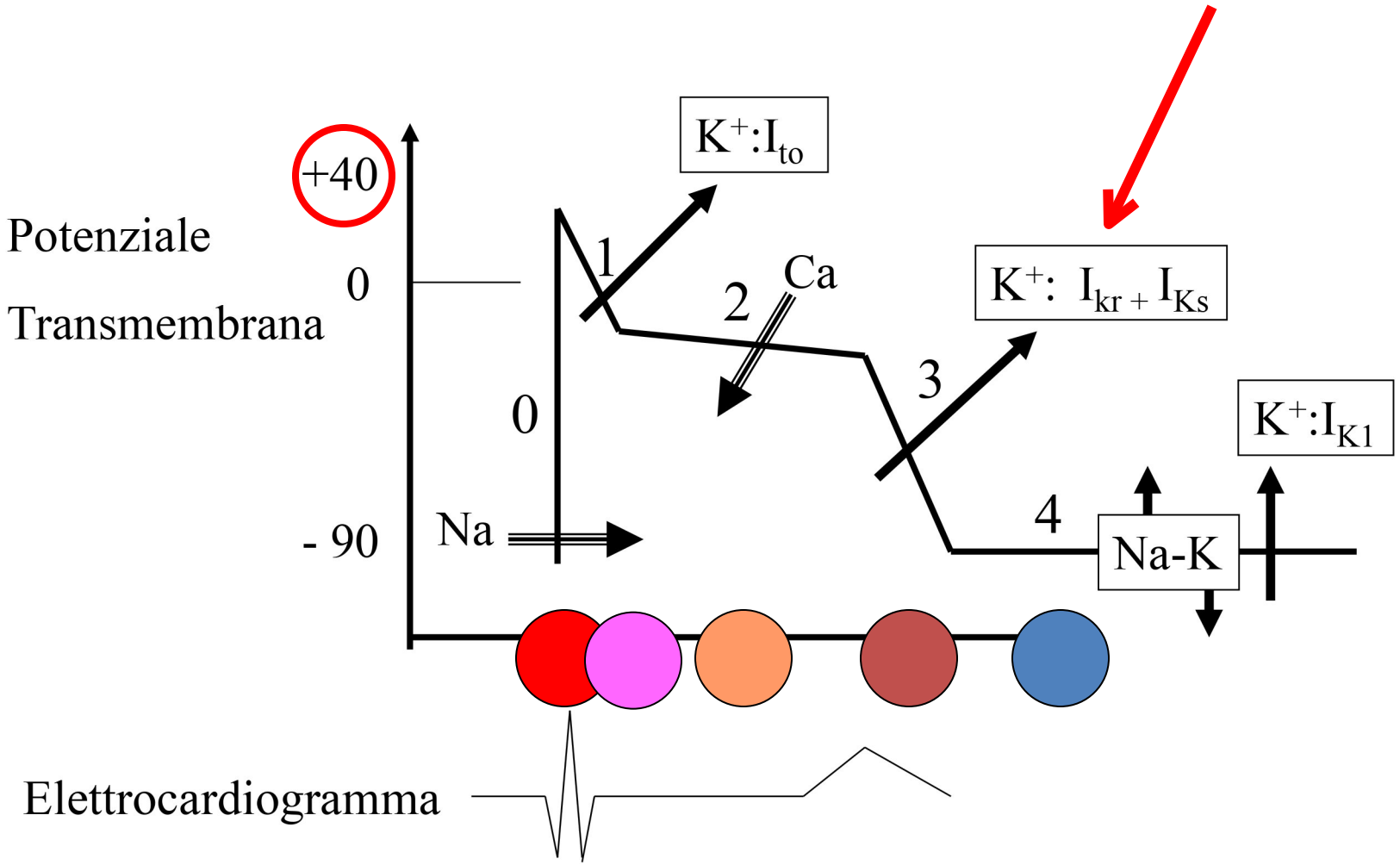
Ruolo Principale del Potassio nel determinismo della Ripolarizzazione Ventricolare



Come correggere il QT per la frequenza cardiaca

il QTc

Come definire un QT Normale? In valore assoluto e corretto per la frequenza cardiaca

Table 1
Correction formula for rate-adjusted QT interval

Name of the Formula	Correction Formula
Bazett	$QT_c = QT/\sqrt{RR}$
Fridericia	$QT_f = QT/\sqrt[3]{RR}$
Linear	$QT_l = QT + a\,(1\text{-}RR)$
Exponential	$QT_e = QT - be^{-k1000} - e^{-kRR}$
Prediction	$QTp\ (ms) = 65.600/(100 + \text{heart rate})$

QTc

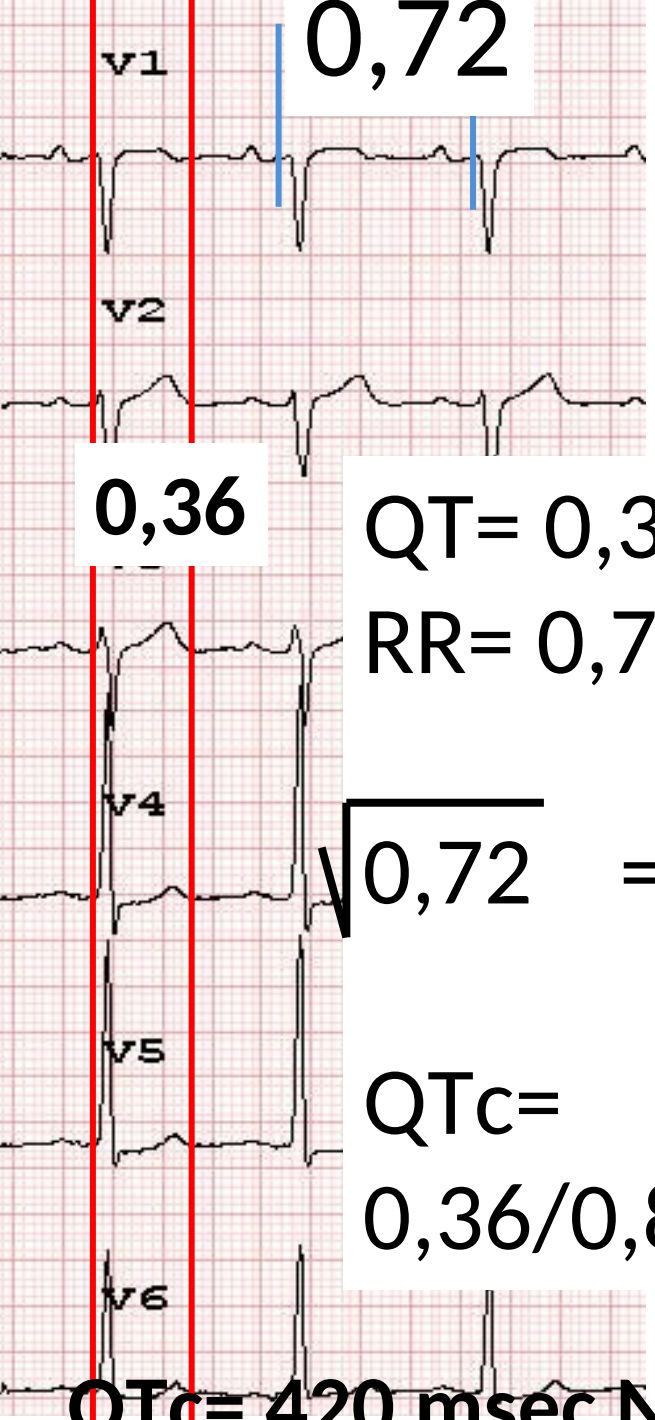
QT corretto per la frequenza cardiaca

La formula di Bazett: $QTc = QT / \sqrt{RR}$

- **Il QTc fornisce il limite superiore di normalità:**
- **440 msec per uomo**
- **460 msec per donna**

NB: notoriamente la Bazett's
- soprastima alle alte frequenze (falso QT lungo)
- sottostima alle basse frequenze (falso QT normale)

Alcuni esempi di calcolo:
ricordare di fare le misure in secondi



0,72

0,36

QT= 0,36 sec

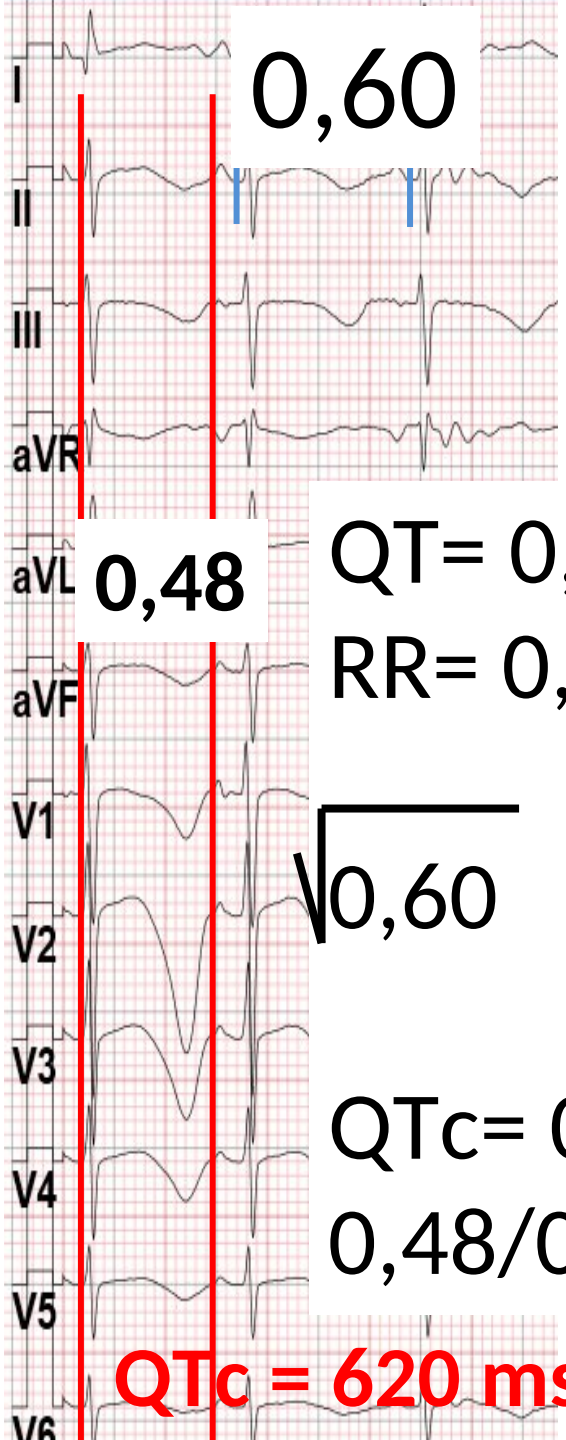
RR= 0,72 sec

$\sqrt{0,72}$ = 0,84

QTc=

0,36/0,84=**0,42**

QTc= 420 msec NORMALE



0,60

0,48

QT= 0,480 sec

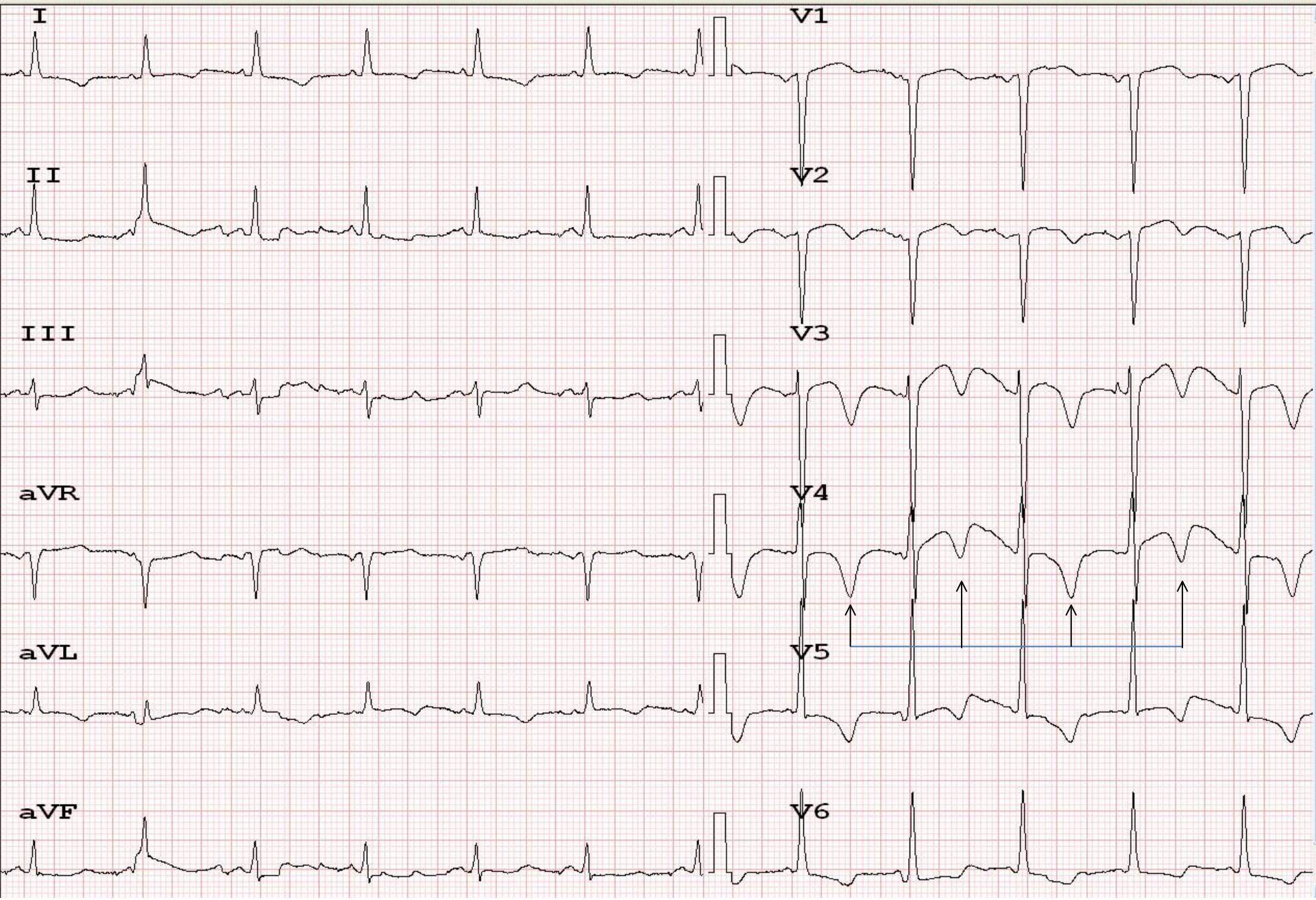
RR= 0,600 sec

$\sqrt{0,60}$ = 0,77

QTc= 0,62

0,48/0,77=**0,62**

QTc = 620 msec LUNGO


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

Quale è il problema?

Analisi della Ripolarizzazione

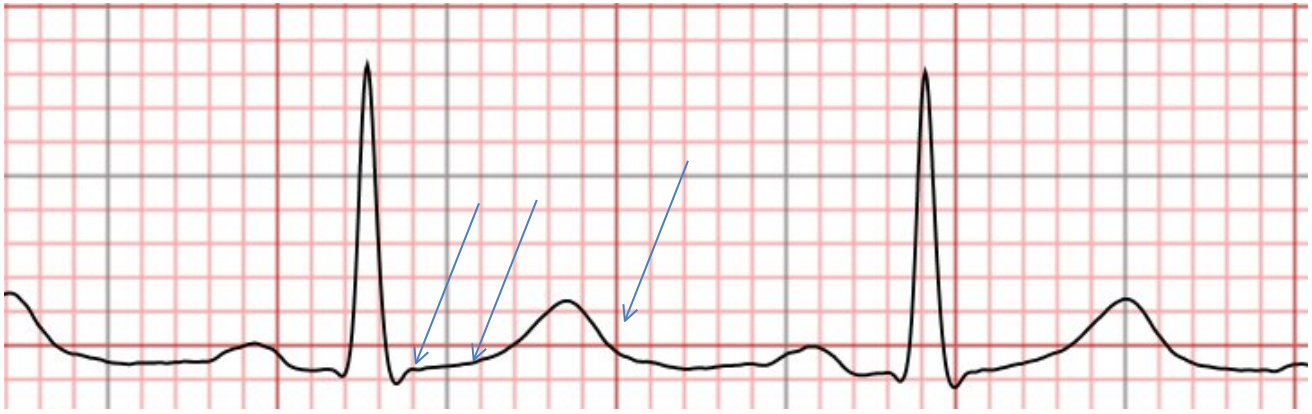
come strumento diagnostico di Cardiopatie

a) Ischemia
b) Miocardiopatia
c) Miocarditi

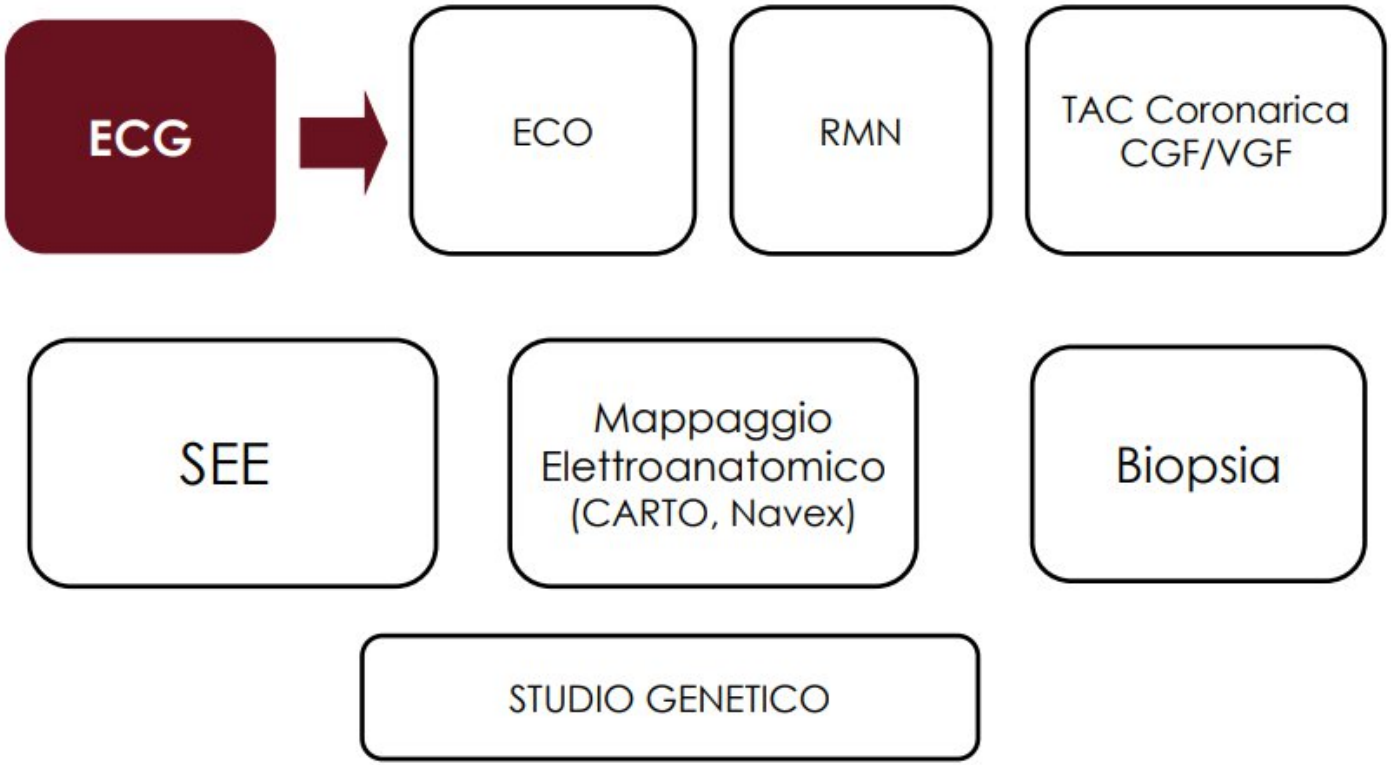
……

Studio delle Canalopatie Aritmogene

a) J Syndromes
b) TV Polimorgica Catecolaminergica
c) LQTS: QT lungo
d) SQTS: QT corto



Percorsi diagnostici nel sospetto di patologie complesse



Nome:

Farmaci:

