Ventricular tachycardia

김 준형

충남대학교 병원 심장내과

Korean Heart Rhythm Society

COI Disclosure

Name of First Author:

The authors have no financial conflicts of interest to disclose concerning the presentation

Disclosure

Relationships with commercial interests:

- Grants/Research Support:
- Speakers Bureau/Honoraria:
- Consulting Fees:
- Other:

증례 1

M/53

- Palpitations and dizziness, especially aggravated after exercise

- PMHx; none

- Wide QRS tachycardia during Treadmill test


2020/03/12
15:15:48
STAGE 3
8:07
5.5 km/h
14.0 %
aVR
V1
II
aVL
V2
III
aVF
V3
II
GE CASE V6.51 (0)
25mm/s 10mm/mV 60Hz 0.01Hz FRFr HR(V3,V4)
Unconfirmed
Amending MD:
Page 8

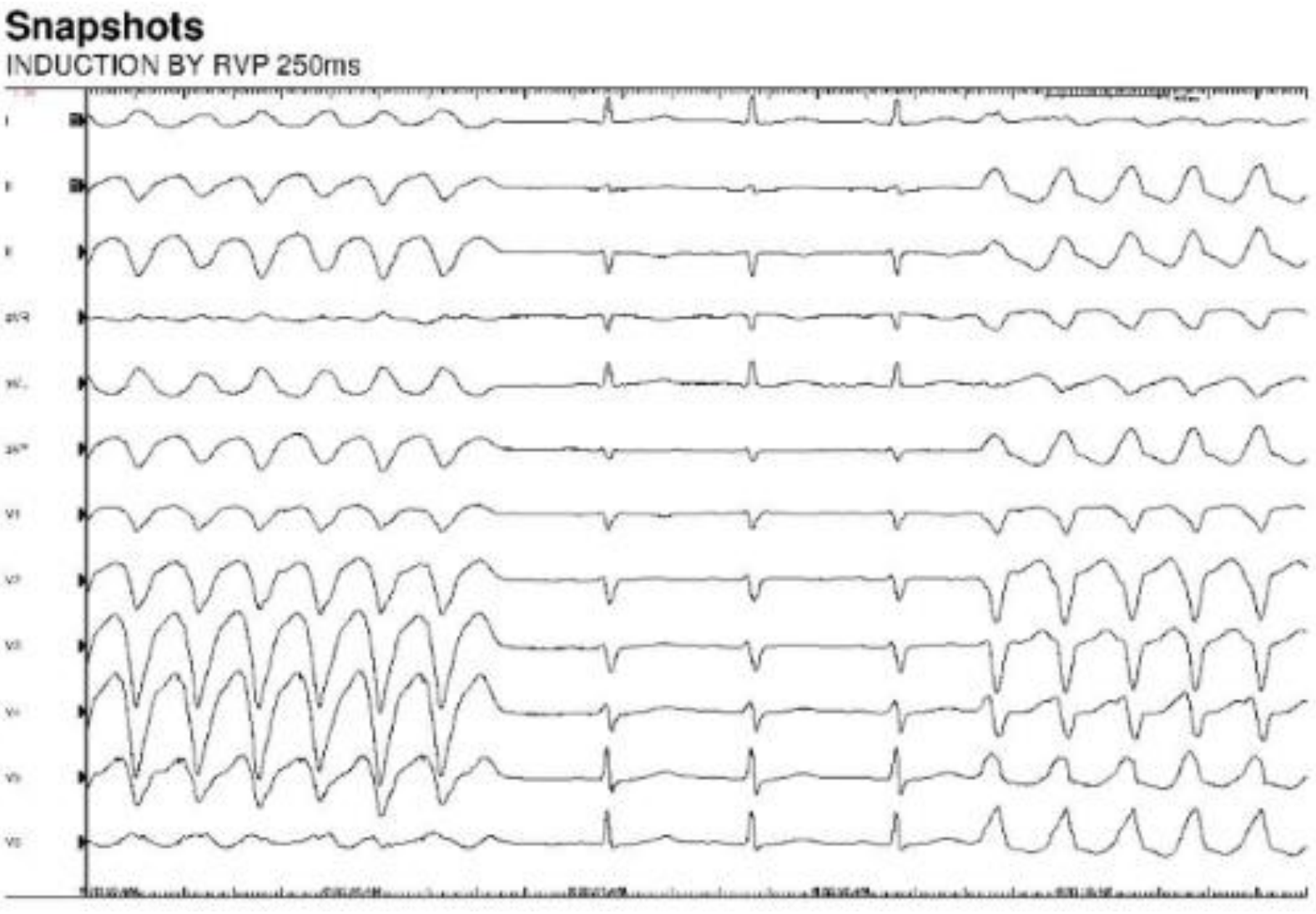

2020/03/12
15:18:09
STAGE 4
10:29
6.8 km/h
16.0 %
I
II
aVR
V1
V2
V3
V4
V5
V6
GE CASE V6.51 (0)
25mm/s 10mm/mV 60Hz 0.01Hz FRF+ HR(V3,V4)
Unconfirmed
Attending MD:
Page: 14