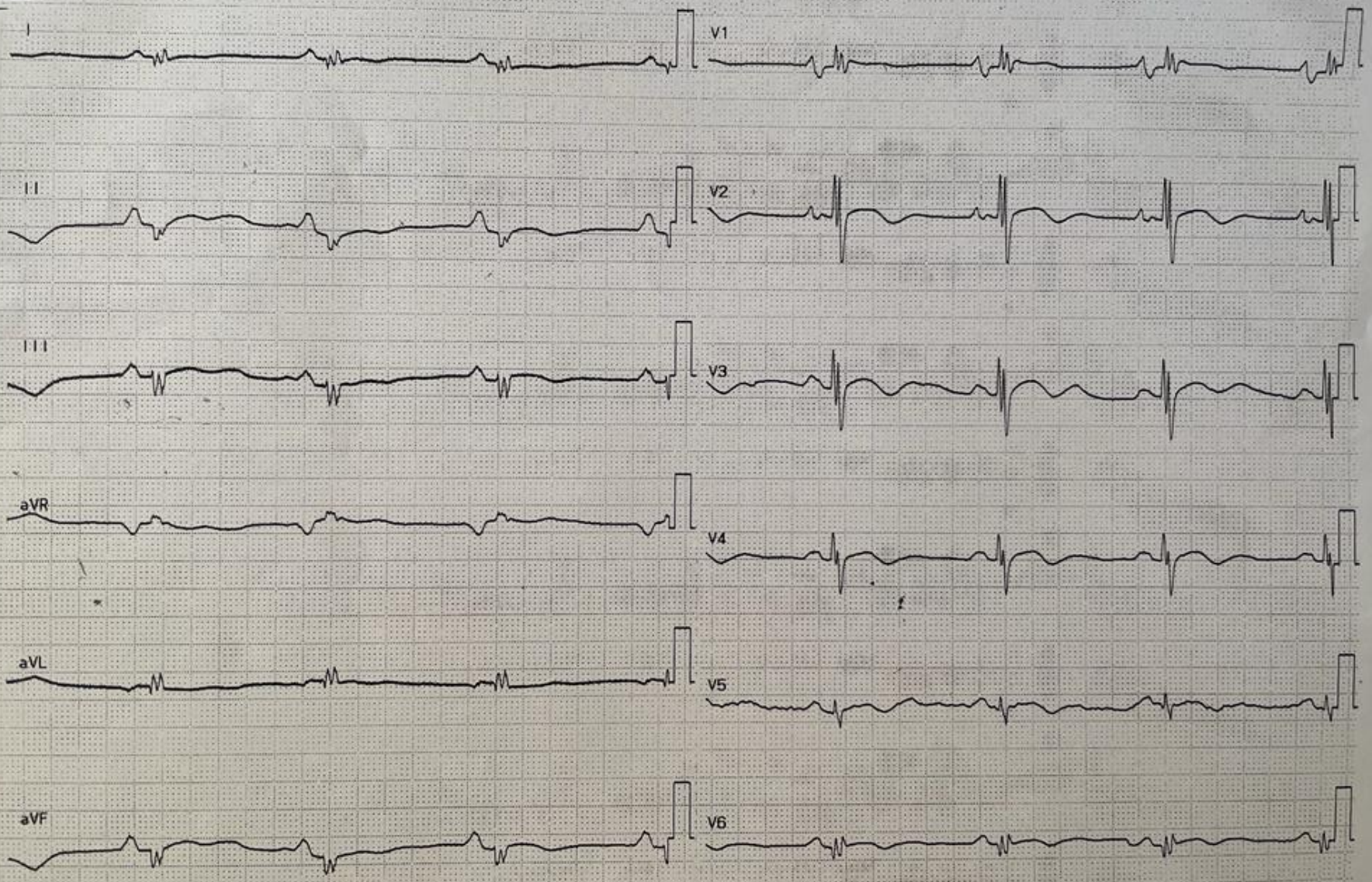
Sesso:M Data di nascita: Anni cm kg / mmHg 48 bpm

Sintomi:

Anamnesi:

10 mm/mV 25 mm/s Filtri: H50 d 100 Hz 10 mm/mV

esale



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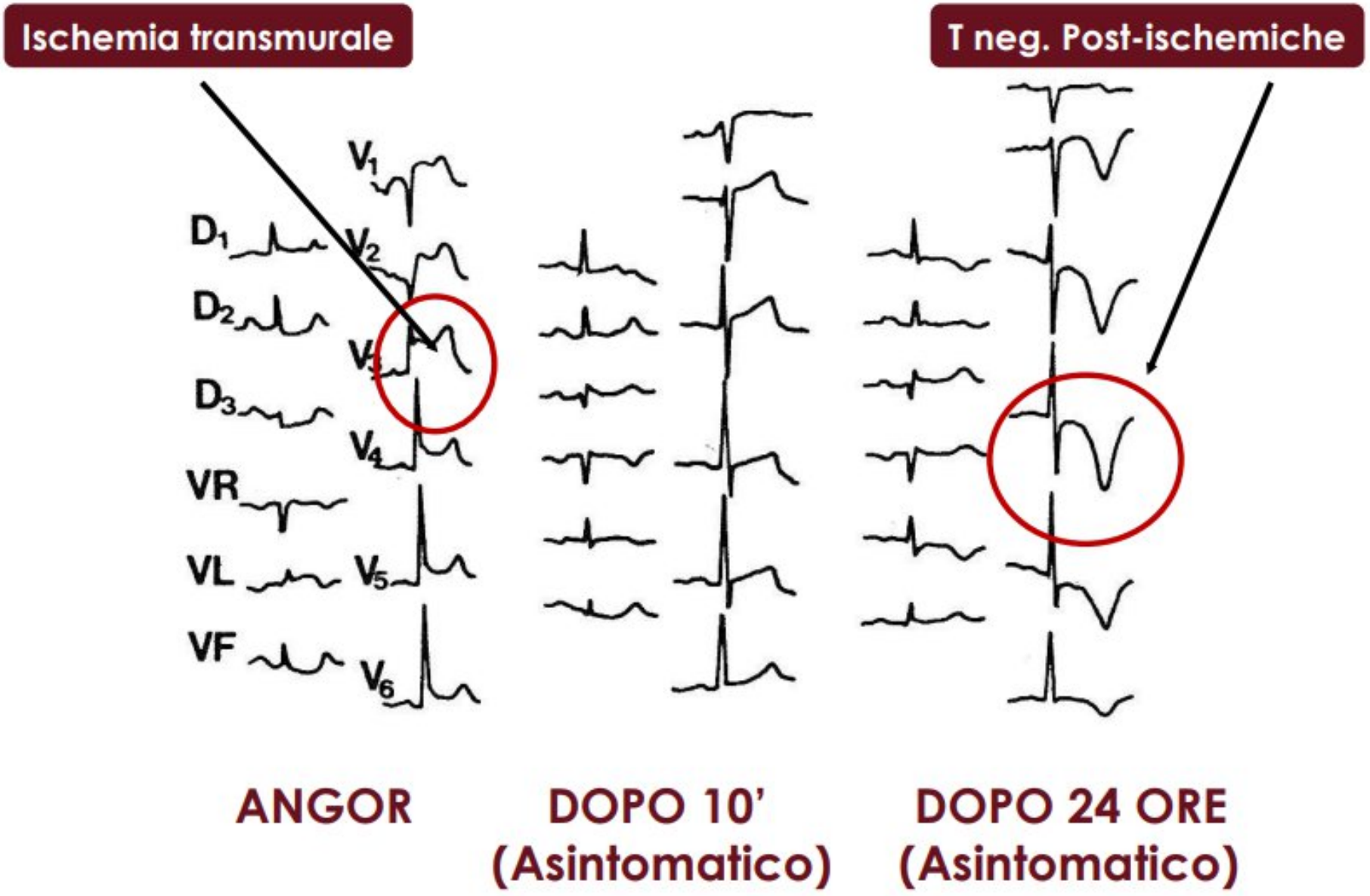
Osp.:


Ischemia transmurale
T neg. Post-ischemiche
D1
D2
D3
VR
VL
VF
V1
V2
V3
V4
V5
V6
ANGOR
DOPO 10'
(Asintomatico)
DOPO 24 ORE
(Asintomatico)

Programma congresso
Sabato 1 Ottobre 2022

11.30 - 12.40

PREVENIRE LA MORTE IMPROVVISA

Moderatori: V. Castelli, Roma - F. Quaranta, Roma - F. Sperandii, Piacenza

I bassi voltaggi del QRS negli sportivi: quali implicazioni cliniche?
M. Tatangelo, Roma

Ripolarizzazione precoce: quali soggetti a rischio
E. Toso, Torino

Extrasistolia ventricolare nell'atleta: dall'ECG al substrato
M. De Lazzari, Padova

Anomalie di ripolarizzazione nel soggetto giovane: diagnosi differenziali e corretti percorsi diagnostici
G. Bagliani, Foligno - PG

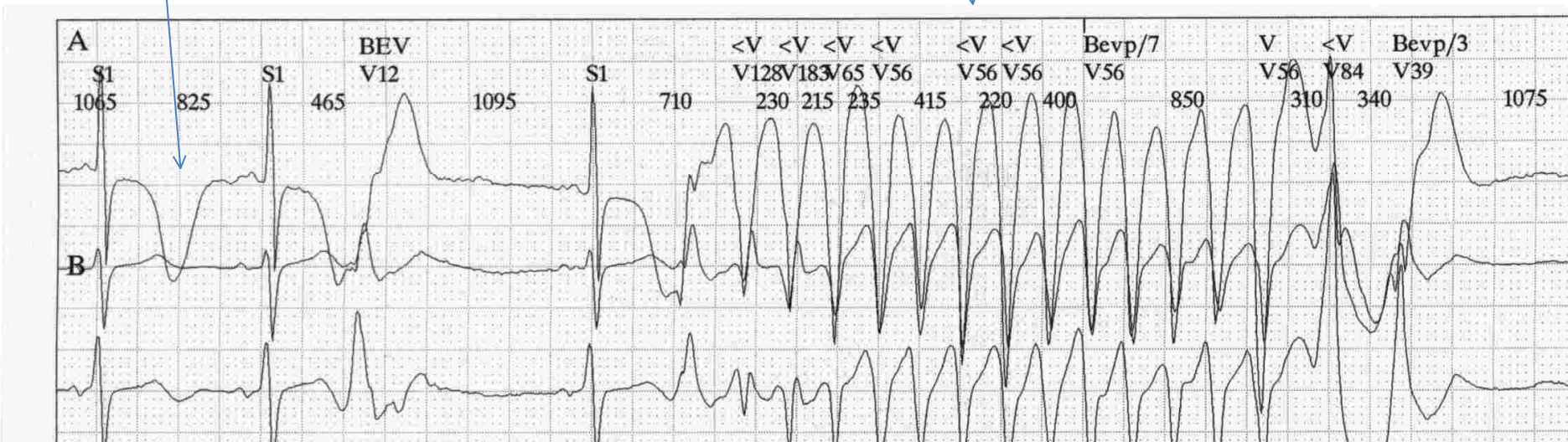
I nuovi criteri per la diagnosi di cardiomiopatia aritmogena applicati agli sportivi: cosa cambia?
F. Graziano, Padova

Genotipo:Sindrome del QT Lungo

?

Fenotipo ECG: QT Lungo

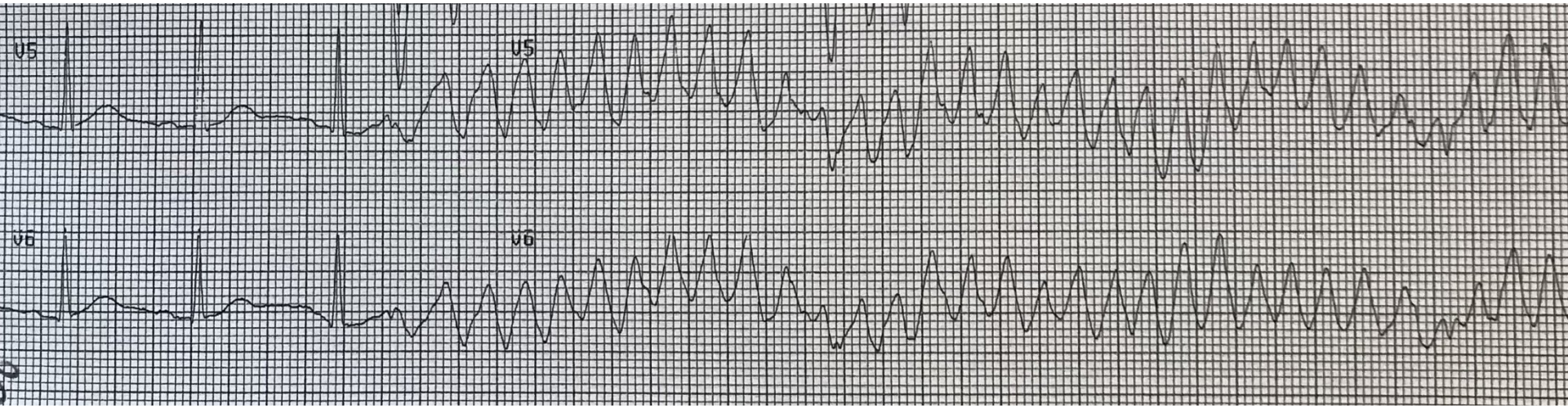
Fenotipo Aritmico: Torsione di Punta



Sindrome del QT Corto

Fenotipo ECG: QT Corto

Fenotipo Aritmico: Fibrillazione Ventricolare

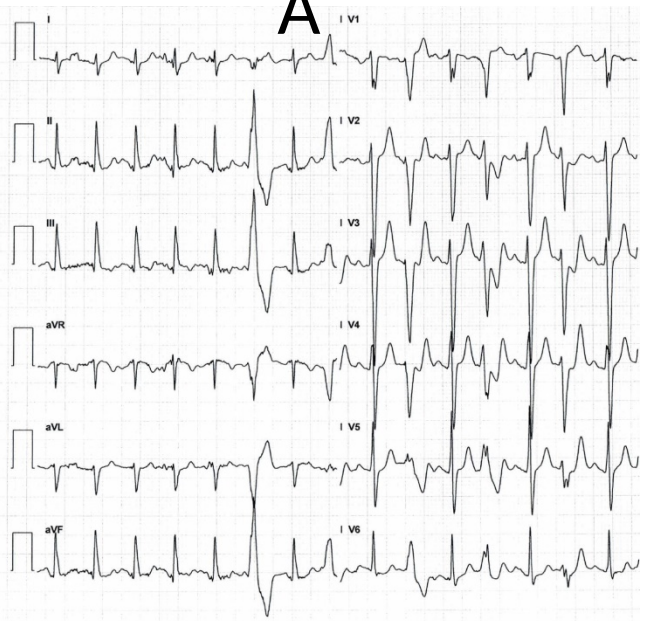


Tachicardia Ventricolare Polimorfa
Anomalia del rilascio del Calcio

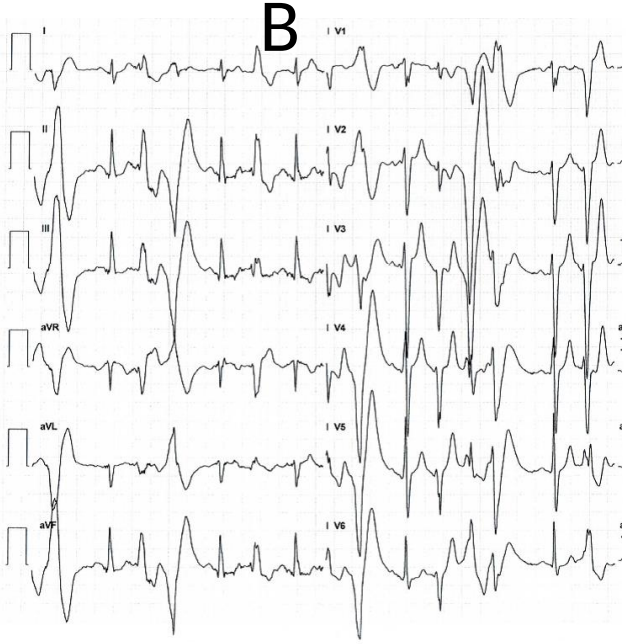
Fenotipo ECG: non evidente

Fenotipo Aritmico: ExV , Bidirezionalità, TVP, FV

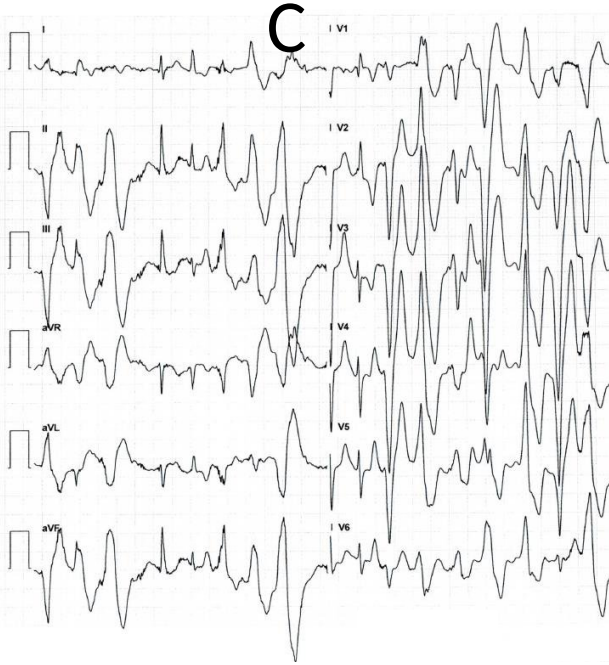
A

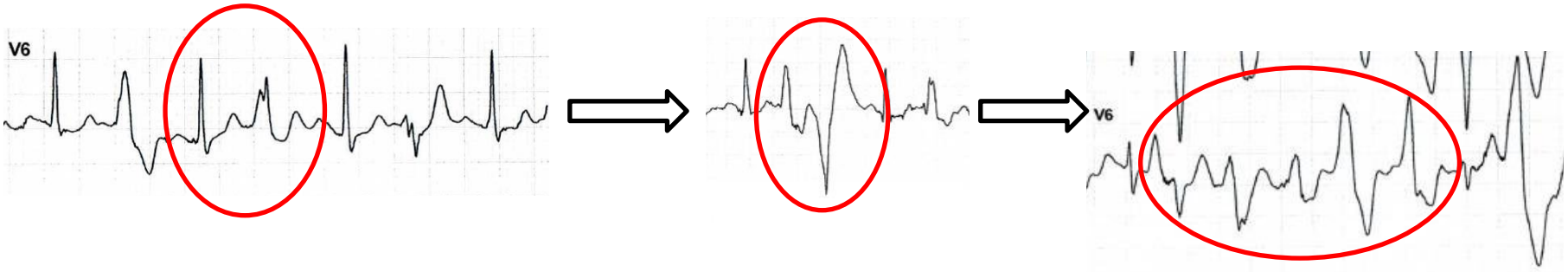


B



C





Bigeminismo

Bidirezionalità

Polimorfismo

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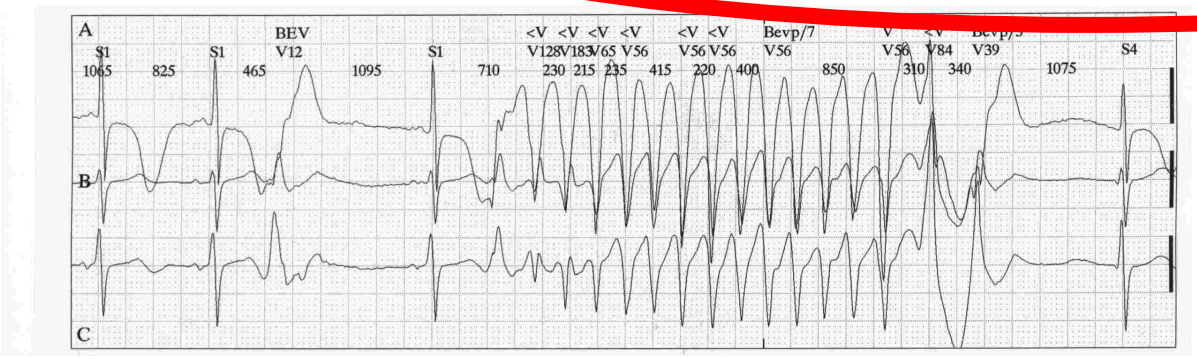
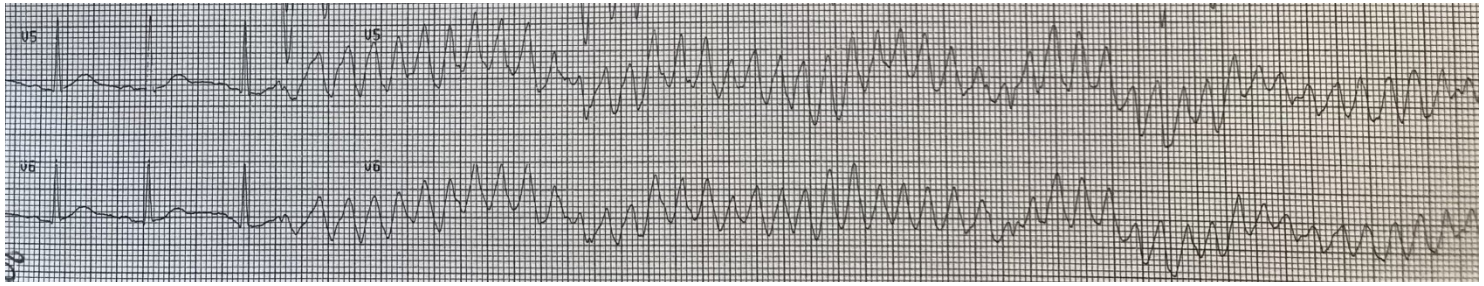
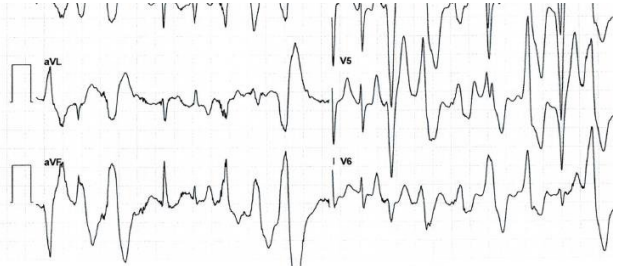
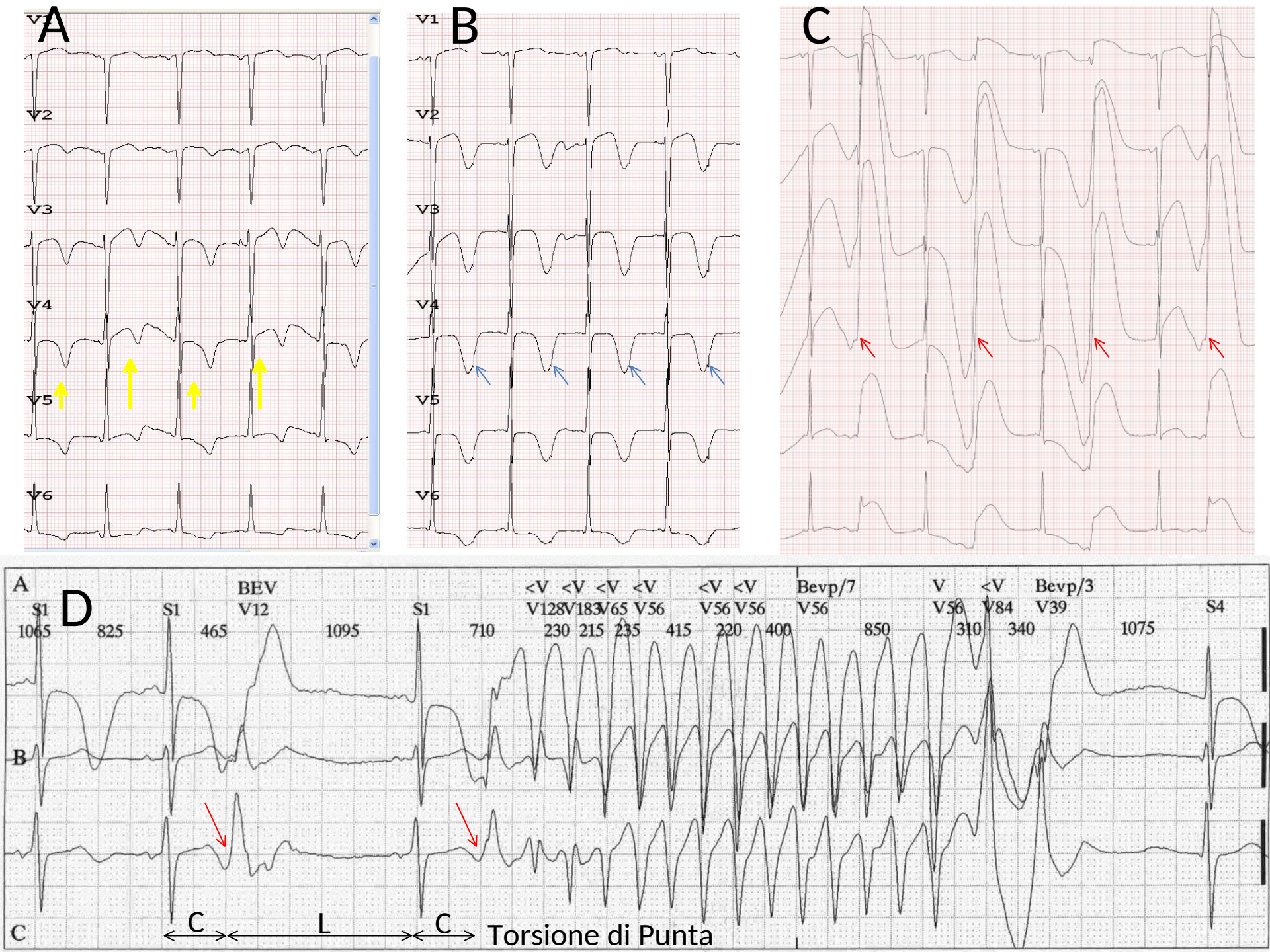




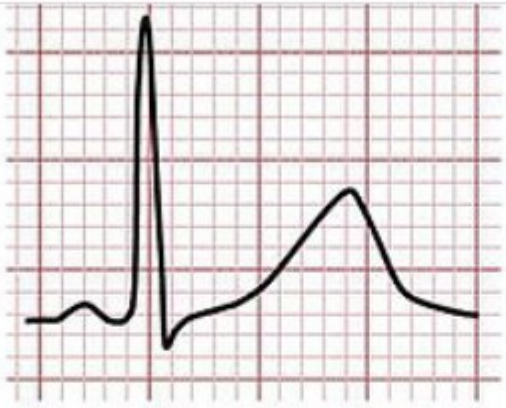


Analisi «di Precisione» dell'ECG

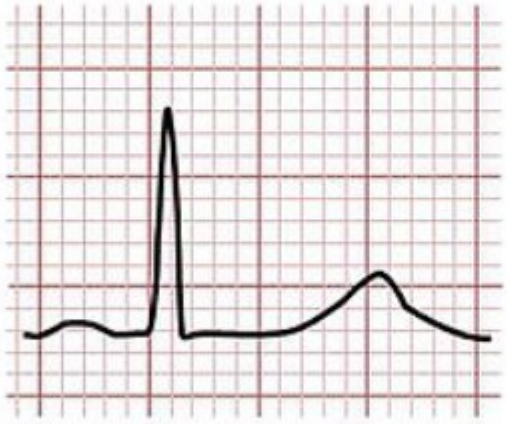

A
V2
V3
V4
V5
V6
B
V1
V2
V3
V4
V5
V6
C
D
A
S1
1065
825
S1
465
BEV
V12
1095
S1
710
<V <V <V <V
V128 V183 V65 V56
230 215 235 415
<V <V
V56 V56
220 400
Bevp/7
V56
850
V <V
V56 V84
310 340
Bevp/3
V39
1075
S4
B
C
C
L
C
Torsione di Punta


FC(38 bpm)
VF
VT
VF
FC(78 bpm)

LQT1



LQT2



LQT3

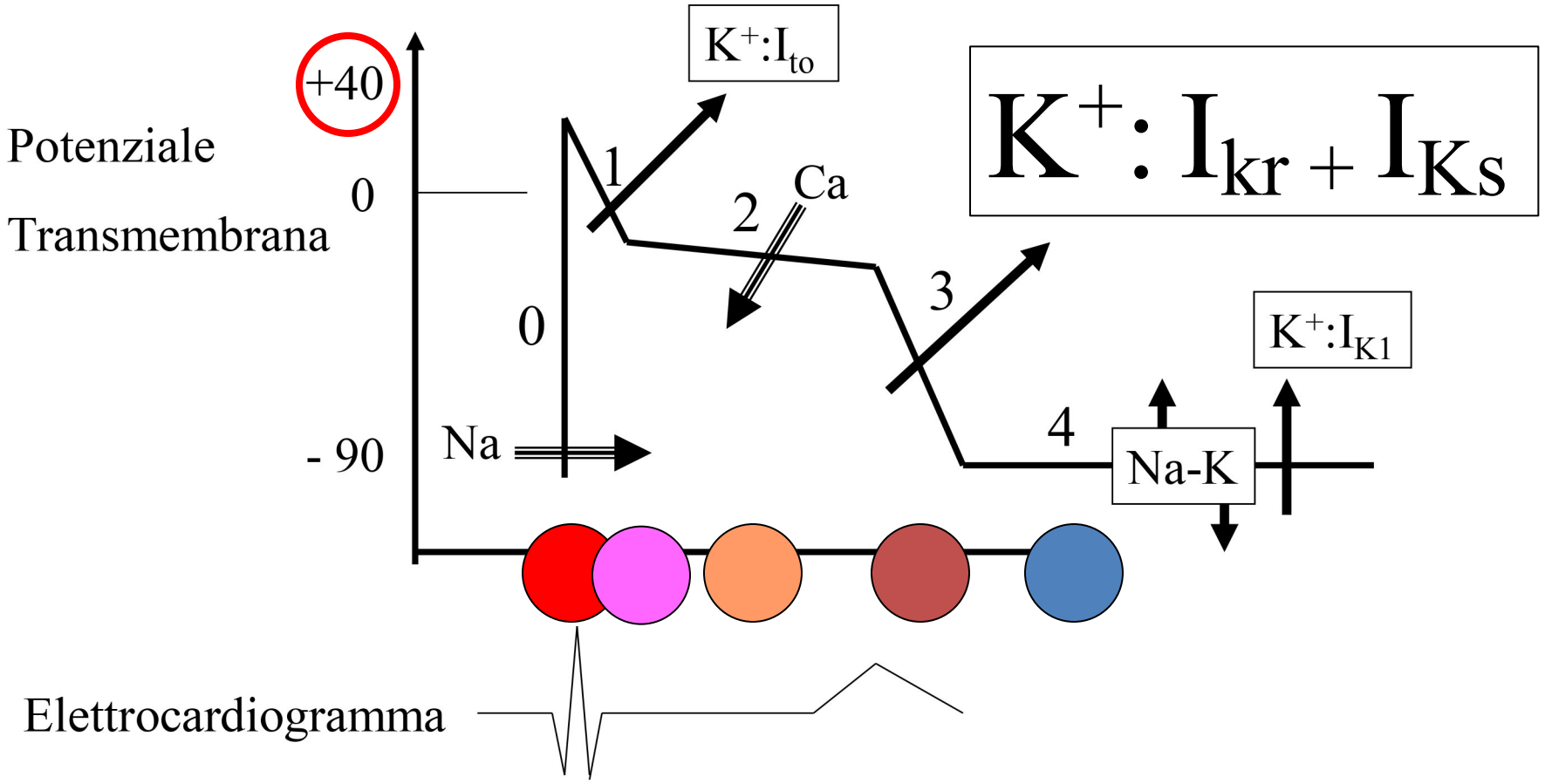
Analisi Geno-Fenotipica

3 principali stereotipi morfologici
di LQTS (in realtà + numerosi)

A ciascun pattern ECG corrisponde

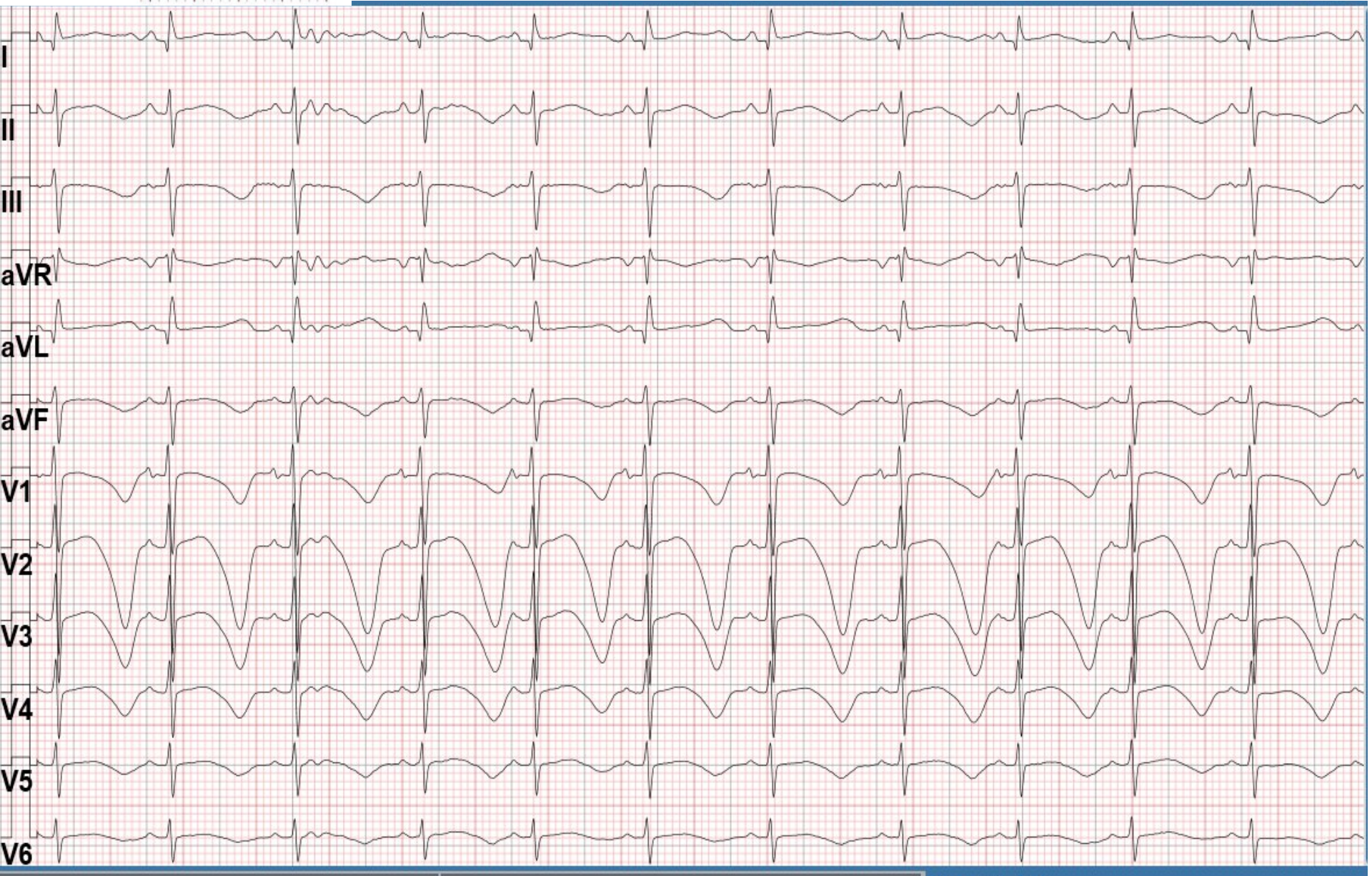
a) una specifica anomalia genetica
b) Una modalità di insorgenza della TdP
c) Una specifica terapia gene-specifica

Ruolo Principale del Potassio nel determinismo della Ripolarizzazione Ventricolare