2020/03/12
15:18:39
0:29
0.0 km/h
0.0 %
aVR
V1
I
V2
II
V3
III
aVF
II
GE CASE V6.51 (0)
25mm/s 10mm/mV 60Hz 0.01Hz FRF+ HR(V3,V4)
Unconfirmed
Attending MD:
Page: 15

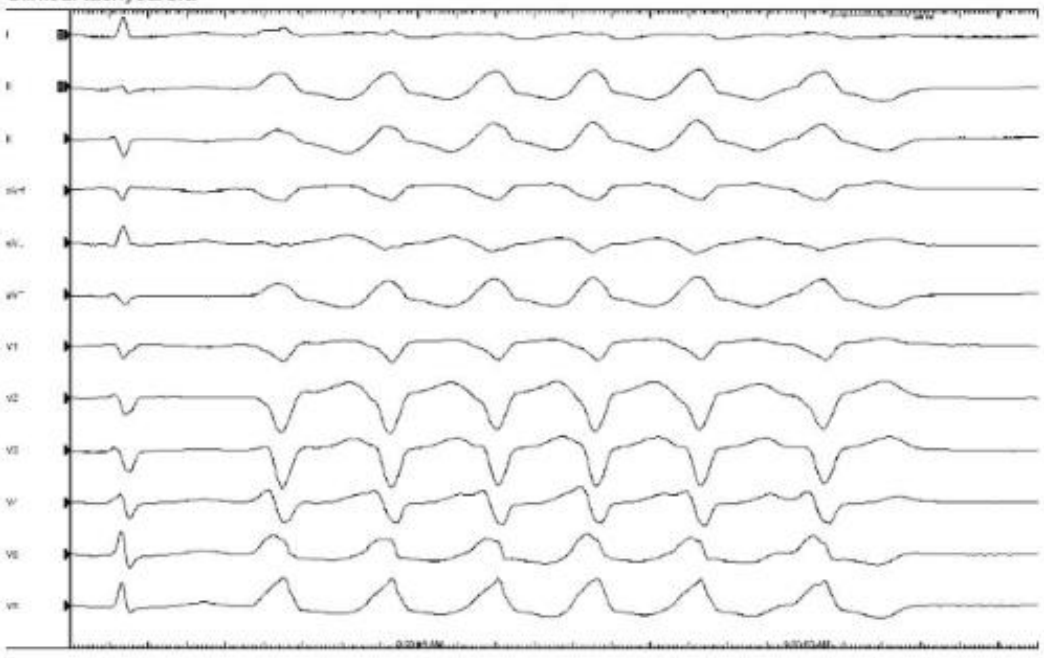
가장 가능성이 높은 것은?

1. Paroxysmal supraventricular tachycardia with aberrant conduction
2. Atrial flutter with aberrant conduction
3. LV fascicular VT
4. Outflow tract VT
5. VT in structural heart disease