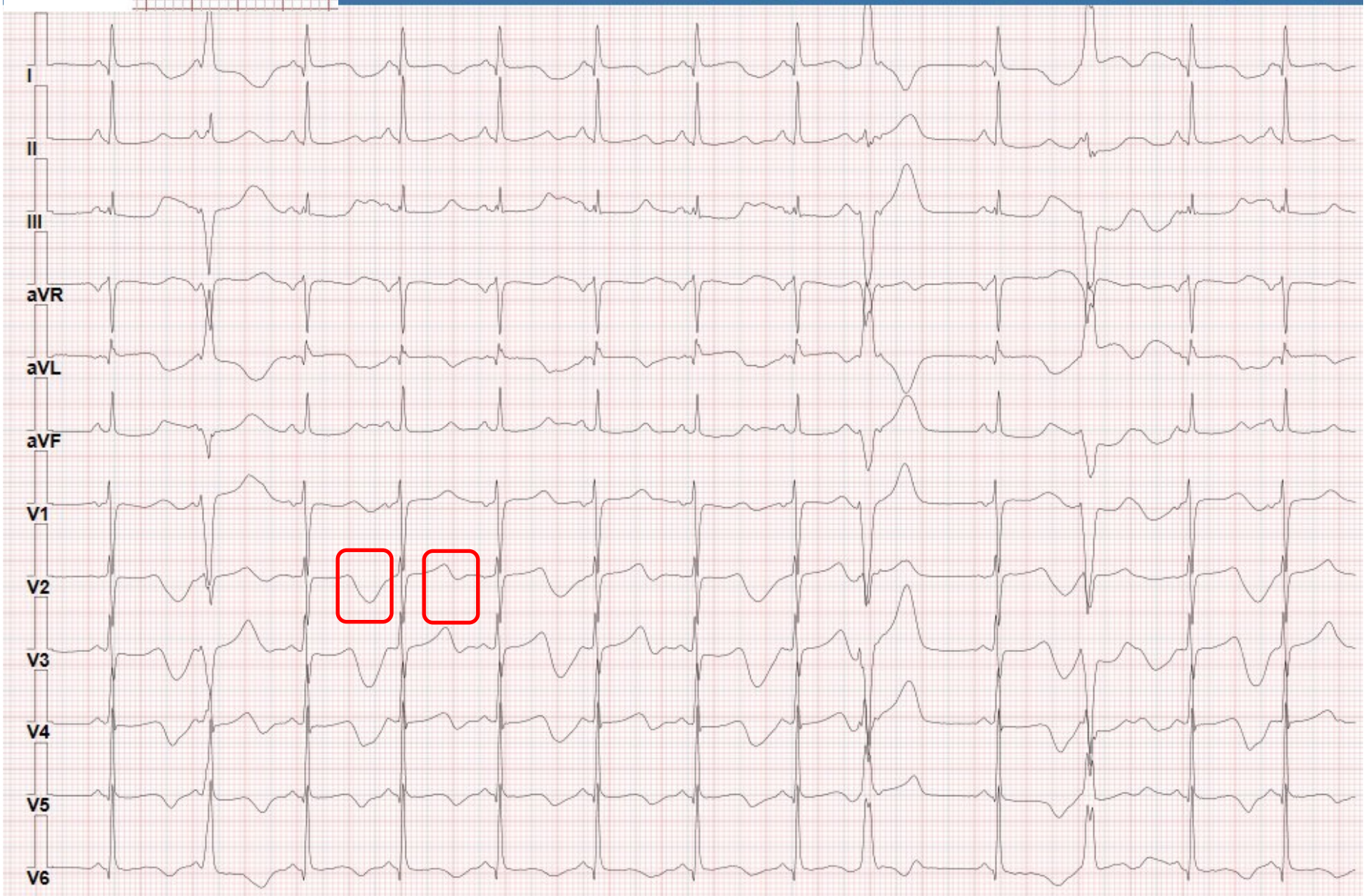
LQT1

QT allungato, T a base larga con tratto ST ridotto



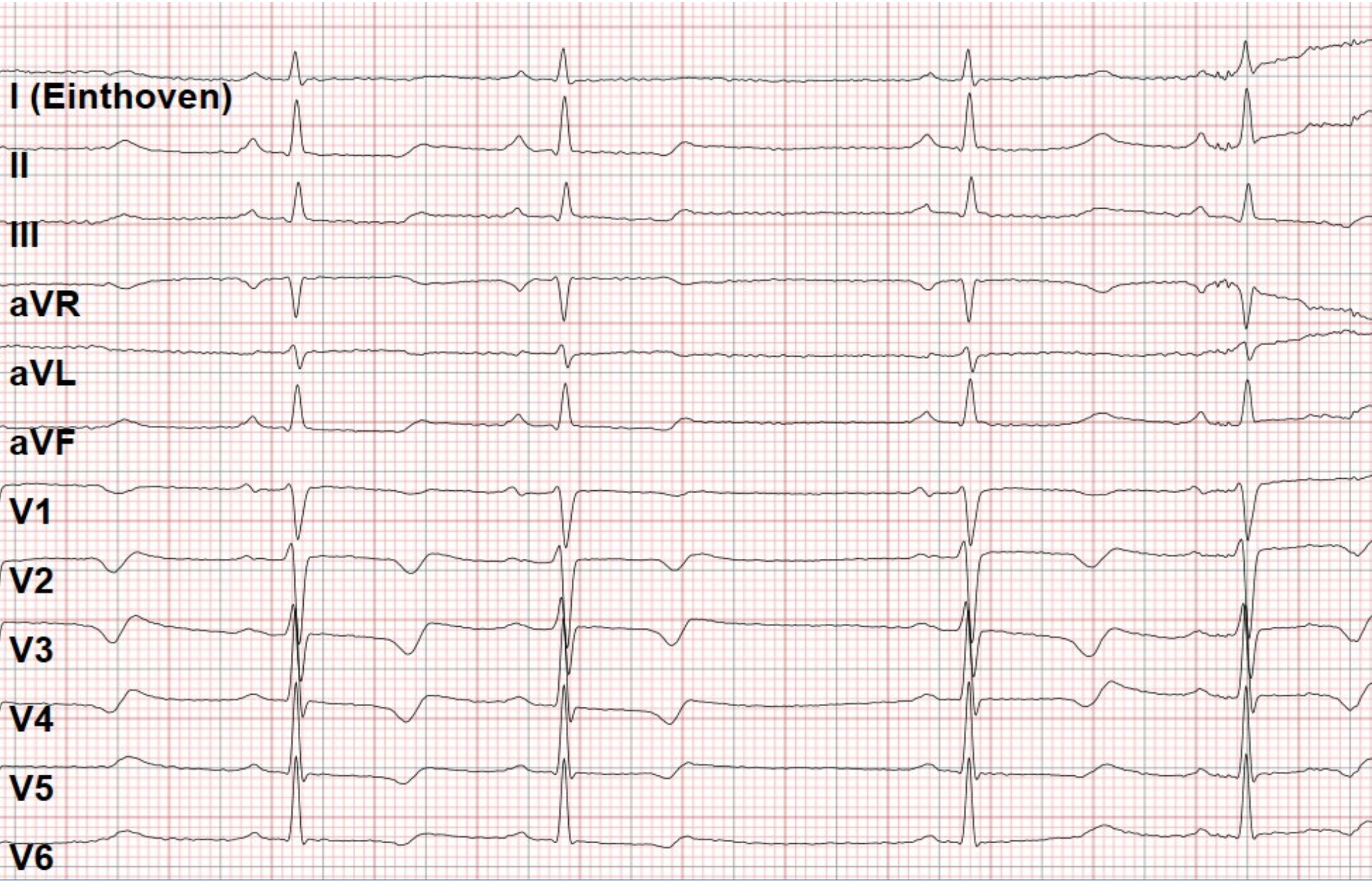
LQT2

QT allungato, T con anomalie (bifida ,notch, alternans), ST mantenuto

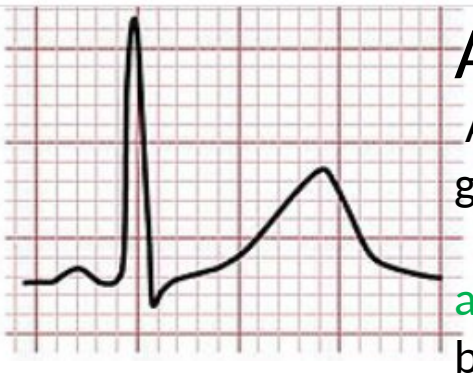


LQT3

QT prolungato, T stretta , ST prolungato



LQT1



Analisi Geno-Fenotipica

Anomalia Genetica di KVLQT1 (KCNQ1)

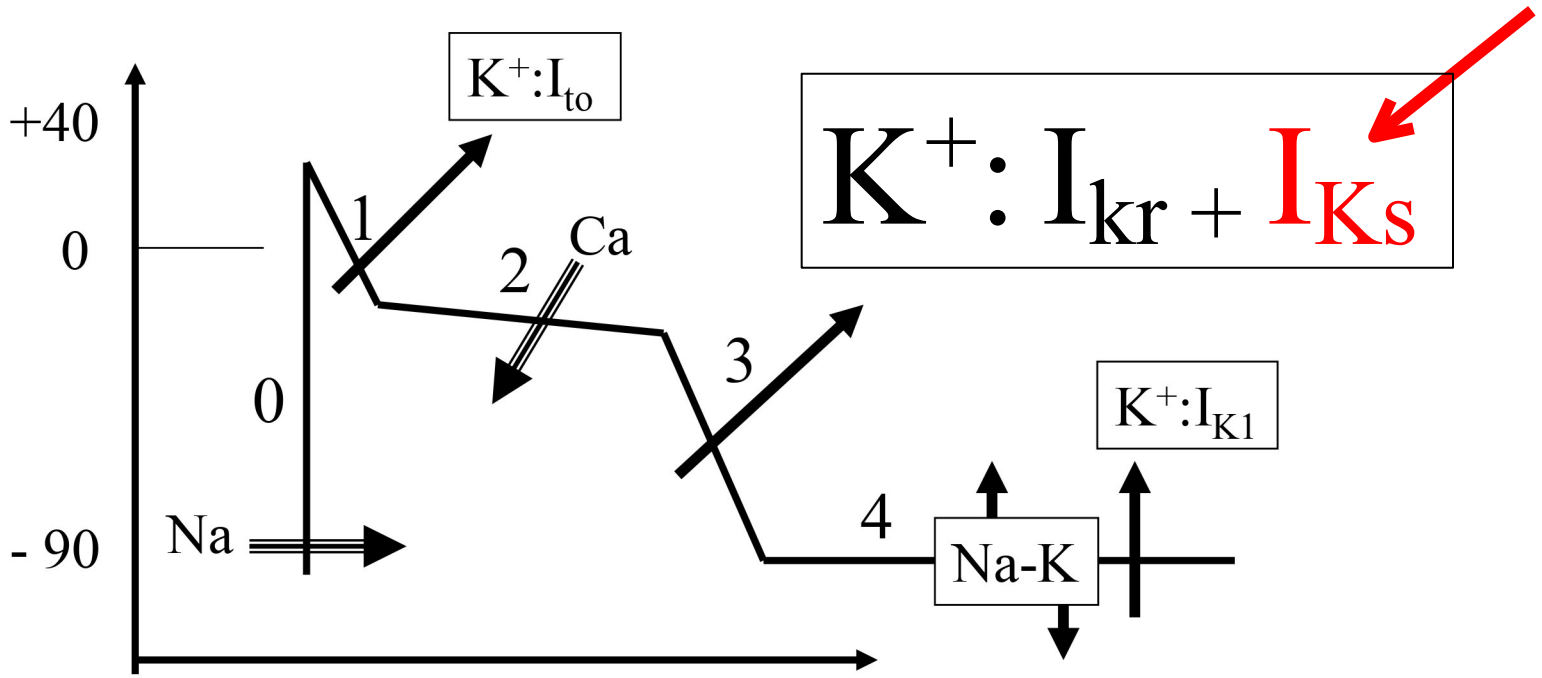
gene codificante il canale dell' Iks

All'anomalia Genica corrisponde

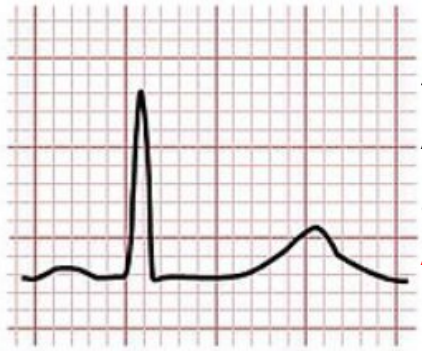
a) compromessa IKs

b) insorgenza della TdP: da SFORZO, Stress

c) Una specifica terapia gene-specifica : Beta bloccante



LQT2

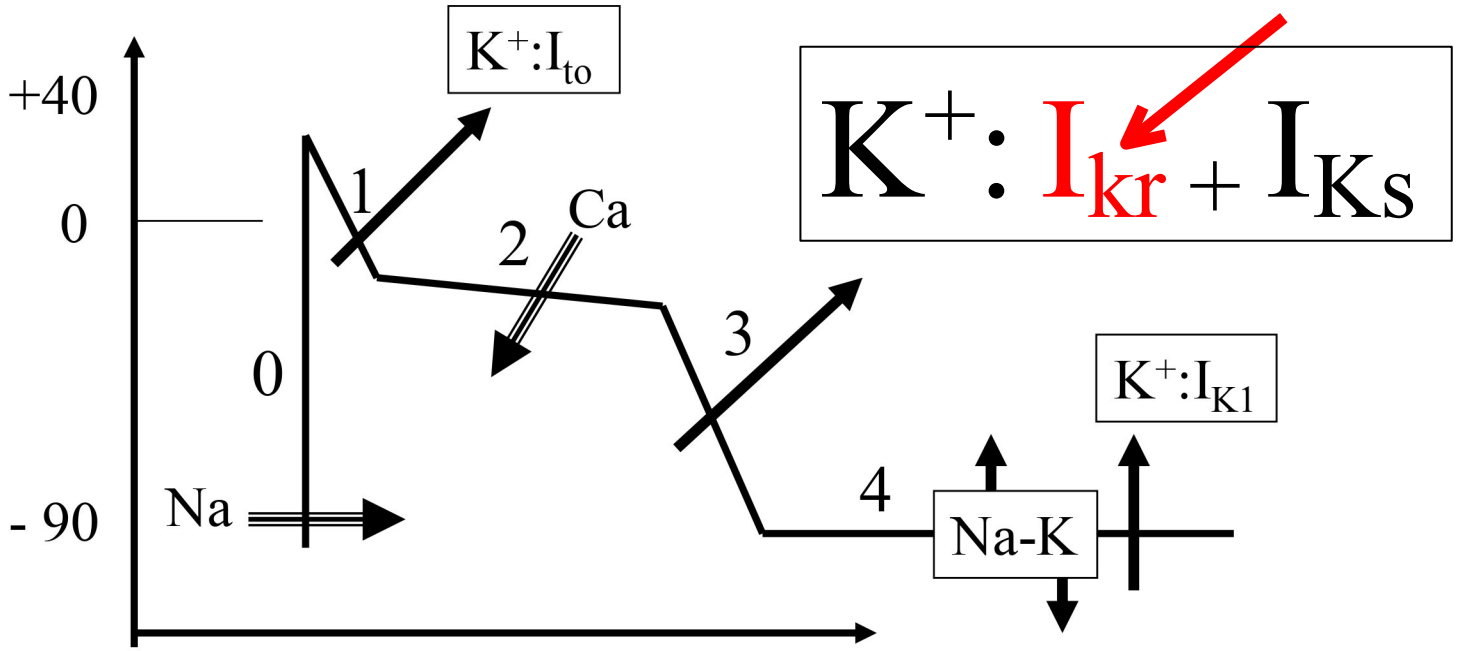


Analisi Geno-Fenotipica

Anomalia Genica: hERG (KCNH2),
gene codificante il canale dell' Ikr

All'anomalia genica corrisponde

a) Compromessa IKr
b) modalità di insorgenza della TdP: a riposo con brusca variazione di FC (stress acuto al risveglio)
c) Una specifica terapia gene-specifica : > Potassiemia



LQT3

Analisi Geno-Fenotipica

Anomalia genica : SCN5A

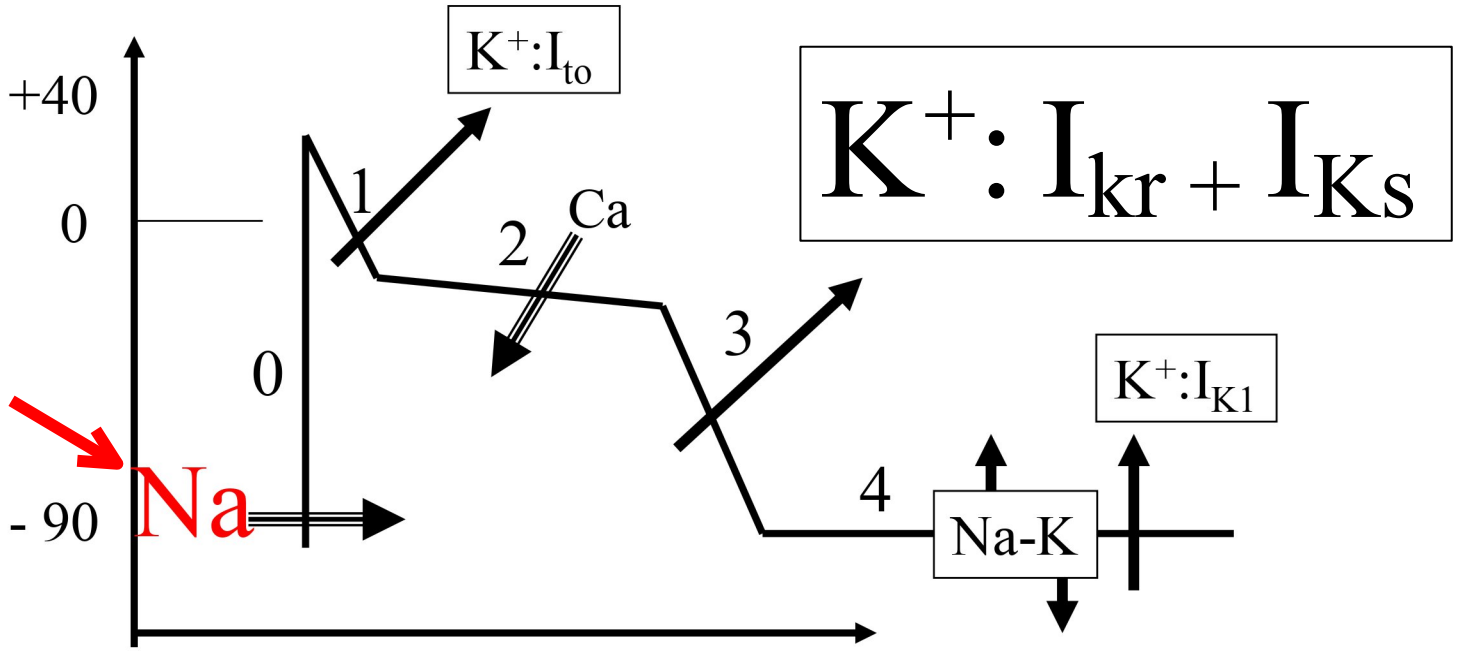
Codificante la corrente rapida del Sodio (INa)

All'anomalia genica corrisponde

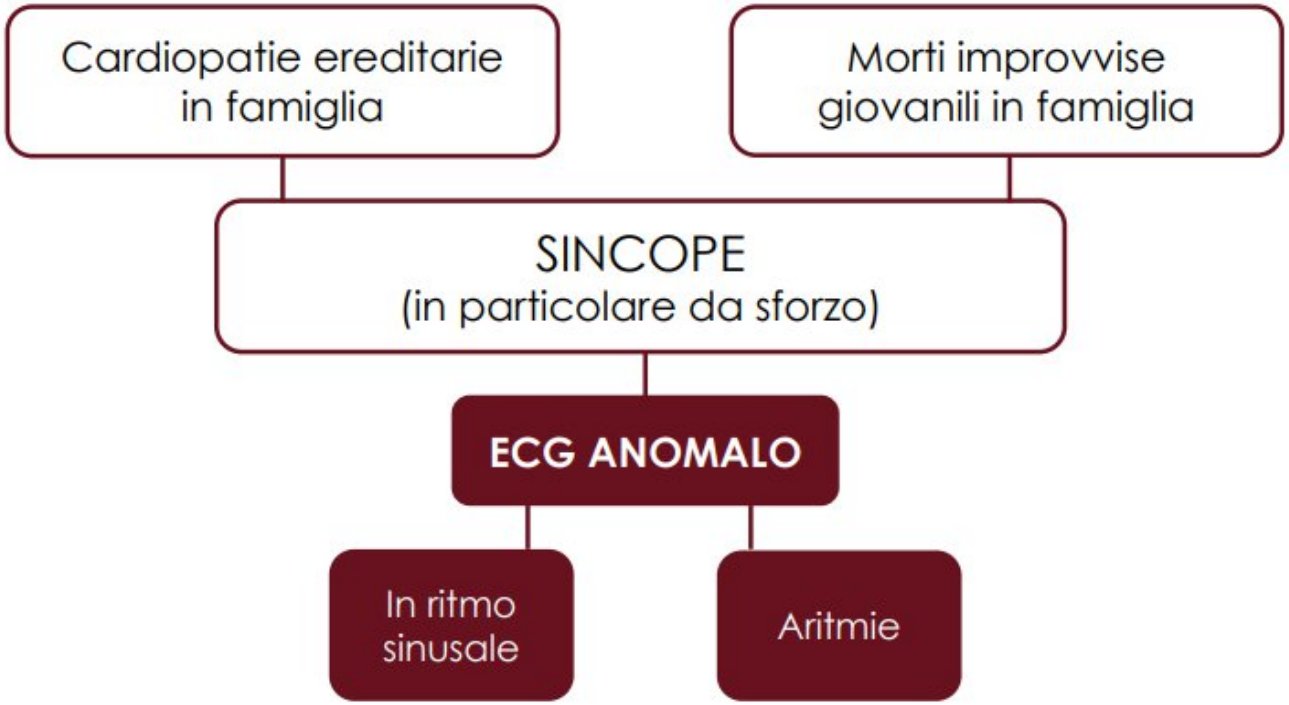
a) aumentata INa

b) Una modalità di insorgenza della TdP: riposo

c) Una specifica terapia gene-specifica : evita bradicardia (PM), Mexiletina (I Na blocc) , NO Beta bloccante!