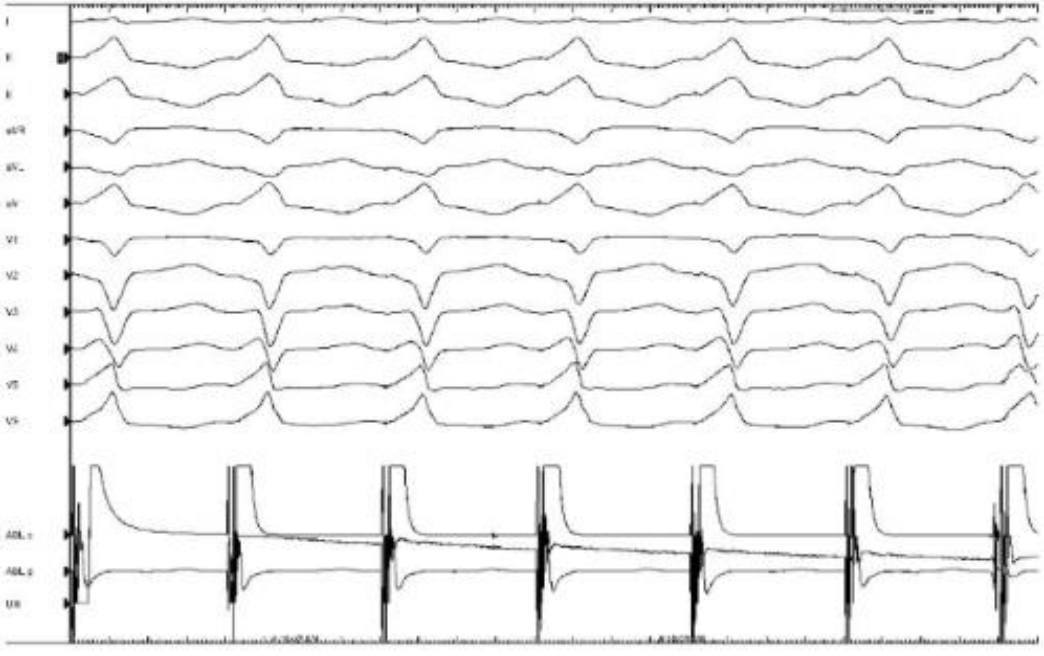
EP study



Clinical tachycardia



PACEMAP 97% ANTERIOR SEPTUM



GOOD ABLATION SIGNAL

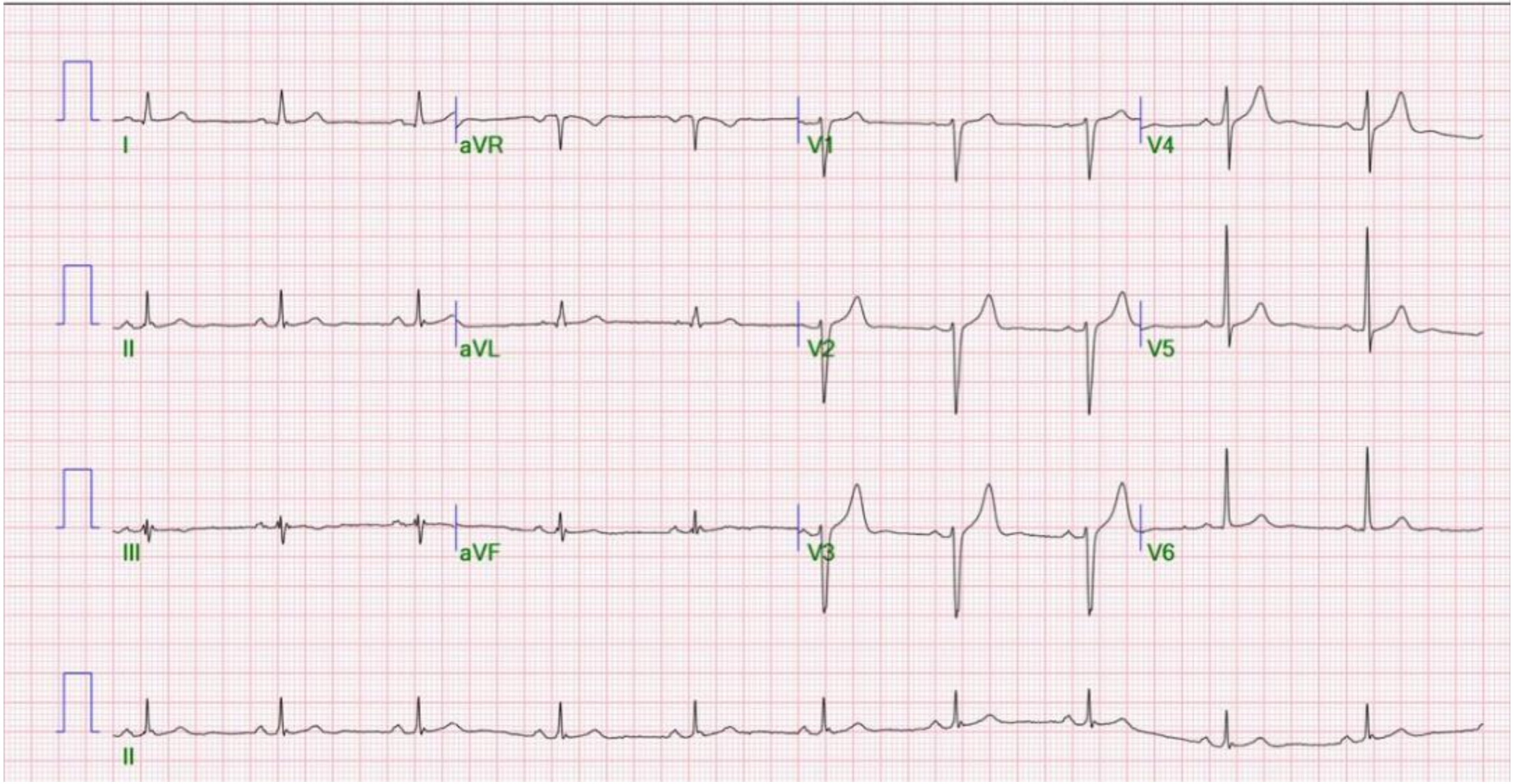