Come individuare le cardiopatie a rischio di morte improvvisa



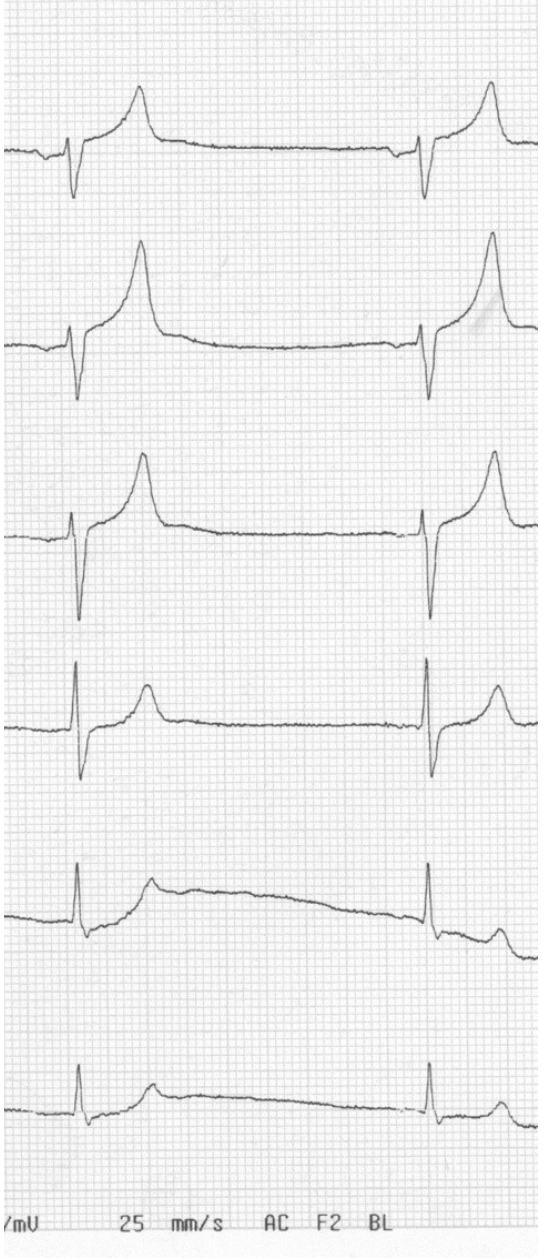
QTc > 480 msec	3
QTc = 460 – 470	2
QTc = 450 (nei maschi)	1
Torsione di Punta	2
T wave alternans	1
Notched T wave (2 deriv)	1
Bassa frequenza X età	0,5
Sincope da Stress	2
Sincope senza Stress	1
Sordità congenita	0,5
Familiari con LQTS	1
Familiari con M.I. < 30 aa	0,5

Probabilità di LQTS
- 1 punto Bassa
- 2-3 punti Intermedia
- 4 punti Alta

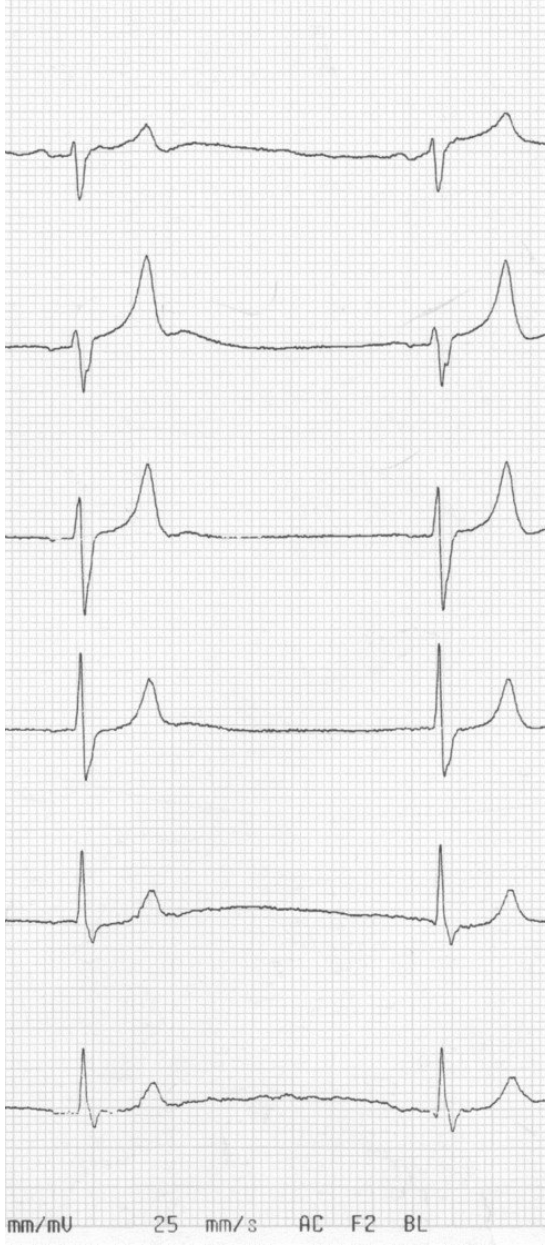
il QT fino al 2000

focus su prolungamento del QT :
durata e morfologia

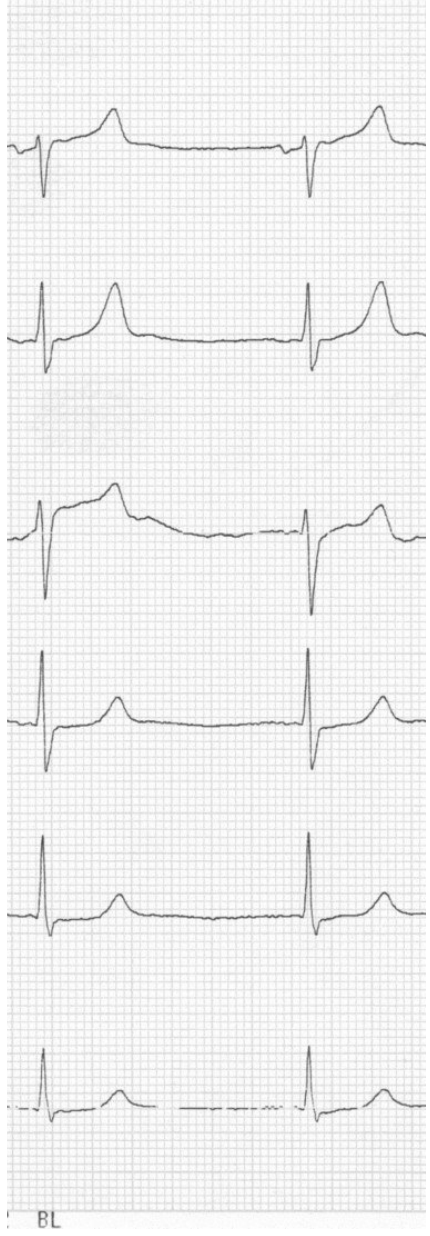
Il QT normale sembrava essere tanto più normale tanto più si allontanasse da quello «lungo»



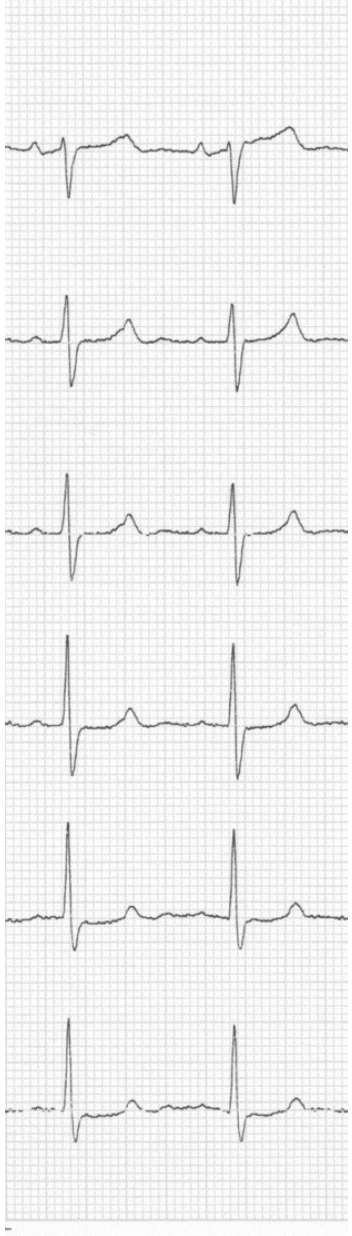
K^+= 8 meq / l



K^+= 7 meq / l

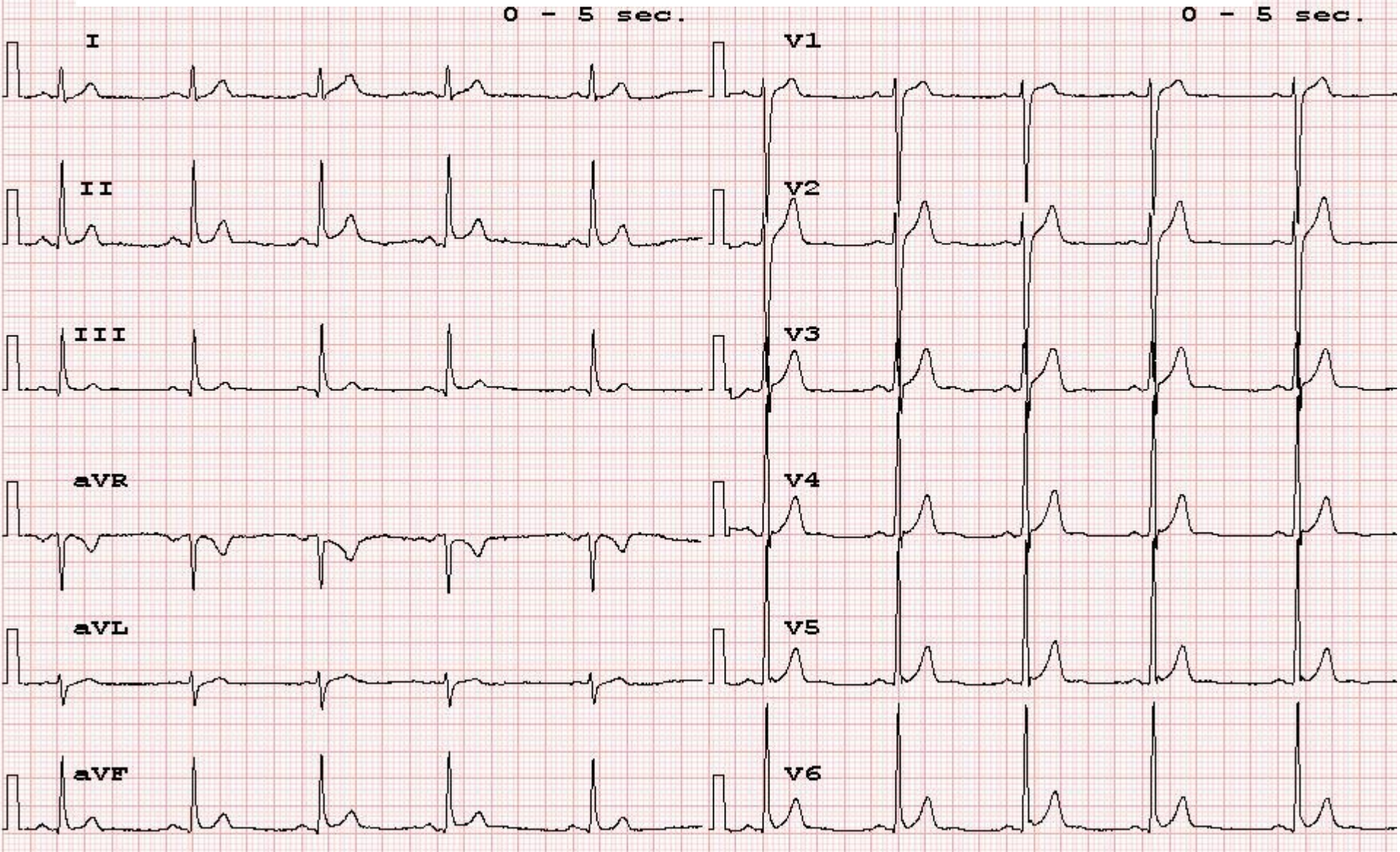


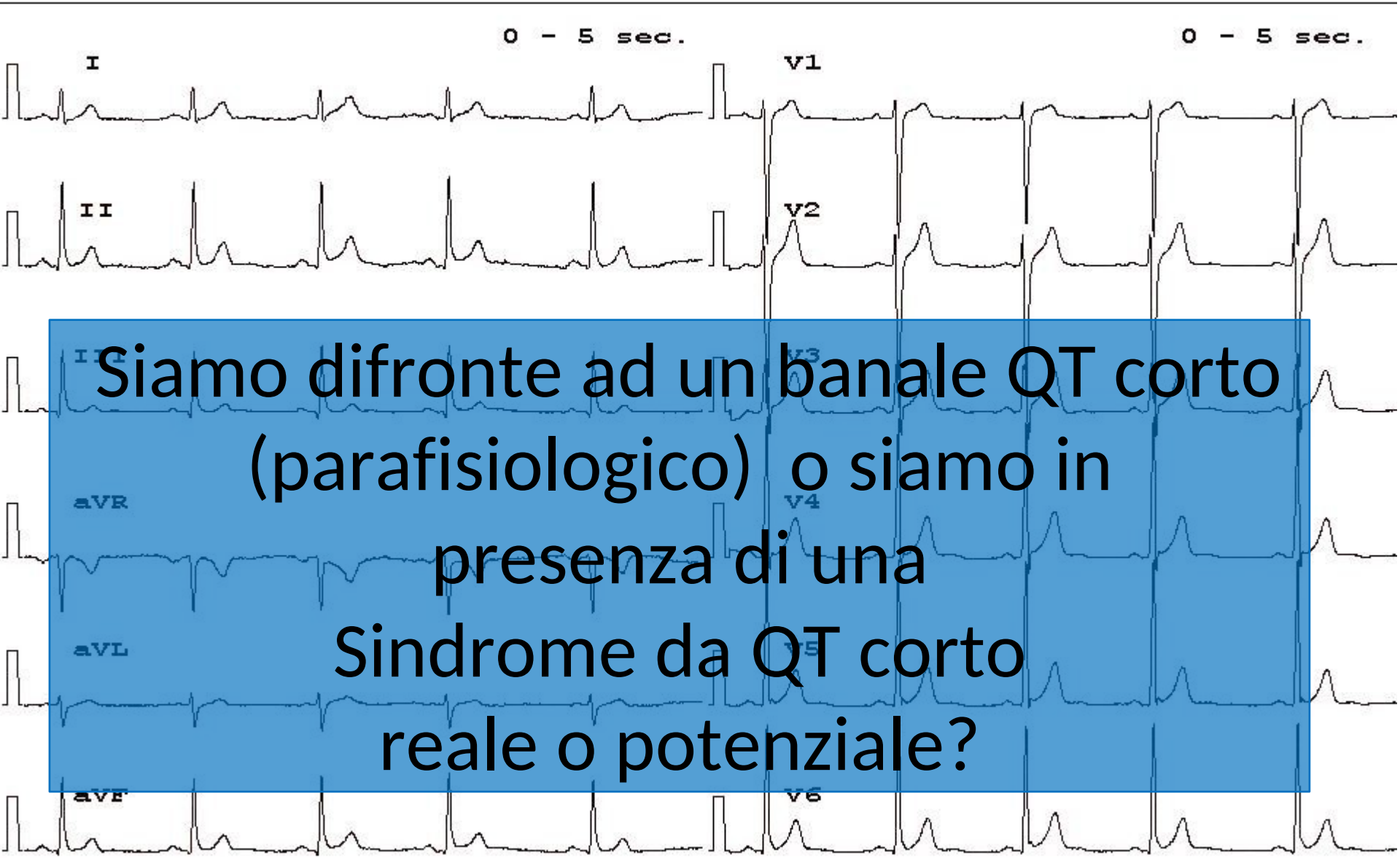
K^+= 6 meq / l



K^+= 5 meq / l

L’intervallo QT può essere troppo corto?
Si! Deve essere calcolato?





Siamo difronte ad un banale QT corto (parafisiologico) o siamo in presenza di una Sindrome da QT corto reale o potenziale?

QT predetto: formula di Rautaharju

Rautaharju (14,379 pts):

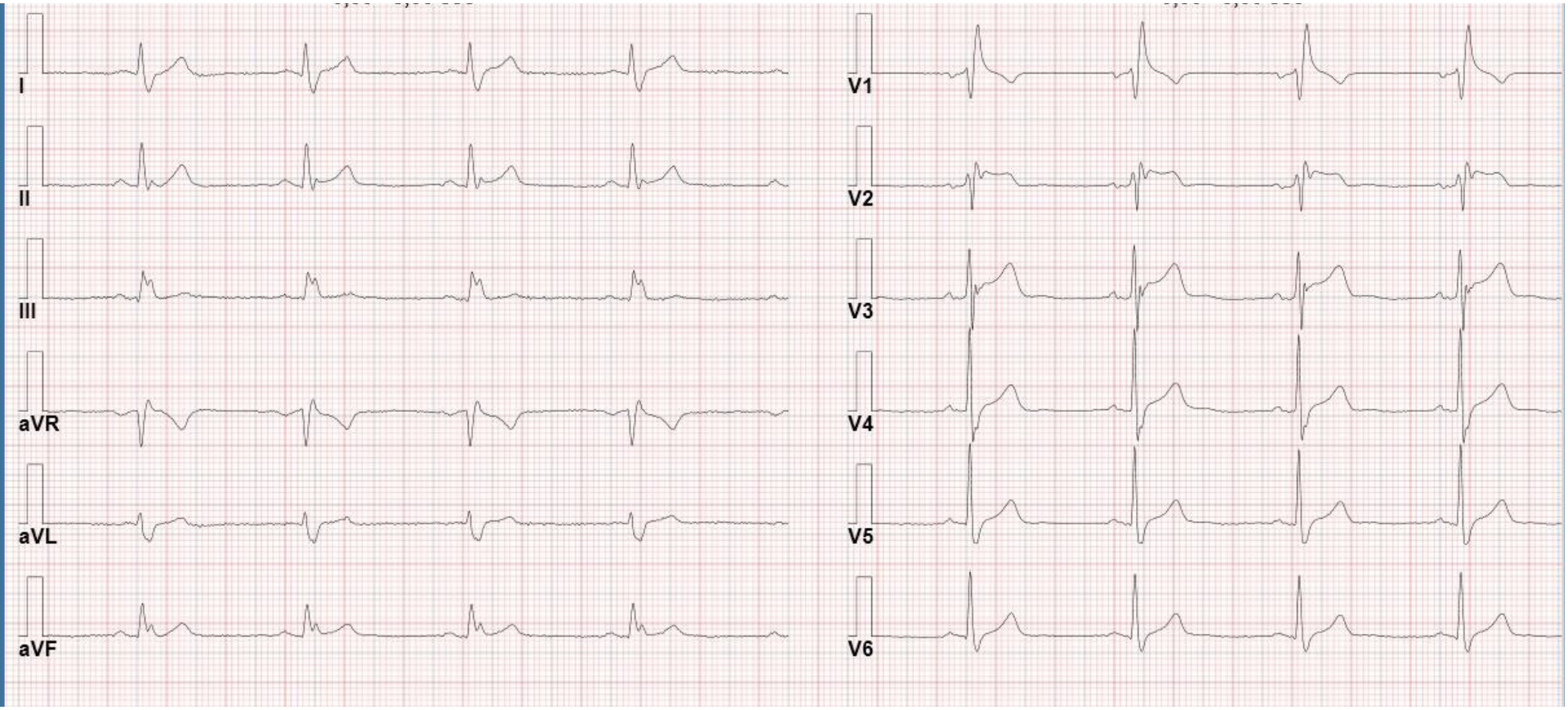
- QTp (ms)= 65.600 / (100+HR)

- QT/QTp x 100% = % QTpredicted.
- Limite inferiore di normalità del QT = 88% of QTp

Si definisce QT Corto un valore inferiore all' 88 % del predetto

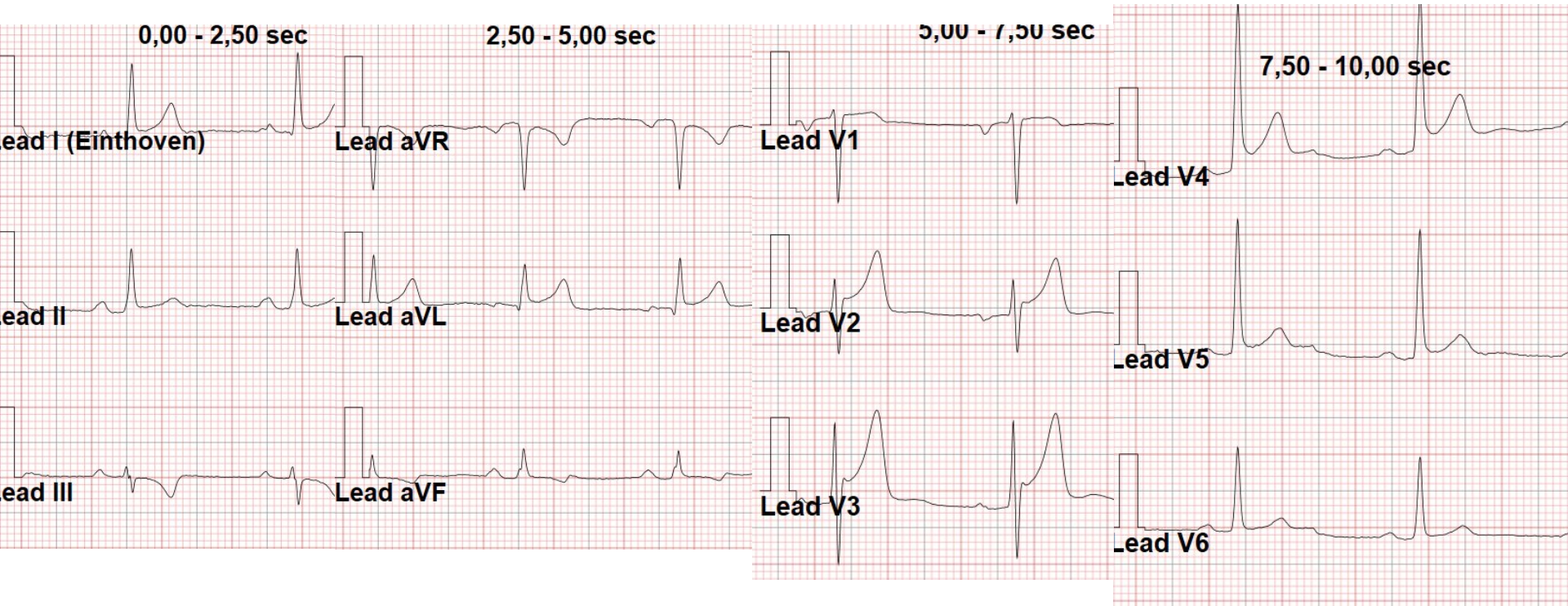
QTp (ms)= 65600 / (100+HR)=65600/155=423 msec
88% del QT predetto 423x88/100=372