증례 2

M/41

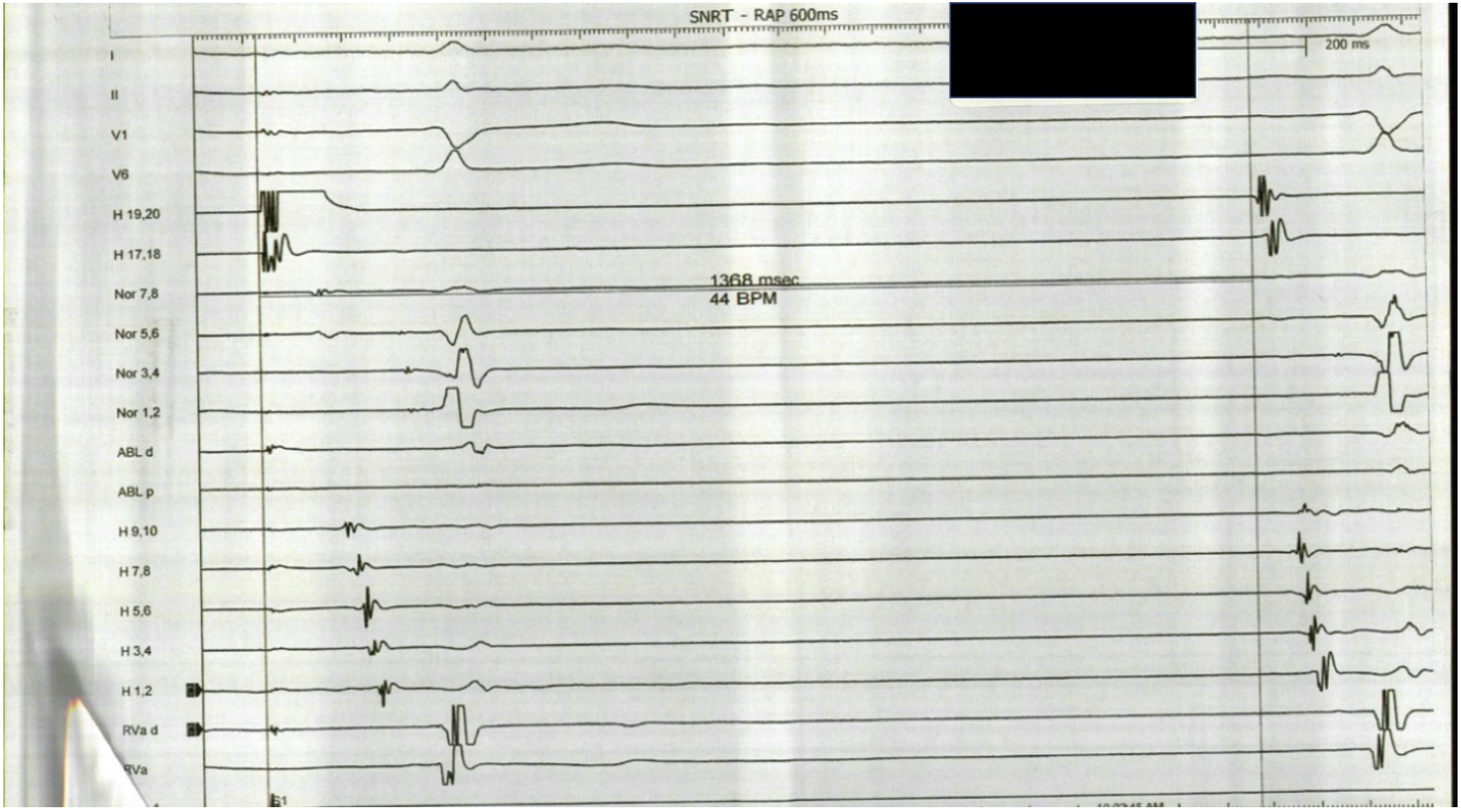
- Chest pain with palpitation
- PMHx; pul Tb (96)
- Wide QRS tachycardia at ER

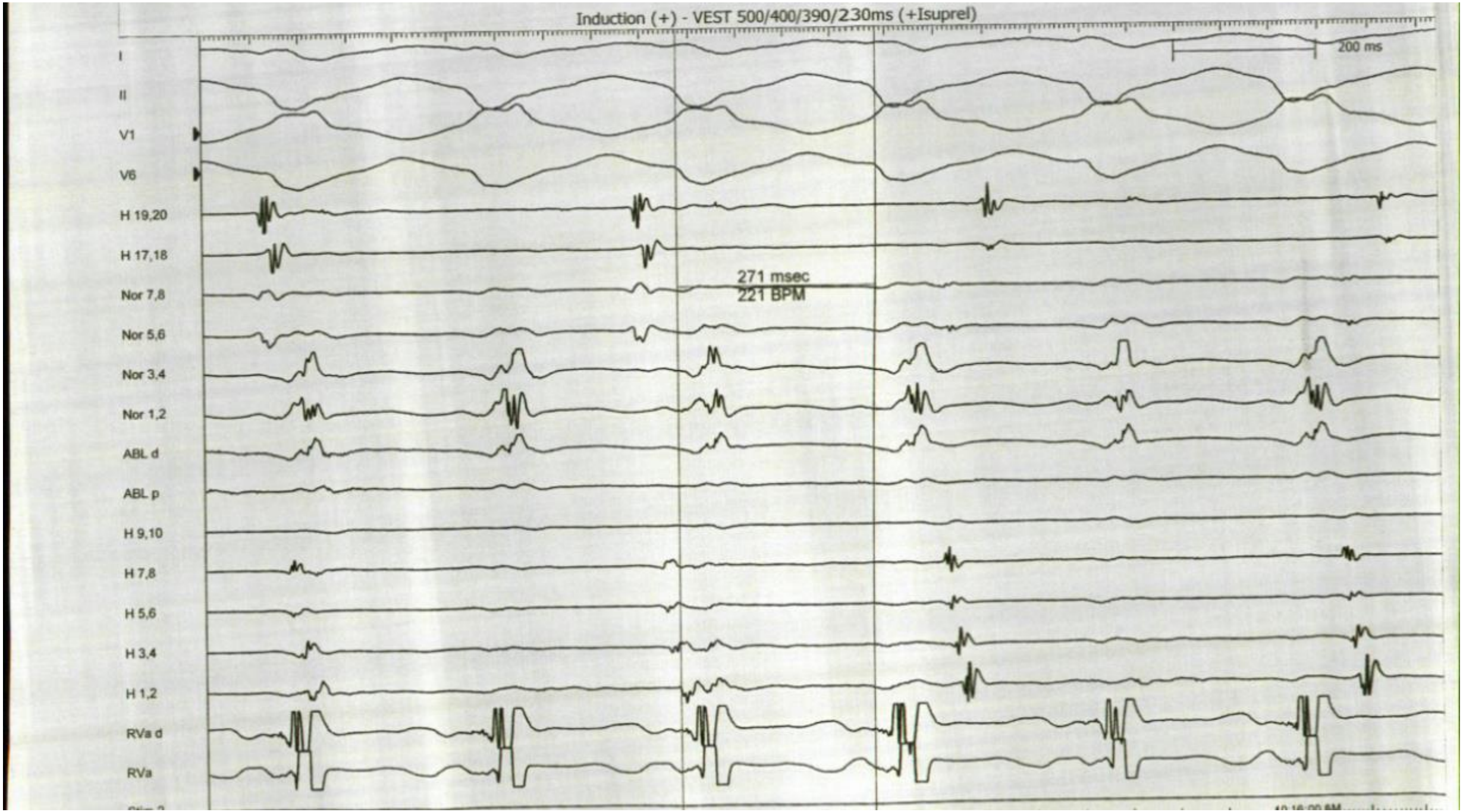
ER ECG

ECG after DC cardioversion

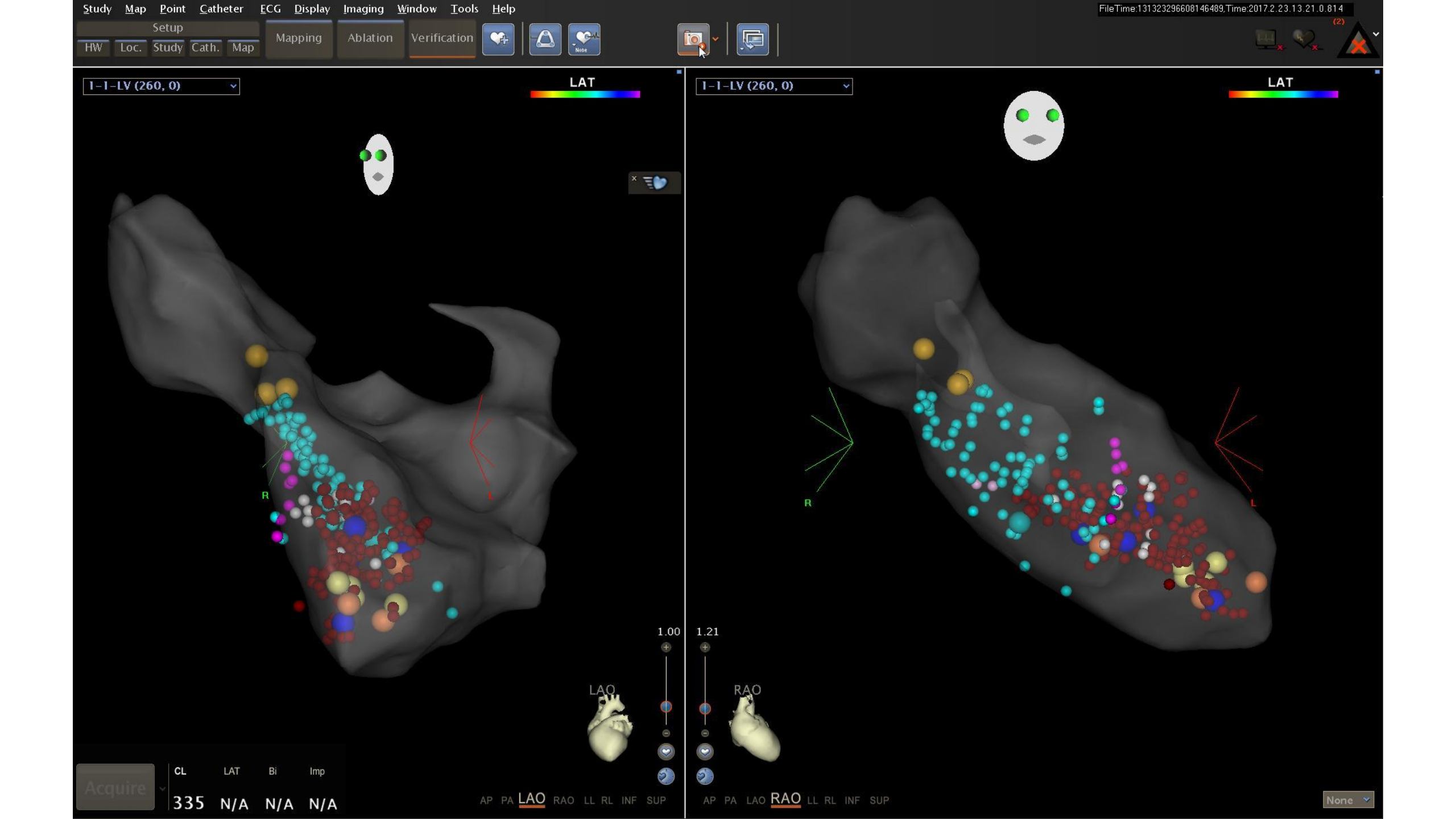


EP study


SNRT - RAP 600ms
200 ms
I
II
V1
V6
H 19,20
H 17,18
1368 msec
44 BPM
Nor 7,8
Nor 5,6
Nor 3,4
Nor 1,2
ABL d
ABL p
H 9,10
H 7,8
H 5,6
H 3,4
H 1,2
RVa d
RVa