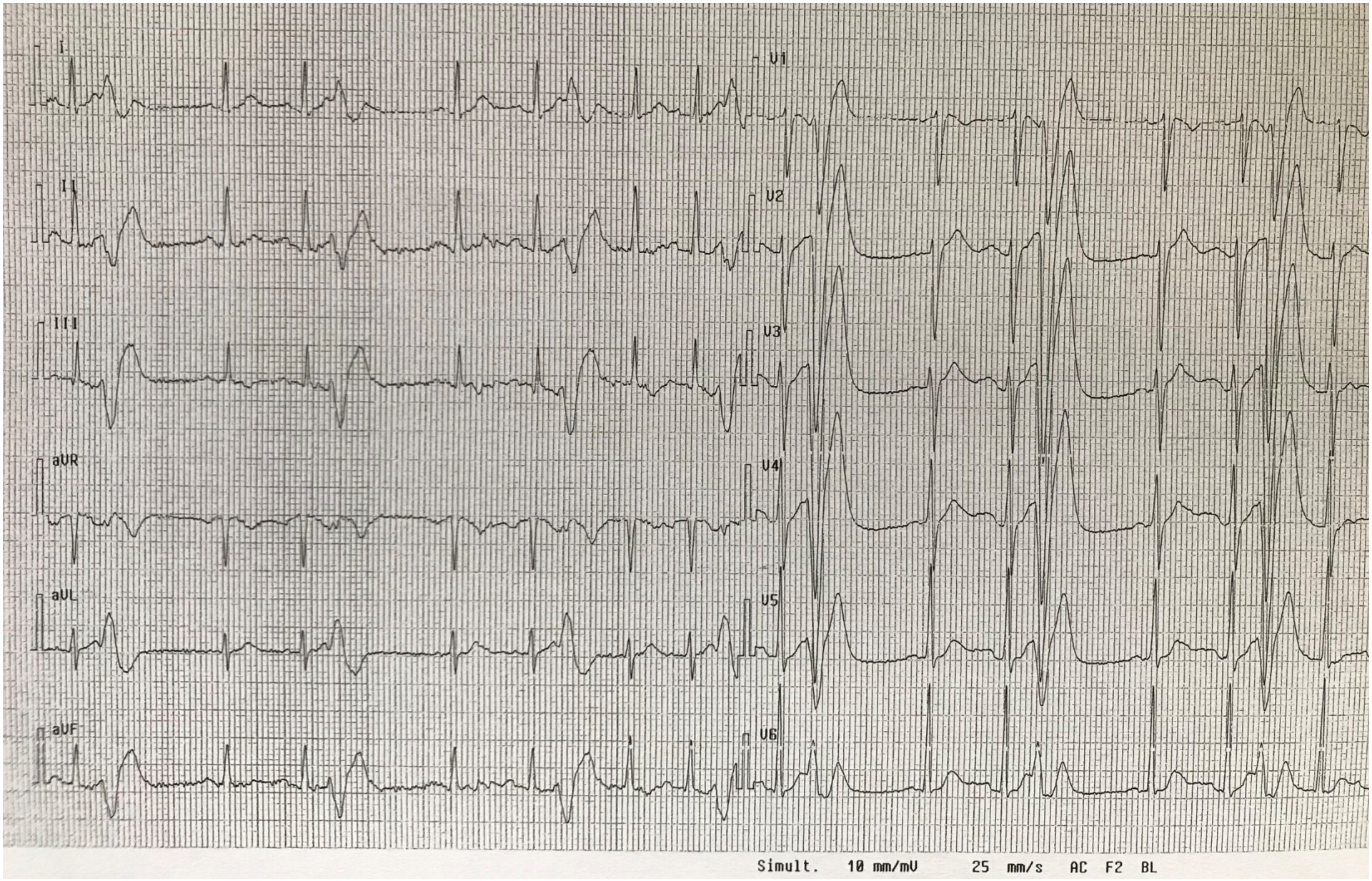
QT= 380 Normale

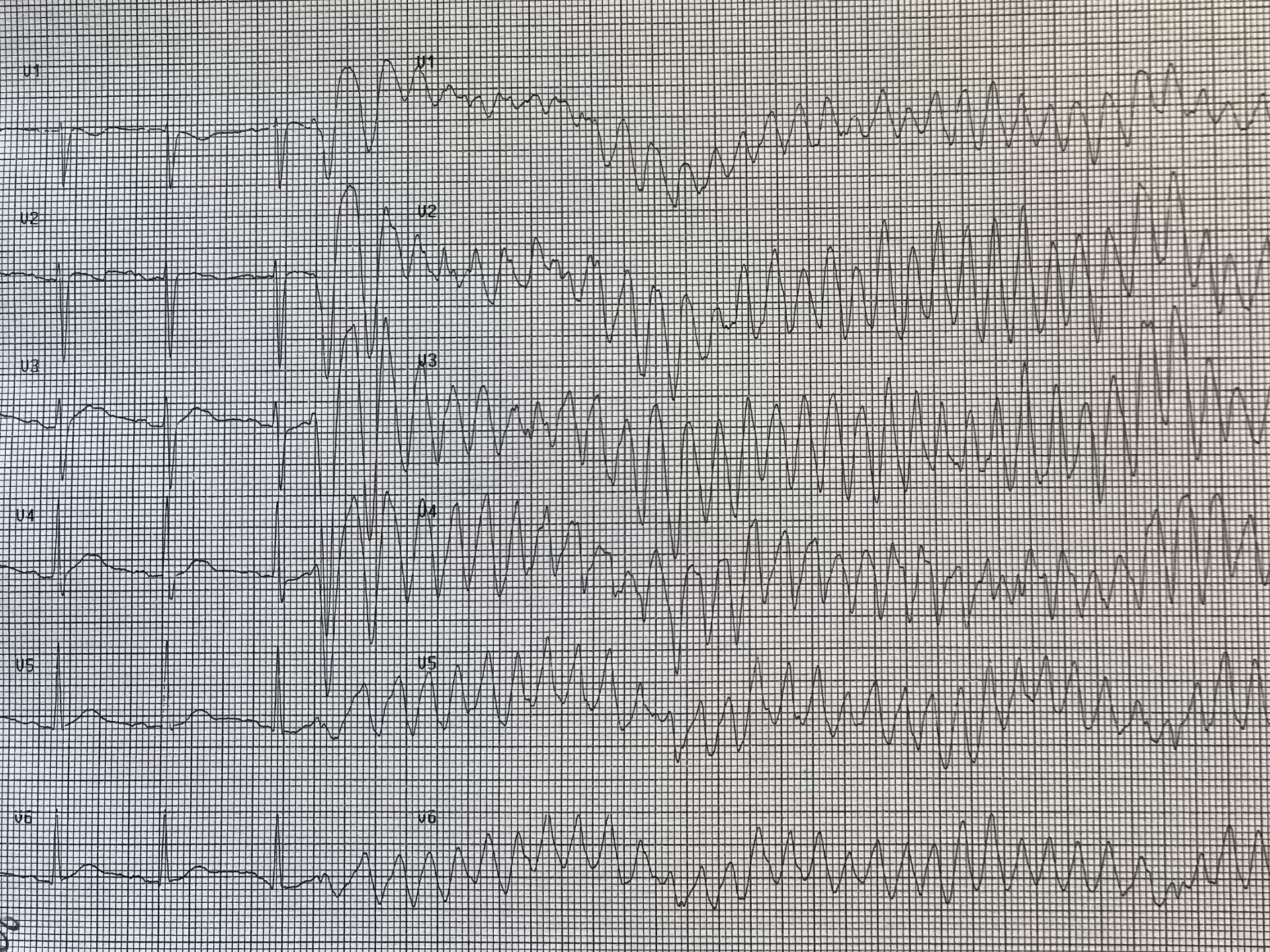


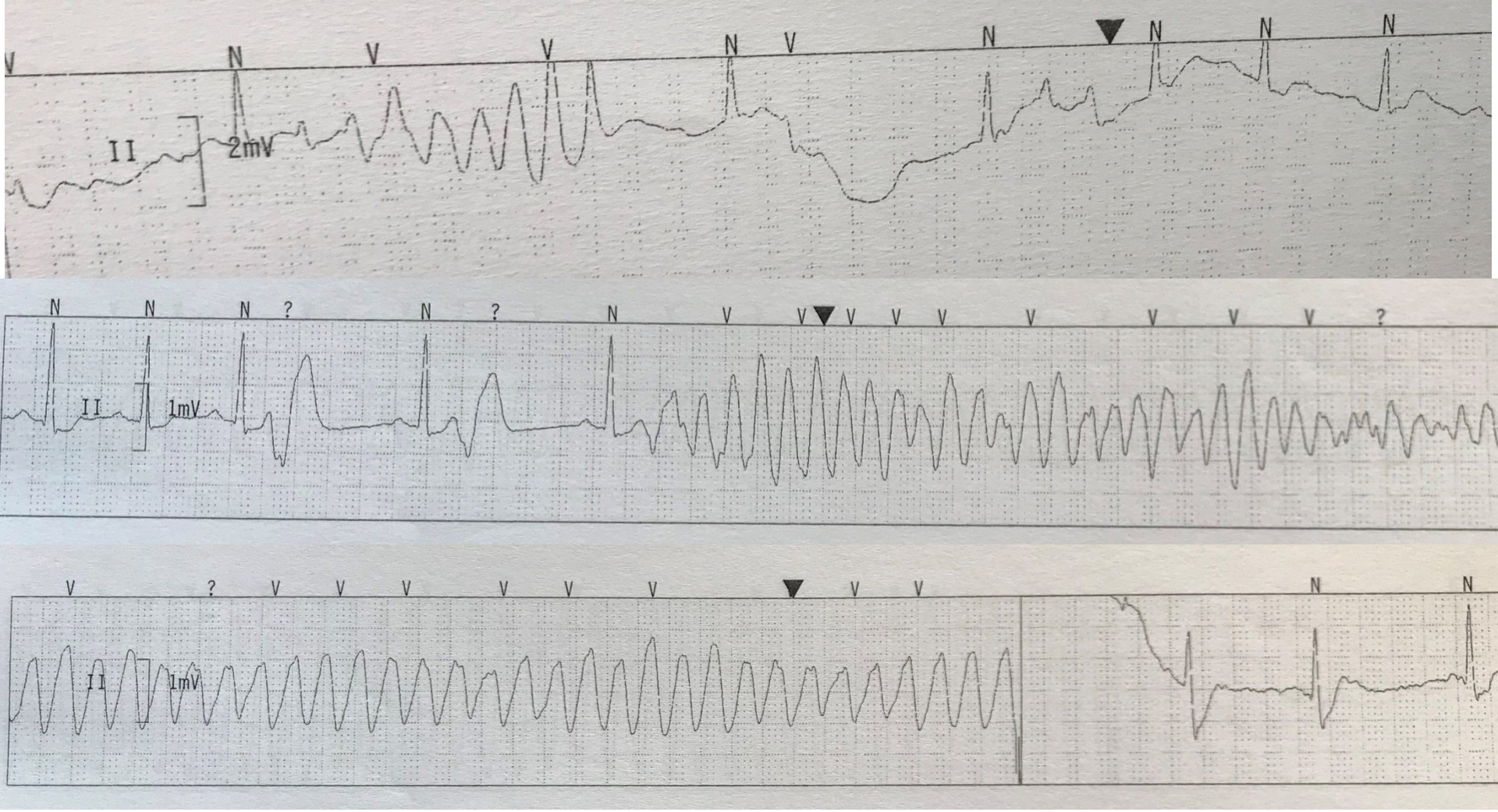
QTp (ms)= 65600/160=410 msec
88% del QT predetto =360

QT = 340 corto



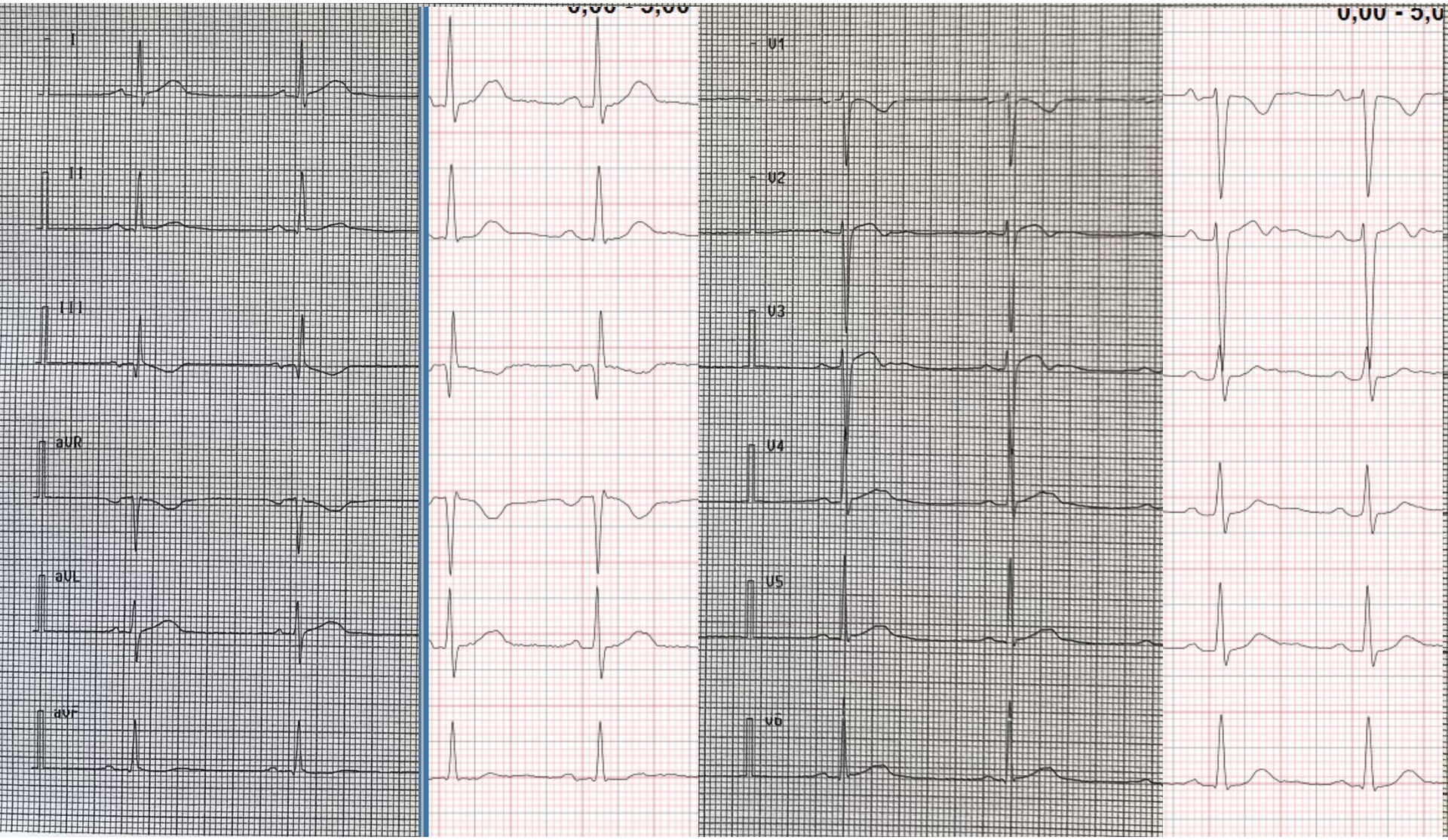

I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
Simult. 10 mm/mV 25 mm/s AC F2 BL


V1
V1
V2
V2
V3
V3
V4
V4
V5
V5
V6
V6

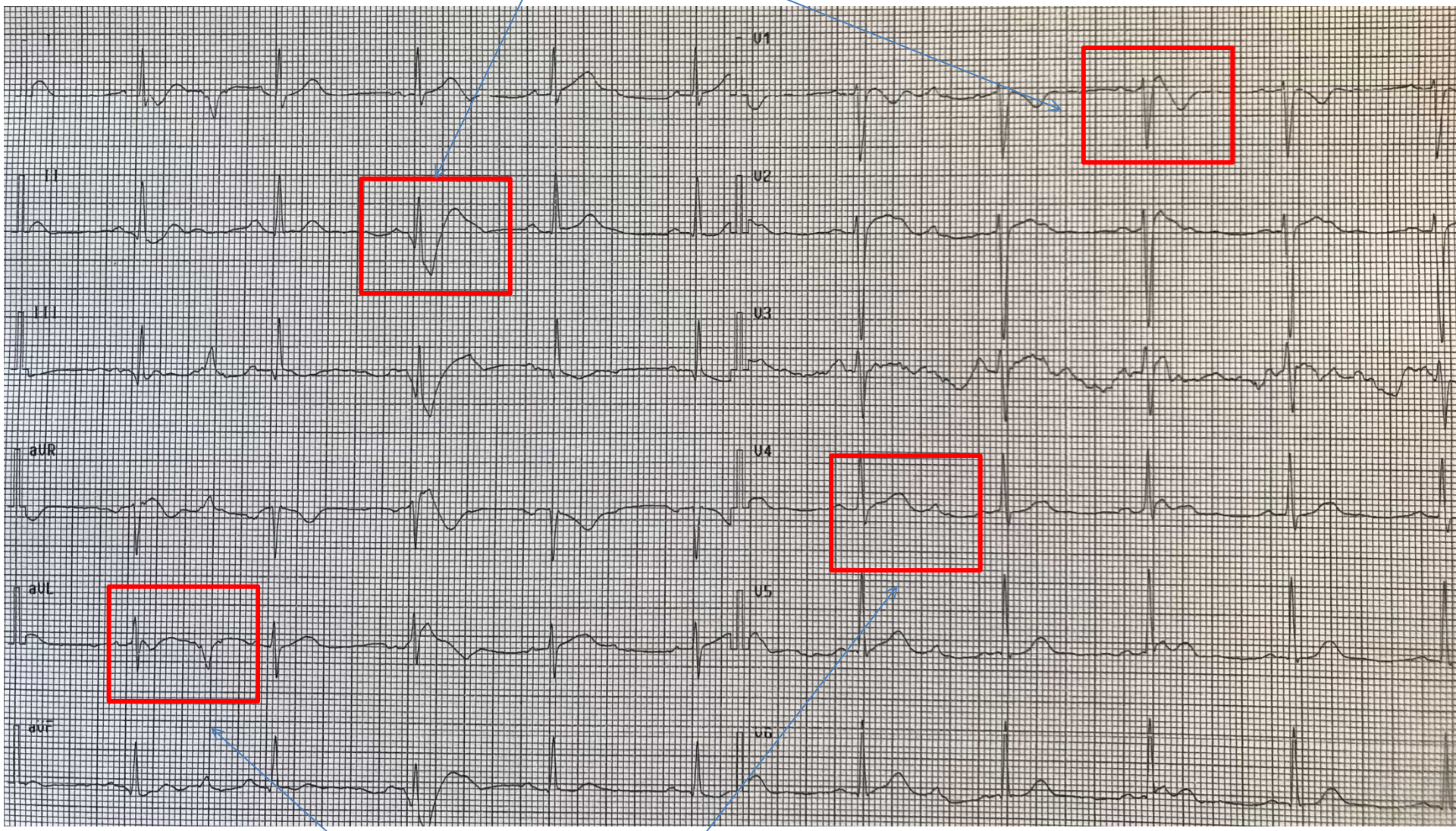

N V V N V N N N N
II
2mV
N N N ? N ? N V V V V V V V V ?
II
1mV
V ? V V V V V V V V V N N
II
1mV

Conclusione:
Ma è solo la durata del QRS che influenza la induzione di aritmie?

Base Quinidine Base Quinidine



Pattern «Brugada-like»



Pattern «LQTS-like»

Grazie

riserva

ESC European Society of Cardiology
European Heart Journal (2017) 38, 3029–3034
doi:10.1093/eurheartj/ehx490
SPECIAL ARTICLE
Arrhythmia/electrophysiology

The definition of the Brugada syndrome

Juan Sieira and Pedro Brugada*

Brugada syndrome is diagnosed in patients with **ST-segment elevation with type 1 morphology ≥2 mm in ≥ 1 lead in the right precordial leads V1, V2, positioned in the 2nd, 3rd, or 4th intercostal space occurring either spontaneously or after provocative drug test** with intravenous administration of class I antiarrhythmic drugs.