Induction (+) - VEST 500/400/390/230ms (+Isuprel)
200 ms
I
II
V1
V6
H 19,20
H 17,18
271 msec
221 BPM
Nor 7,8
Nor 5,6
Nor 3,4
Nor 1,2
ABL d
ABL p
H 9,10
H 7,8
H 5,6
H 3,4
H 1,2
RVa d
RVa

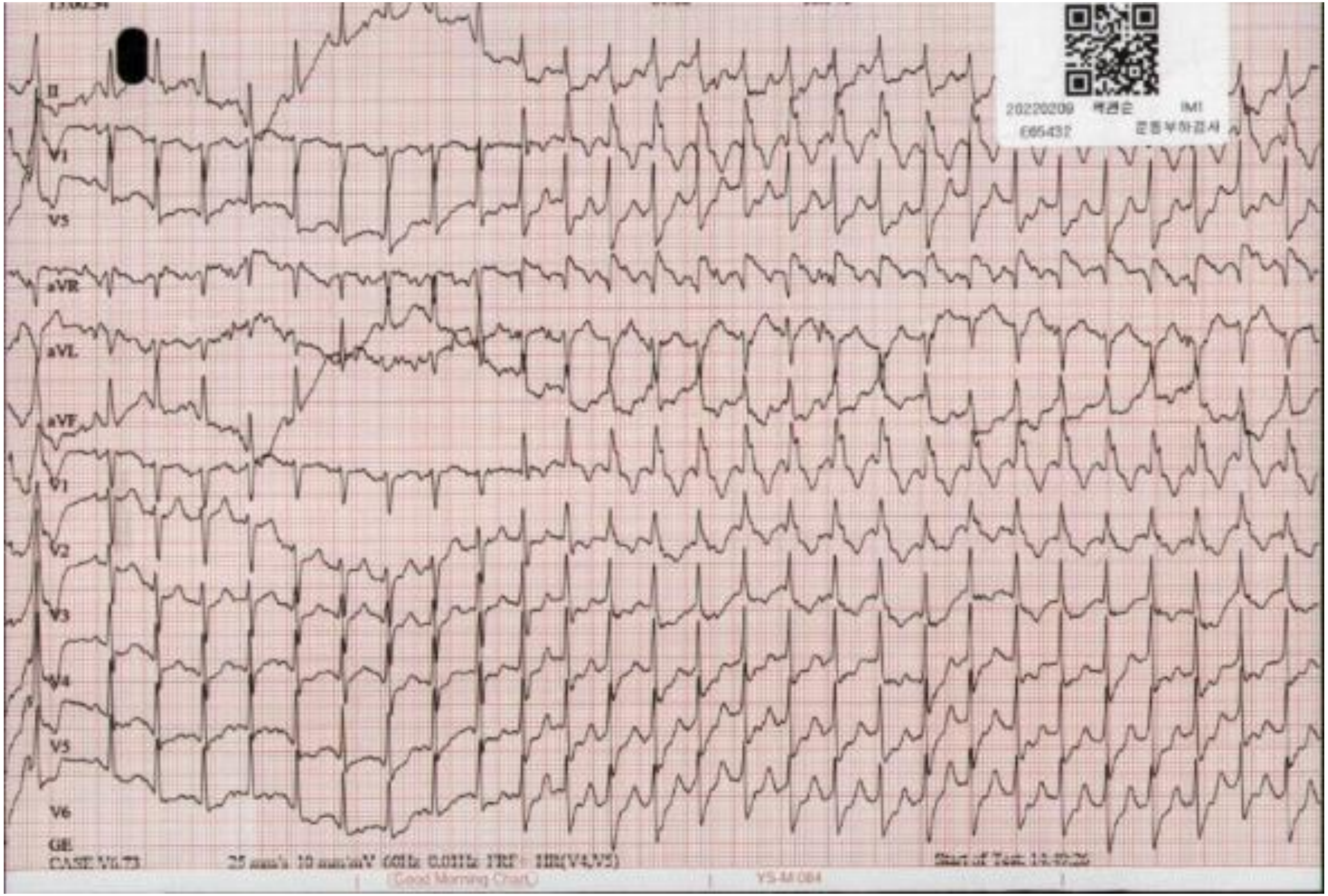

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II


Study Map Point Catheter ECG Display Imaging Window Tools Help
FileTime:131323296608146489,Time:2017.2.23.13.21.0.814
Setup
HW Loc. Study Cath. Map
Mapping
Ablation
Verification
1-1-LV (260, 0)
LAT
R
L
1.00
LAO
AP PA LAO RAO LL RL INF SUP
1-1-LV (260, 0)
LAT
R
L
1.21
RAO
AP PA LAO RAO LL RL INF SUP
Acquire
CL LAT Bi Imp
335 N/A N/A N/A
None

증례 3

F/72

- Palpitation with chest pain during walking (15 min)
- Mild coronary artery disease according to outside coronary CT angio (2021)
- Impaired glucose tolerance (HbA1c 6.2)
- Wide QRS tachycardia during treadmill test


II
V1
V5
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
20220209
IMI
운동부하검사
GE
(Good Morning Chart)

During EP study

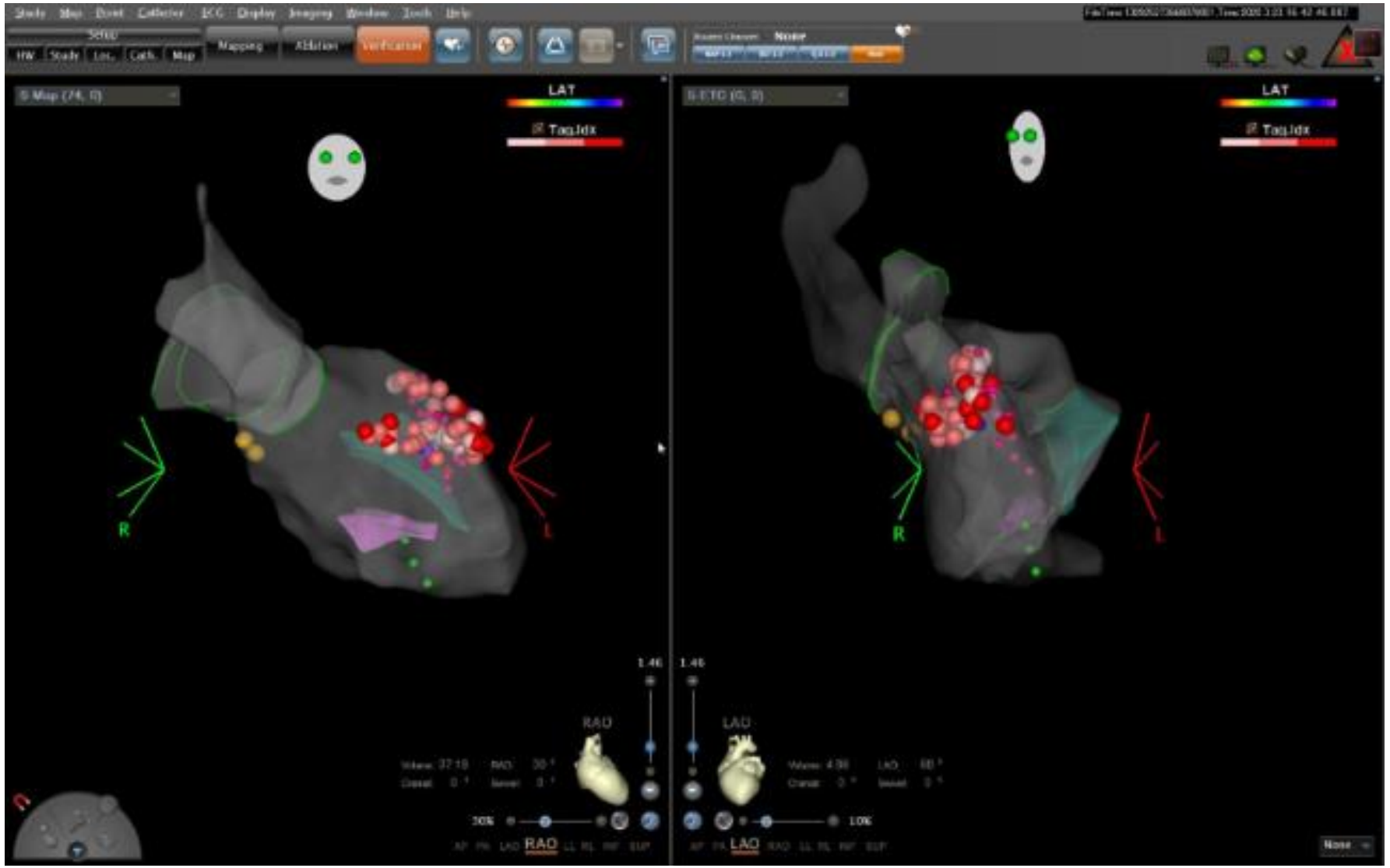
ECG during EP study

증례 3

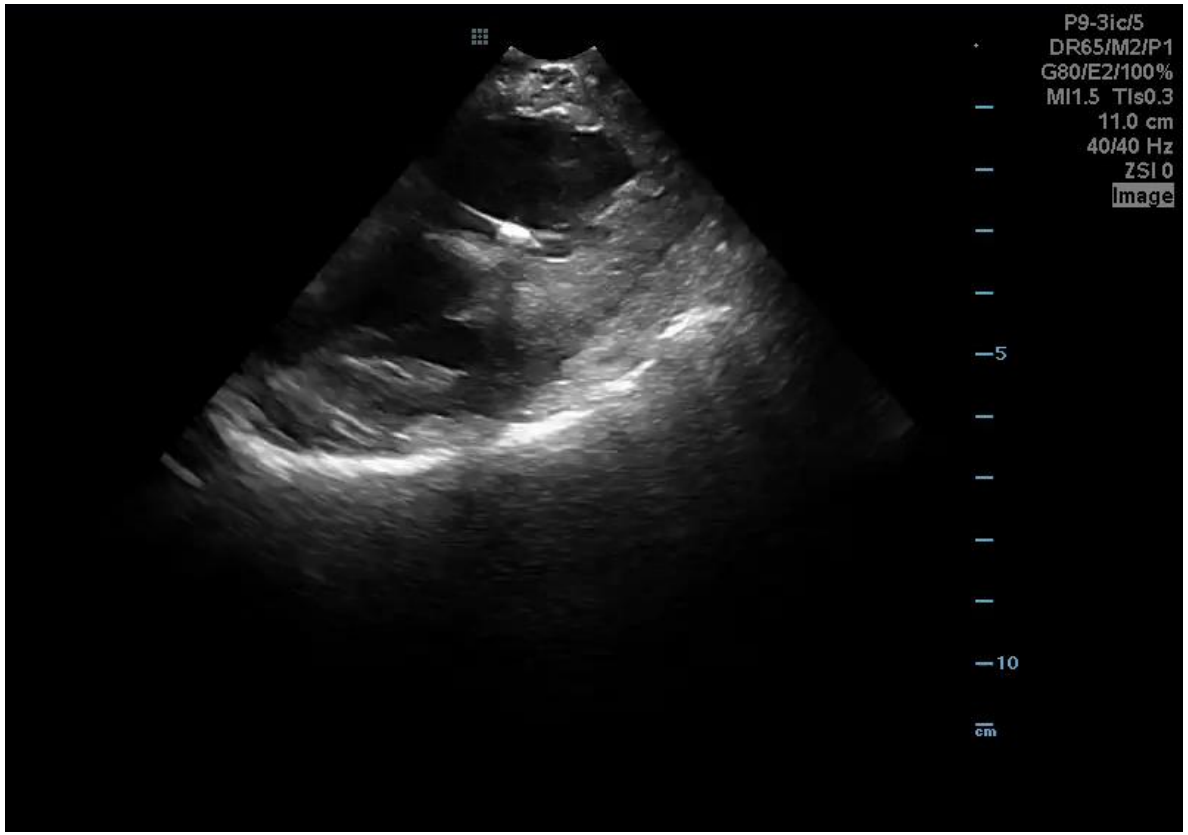