Two important aspects must be highlighted:

1. **Only the type 1 ECG pattern is diagnostic**, either spontaneously or after a drug challenge.
2. A type 2 ECG pattern may raise the suspicion of BS but the diagnosis can only be made when the type 1 pattern appears or is induced by sodium channel blockers. This fact has also prognosis significance as those patients that do not display the type 1 spontaneously have a better outcome, but arrhythmic events and SCD can still occur.

Interestingly, nowadays the type 3 ECG pattern is no longer considered in BS

Table I **Genes identified in Brugada syndrome**

Channel	Gene	Protein	Proportion of BS attributed to genetic variants (%)
Calcium	*CACNA1C*	Voltage-dependent L-type calcium channel subunit alpha-1C	6.6
	CACNB2B	Voltage-dependent L-type calcium channel subunit beta-2	4.8
	CACNA2D1	Voltage-dependent calcium channel subunit alpha-2/delta-1	1.8
	TRPM4	Transient receptor potential cation channel subfamily M member 4	<1
Sodium	*SCN5A*	Sodium channel protein type 5 subunit alpha	11–28
	SCN10A	Neuronal sodium channel Nav1.8	5–16.7
	GPD1-L	Glycerol-3-phosphate dehydrogenase 1-like protein	<1
	SCN1B	Sodium channel subunit beta-1	1.1
	SCN2B	Sodium channel subunit beta-2	<1
	SCN3B	Ran guanine nucleotide release factor	<1
	SLMAP	Sarcolemmal membrane-associated protein	<1
	PKP2	Desmosomal protein plakophilin-2	<1
	RANGRF	Sodium channel subunit beta-3	<1
Potassium	*KCND3*	Potassium voltage-gated channel subfamily D member 3	<1
	KCNE3	Potassium voltage-gated channel subfamily E member 3	<1
	KCNJ8	ATP-sensitive inward rectifier potassium channel 8	2
	HCN4	Hyperpolarization-activated cyclic nucleotide-gated channel 4	<1
	KCNE5	Potassium voltage-gated channel subfamily E member 1-like protein	<1

Sieira J et Brugada P *The definition of Brugada*


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

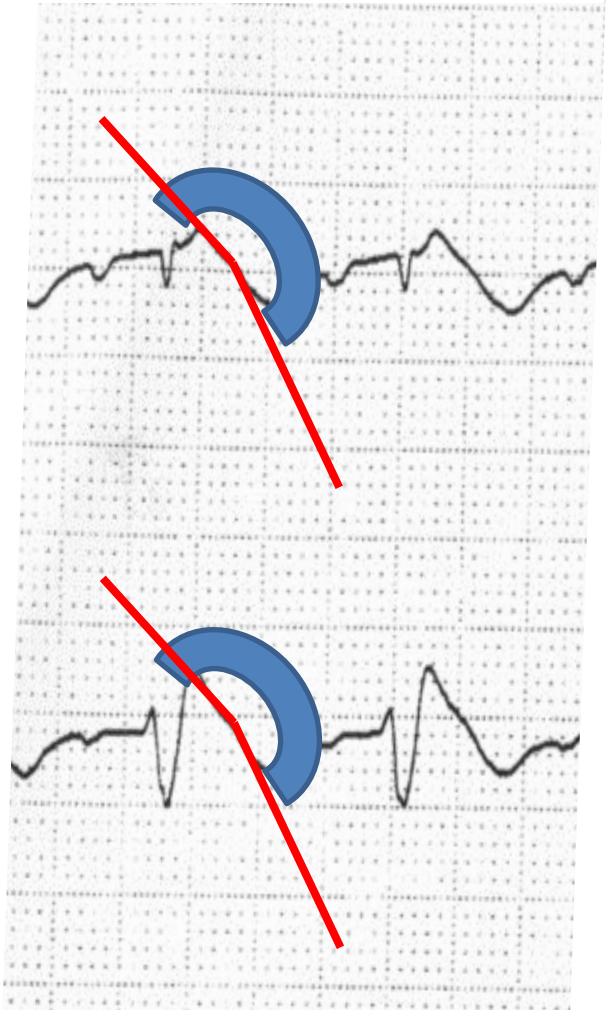
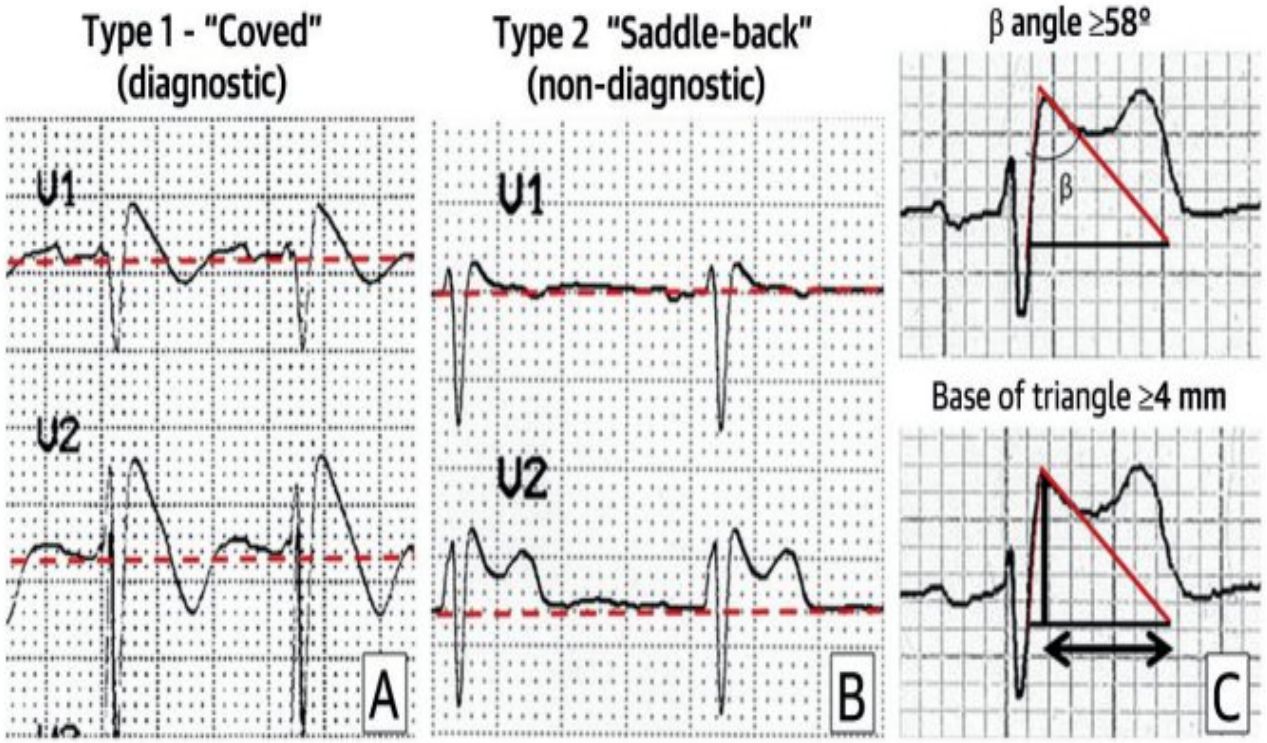


FIGURE 1 Electrocardiographic Patterns in Brugada Syndrome



(A) Type 1 Brugada electrocardiogram pattern showing a concave ST-segment elevation ≥2 mm in ≥1 right precordial lead, followed by a negative T-wave. **(B)** Type 2 Brugada electrocardiogram pattern showing a convex ST-segment elevation ≥0.5 mm (generally ≥2 mm) in ≥1 right precordial lead followed by a positive T-wave. **(C)** Additional criteria for the diagnosis of Brugada electrocardiogram pattern type 2 (**top**: the β angle, described by Chevallier et al. (18); **bottom:** the length of the base triangle of the r' wave 5 mm below the maximum rise point).

Brugada P et Al *Present status of Brugada*

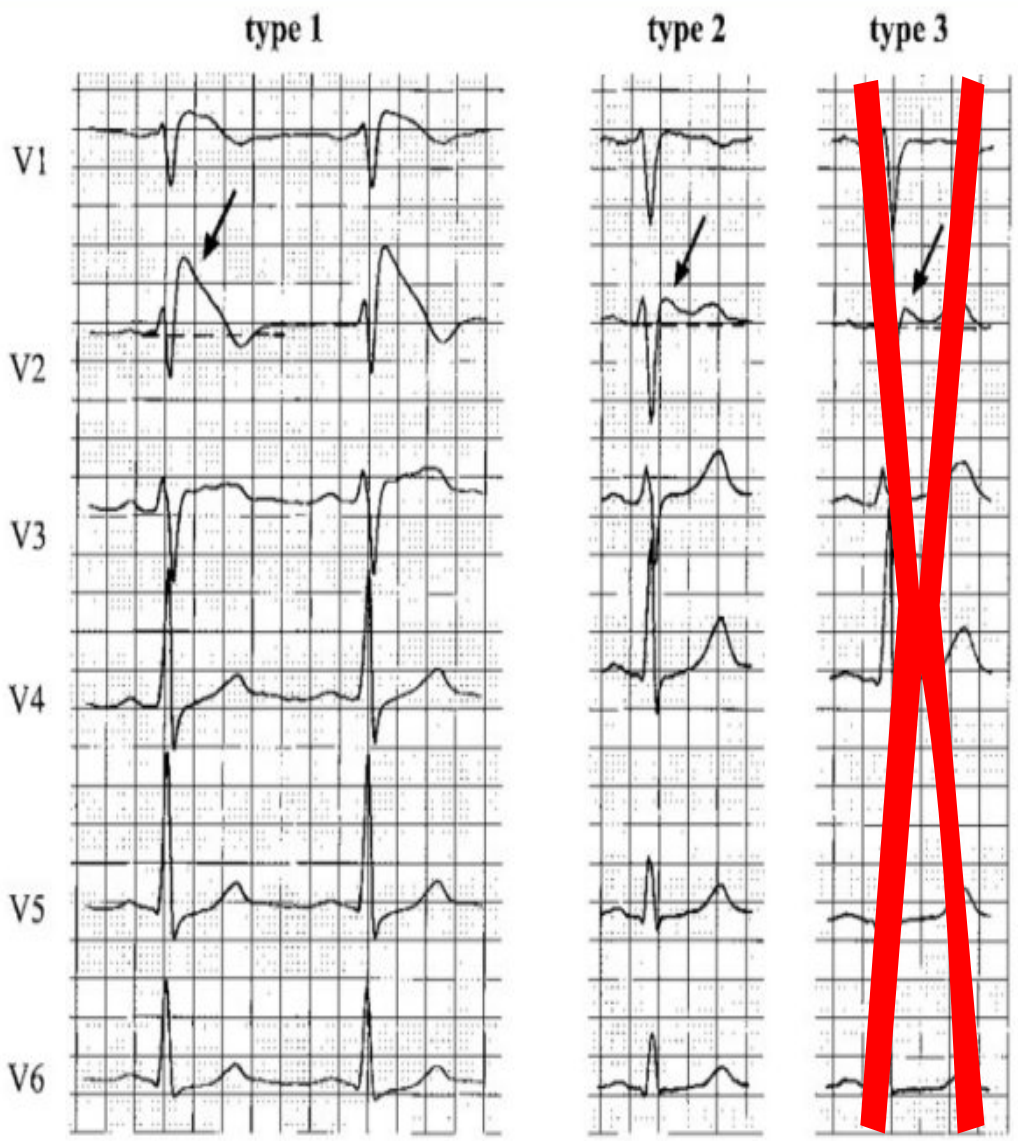
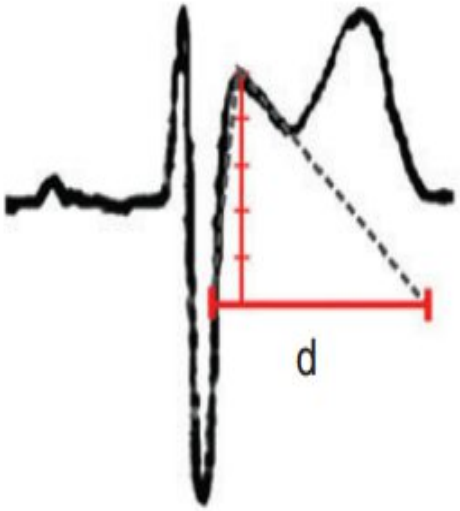


Figure 2 The three different electrocardiogram (ECG) patterns described in the first consensus (modified from Wilde *et al.*[8]).

Sieira J et Brugada P *The definition of Brugada*

Saddle-Back: differential diagnosis

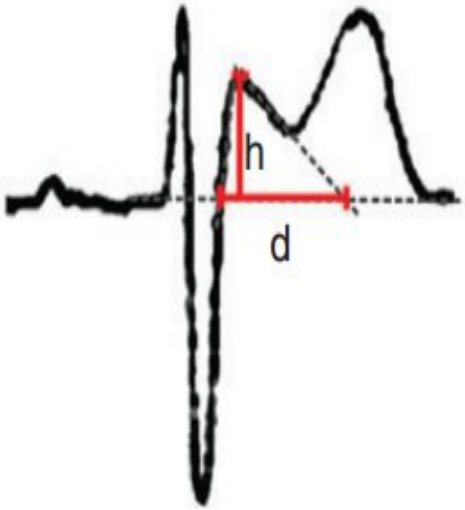
Duration (d) at 5 mm from *r'* spike



d ≥ 4 mm o 160 ms*^

Type 2

Duration (d) and height (h) at baseline

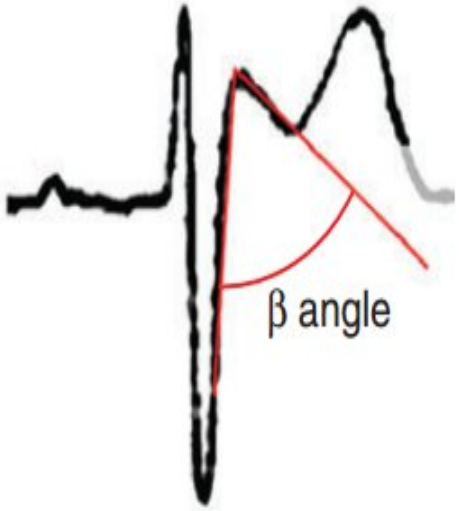


d ≥ 1,5 mm o 60 ms*^

Ratio d/h ≥ 0,8 *^

Ratio d/h ≥ 1.3 ^

β angle



≥ 58° Type 2 ^°

≥ 36,8° Type 2 *

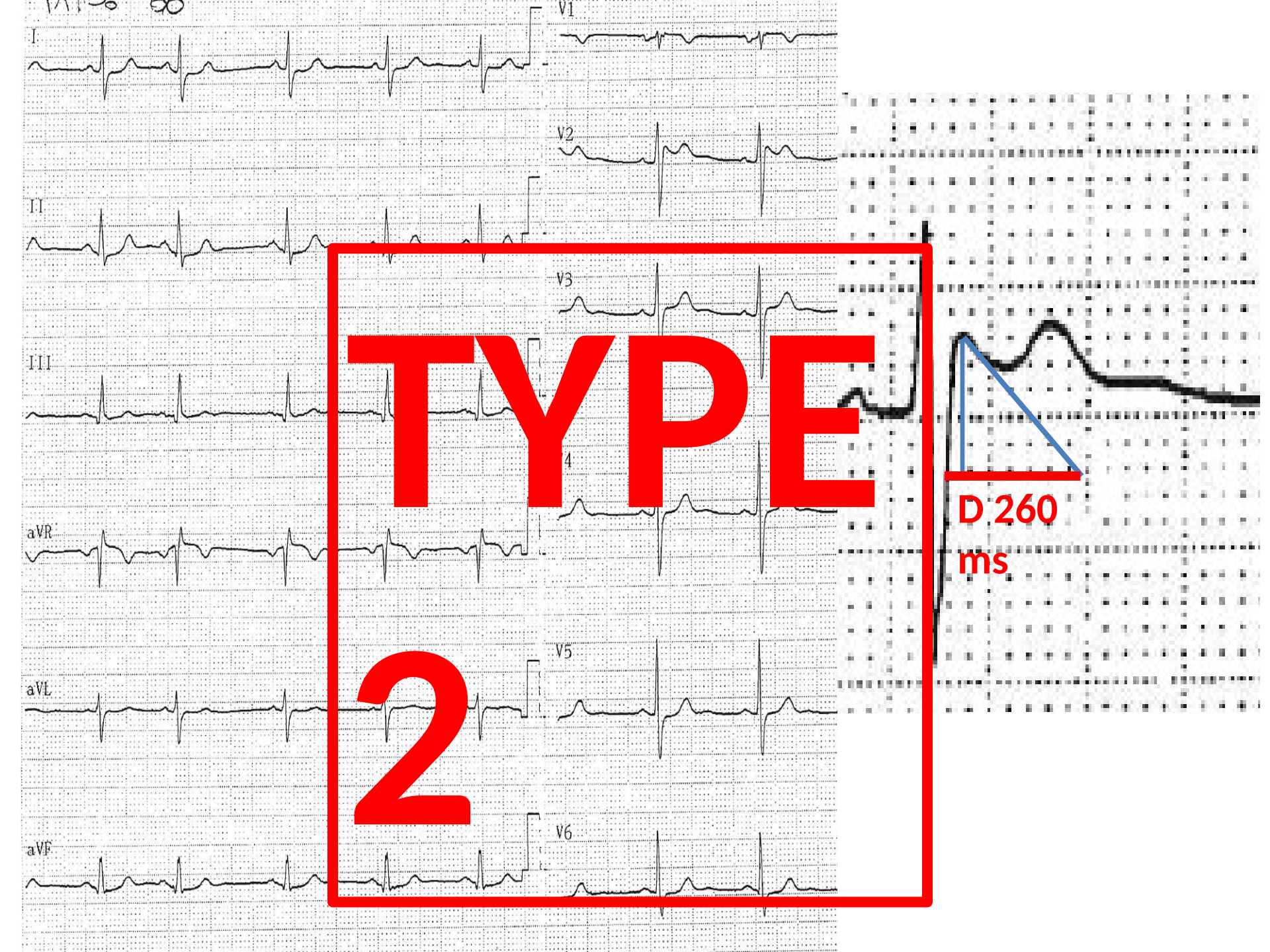
*Serra G et Al *New electrocardiographic criteria to differentiate type 2 Brugada pattern*..... Europace 2014

^ Brugada P et Al *Present status of Brugada Syndrome* JACC 2018

Table I Diagnostic accuracy of the best cut-off values for the different measurements based on the characteristics of the *r′*-wave obtained in leads V1–V2

Leads V1–V2[a]	Sensitivity	Specificity	PPV	NPV
Duration of the base of the triangle at 5 mm from *r′*-wave ≥160 ms (4 mm)	85	95.6	94.4	87.9
Triangle base/height ratio	82	92.1	90.1	83.3
Duration of the base of the triangle at the isoelectric line ≥60 ms (1.5 mm)	94.8	78	79.3	93.5
[b]β angle ≥36.8°	86	94.7	93.5	88.5

Serra G et Al *New electrocardiographic criteria to differentiate Type-2 Brugada pattern from electrocardiogram of healthy athletes with r´-wave in leads V1/V2;*


I
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III
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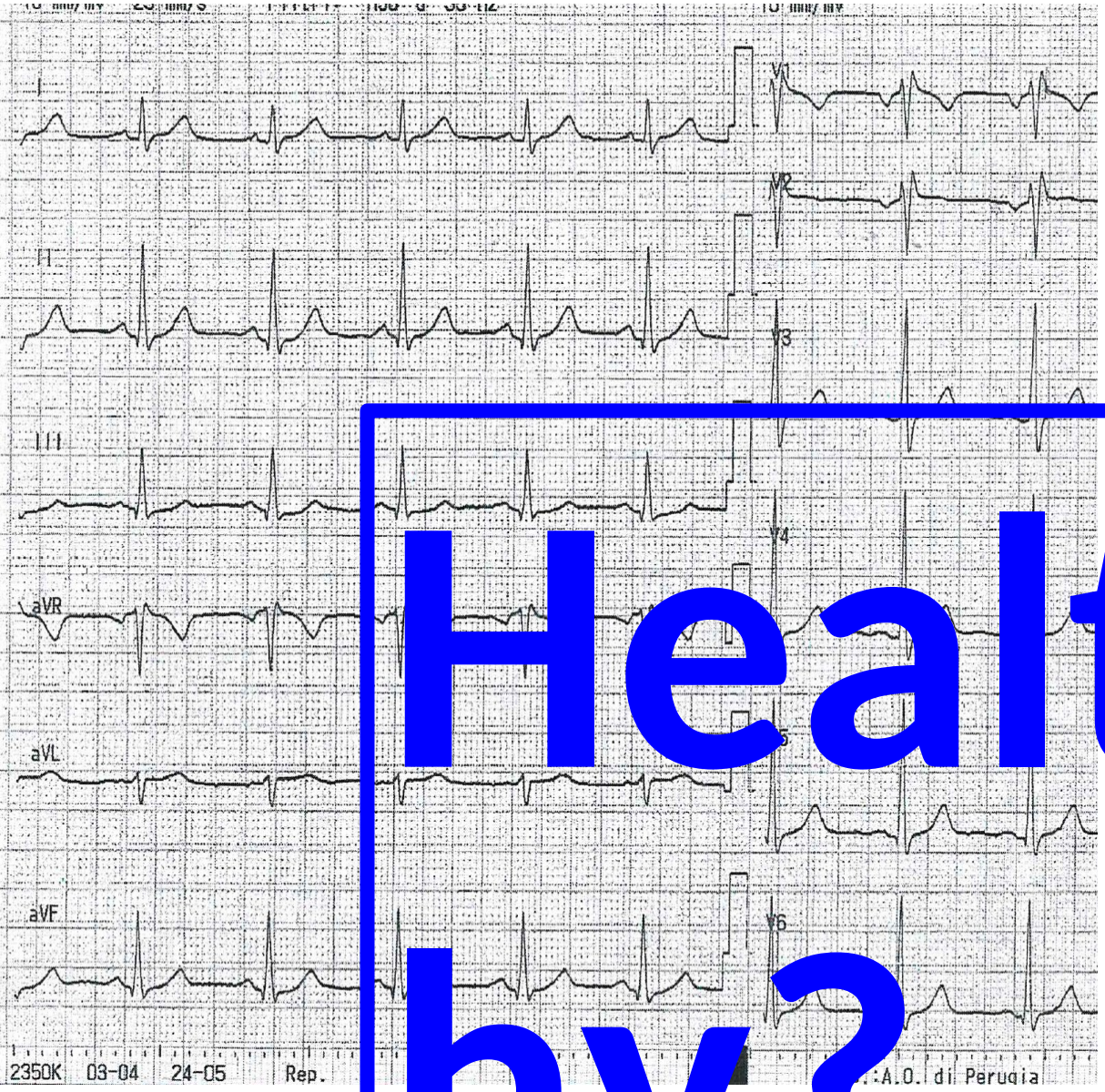
aVL
aVF
V1
V2
V3
V4
V5
V6
TYPE
2
D 260
ms


I
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V1
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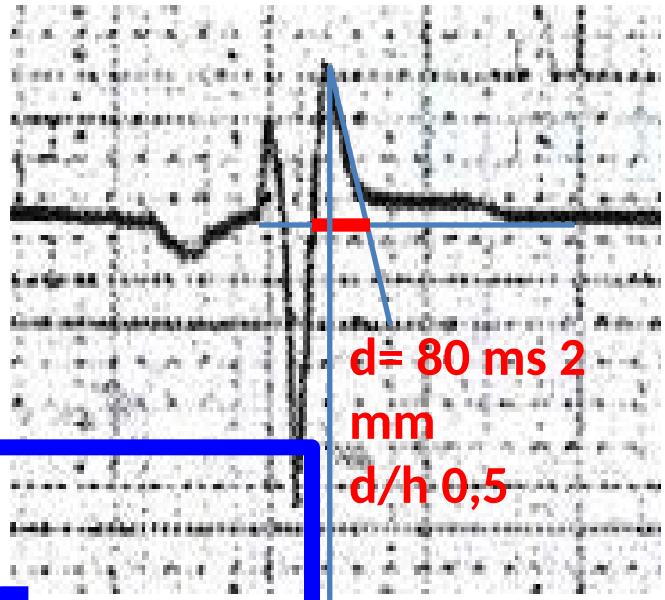
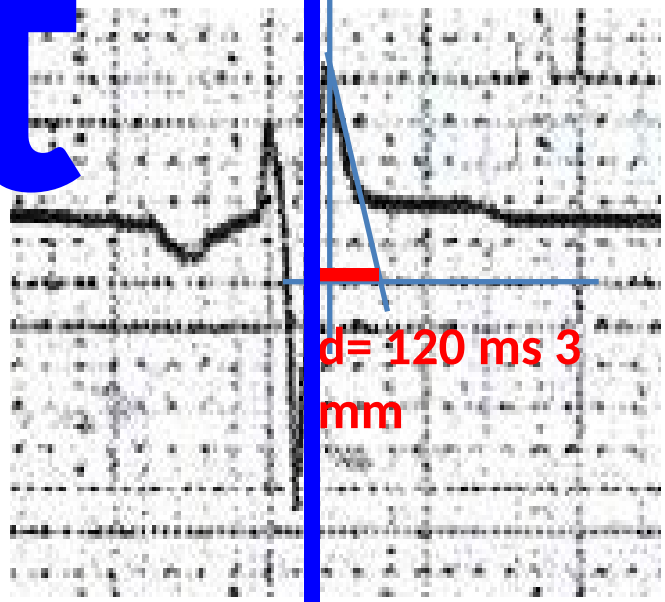
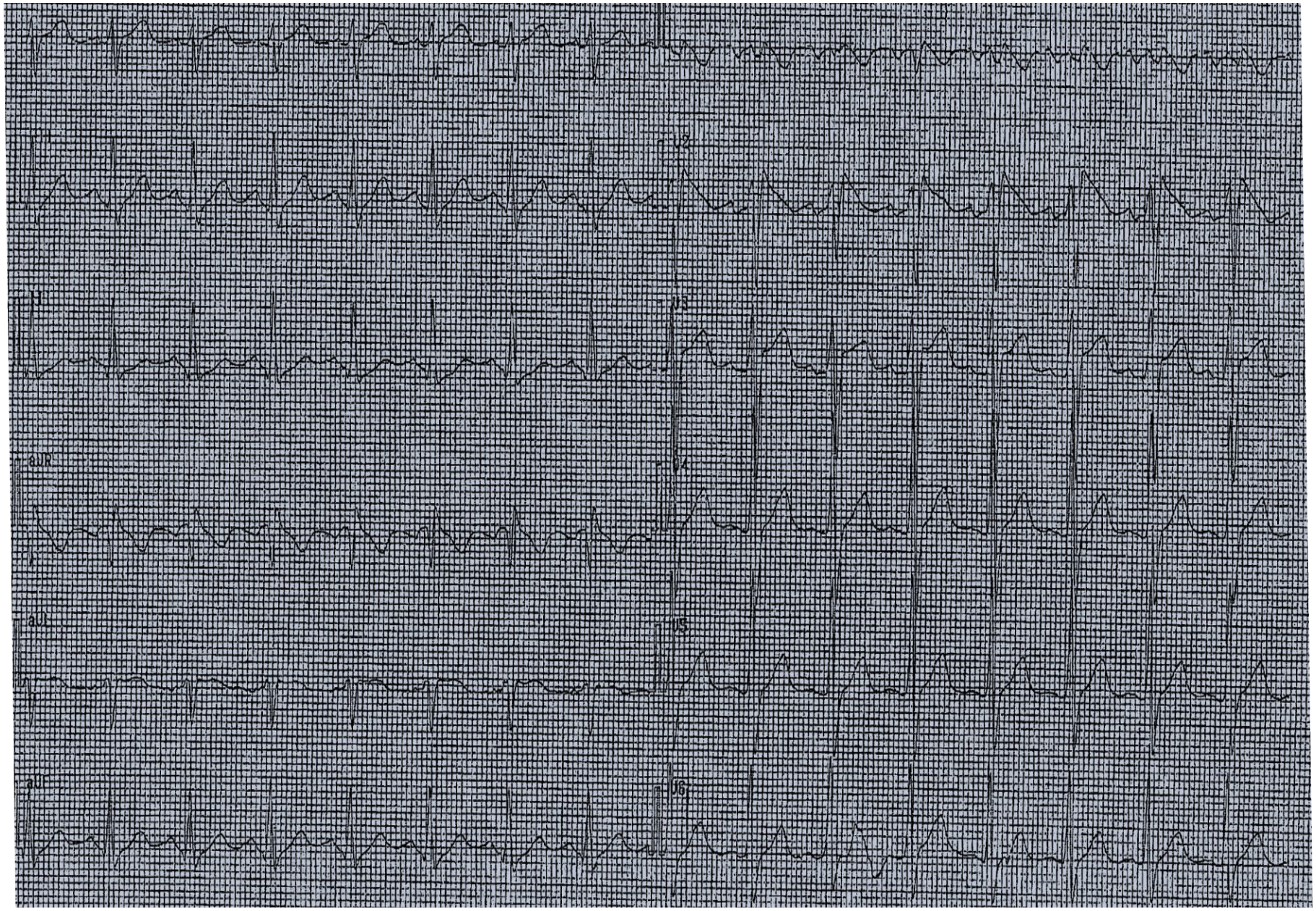
V4
V5
V6
2350K 03-04 24-05 Rep.
A.O. di Perugia


d= 80 ms 2 mm
d/h 0,5


d= 120 ms 3 mm

Healthy?


I
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V1
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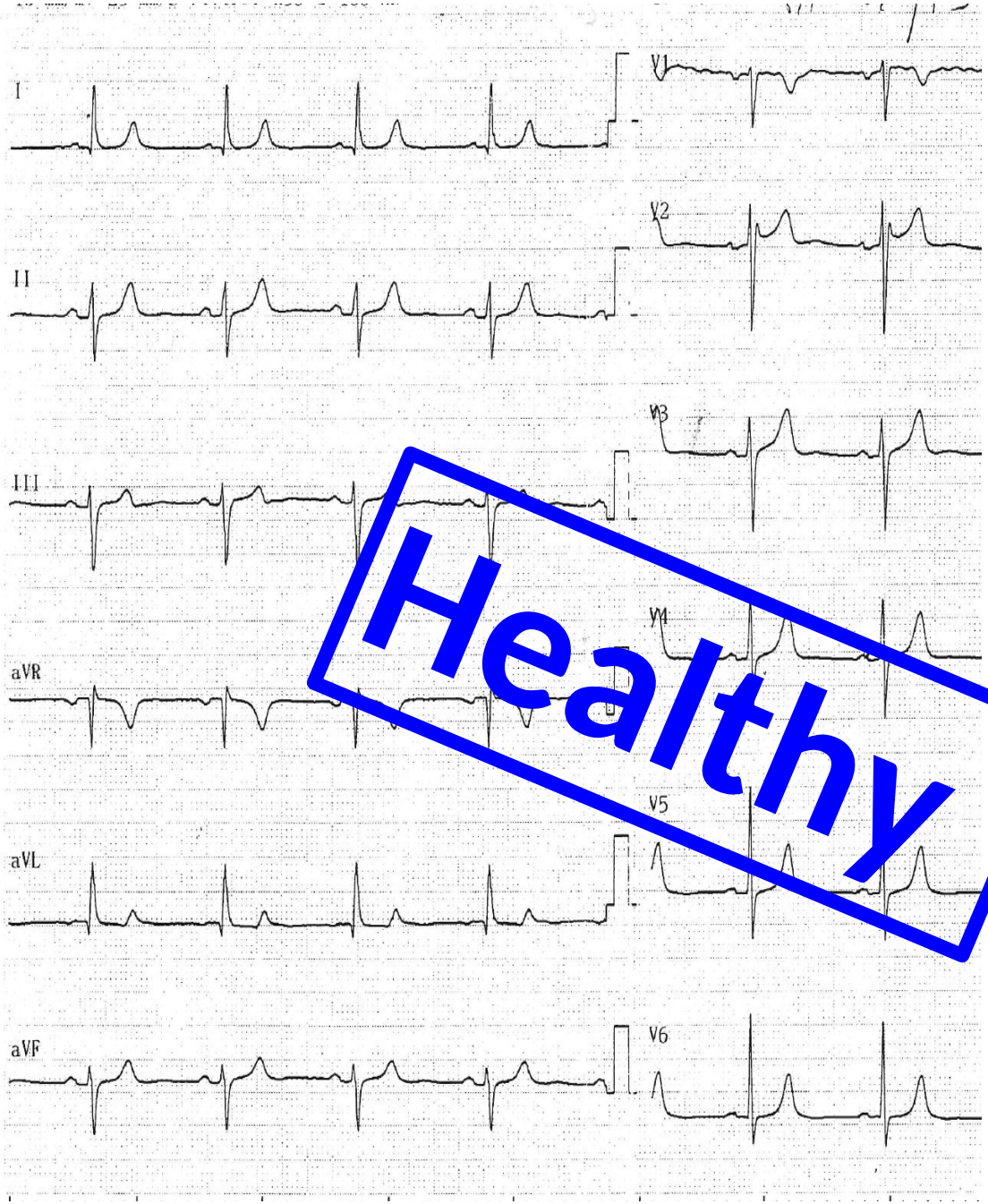
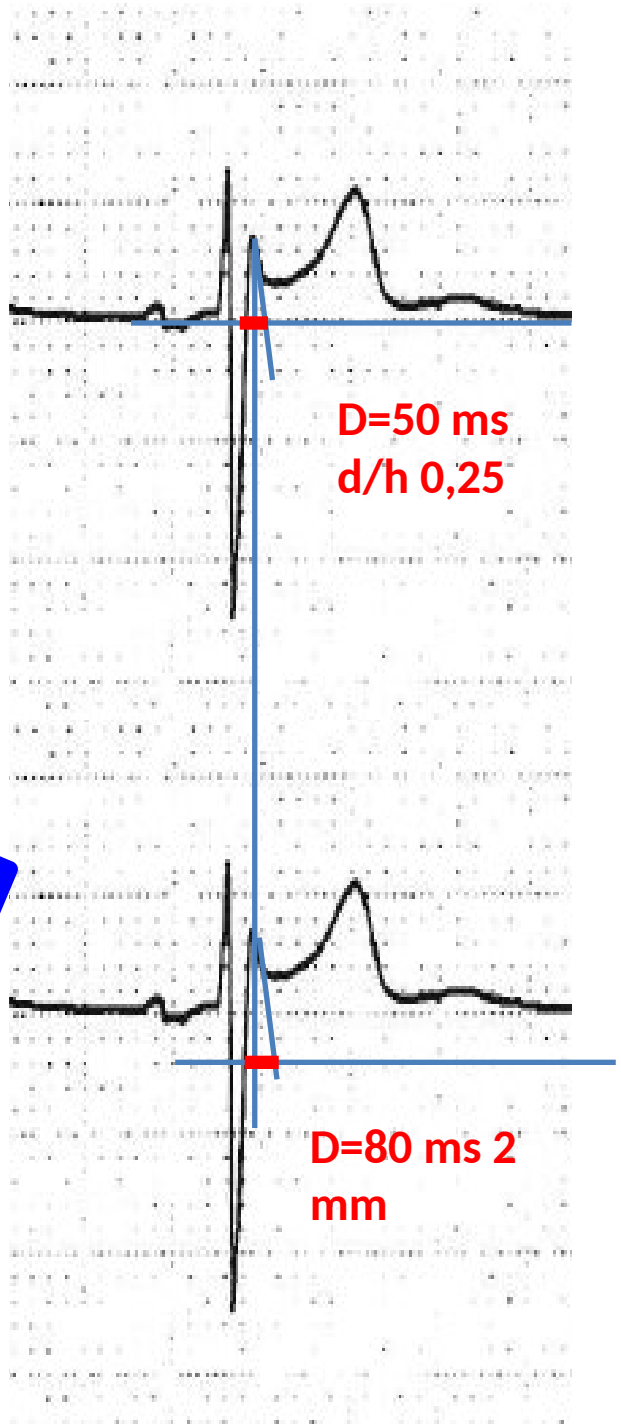
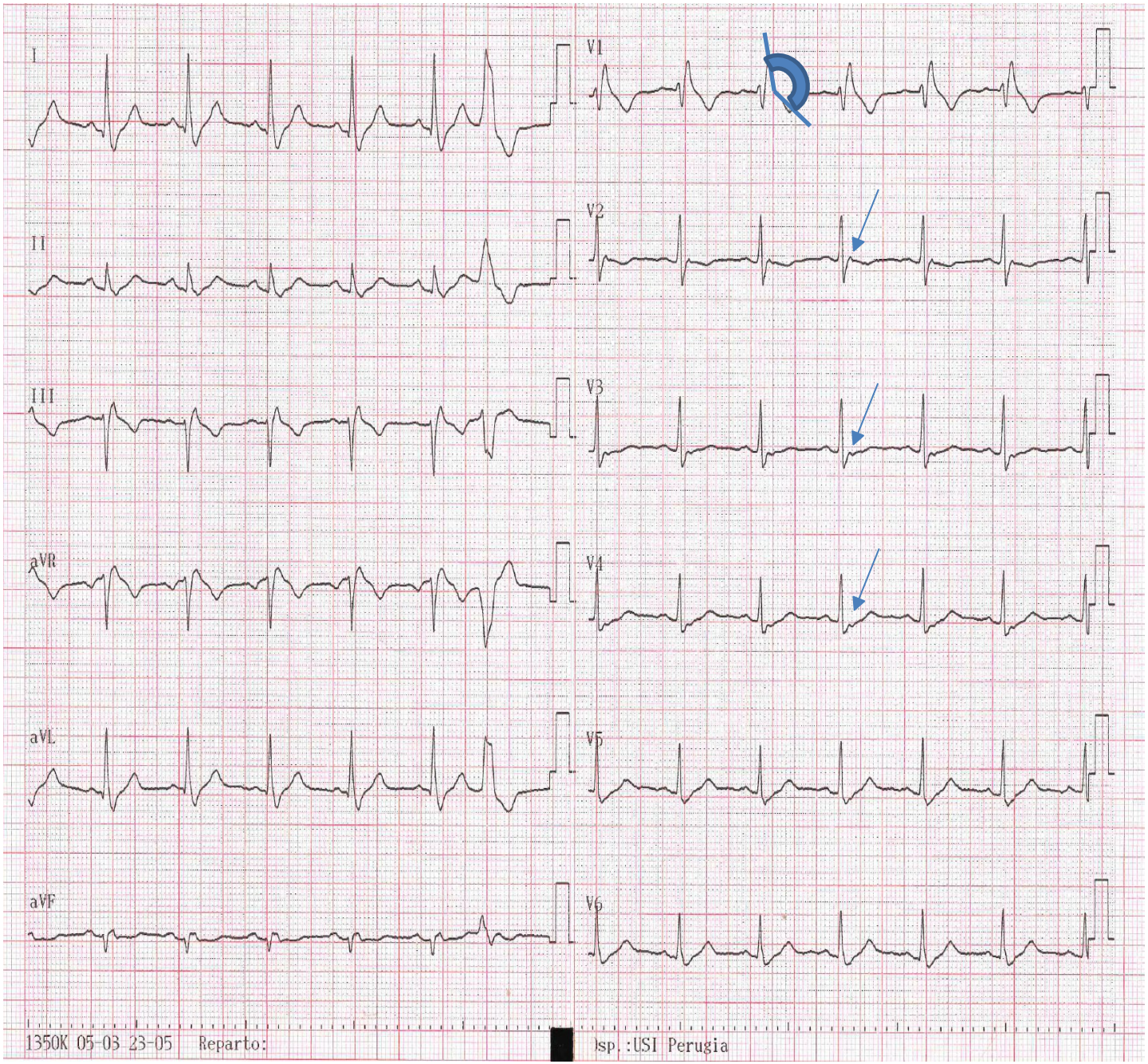
V3
V4
V5
V6



Healthy




I
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1350K 05-03 23-05 Reparto:
Osp. :USI Perugia


I
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III
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aVL
aVF
V1
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V3
V4
V5
V6
1000 ms
13:10:49
13:10:51
13:10:53
13:10:55
13:10:57
13:10:59
CardioLab v6.5
GE Medical Syst