F/72

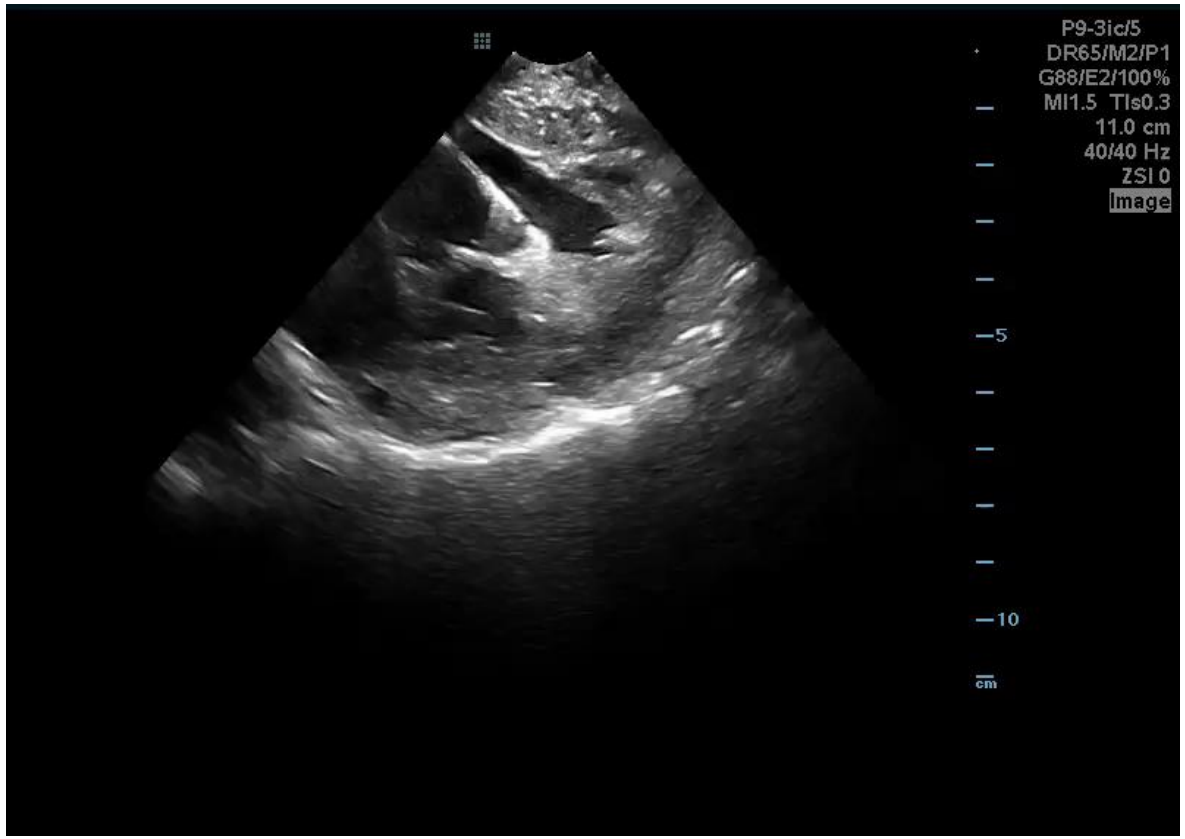
- Failed ablation

Redo ablation after one month

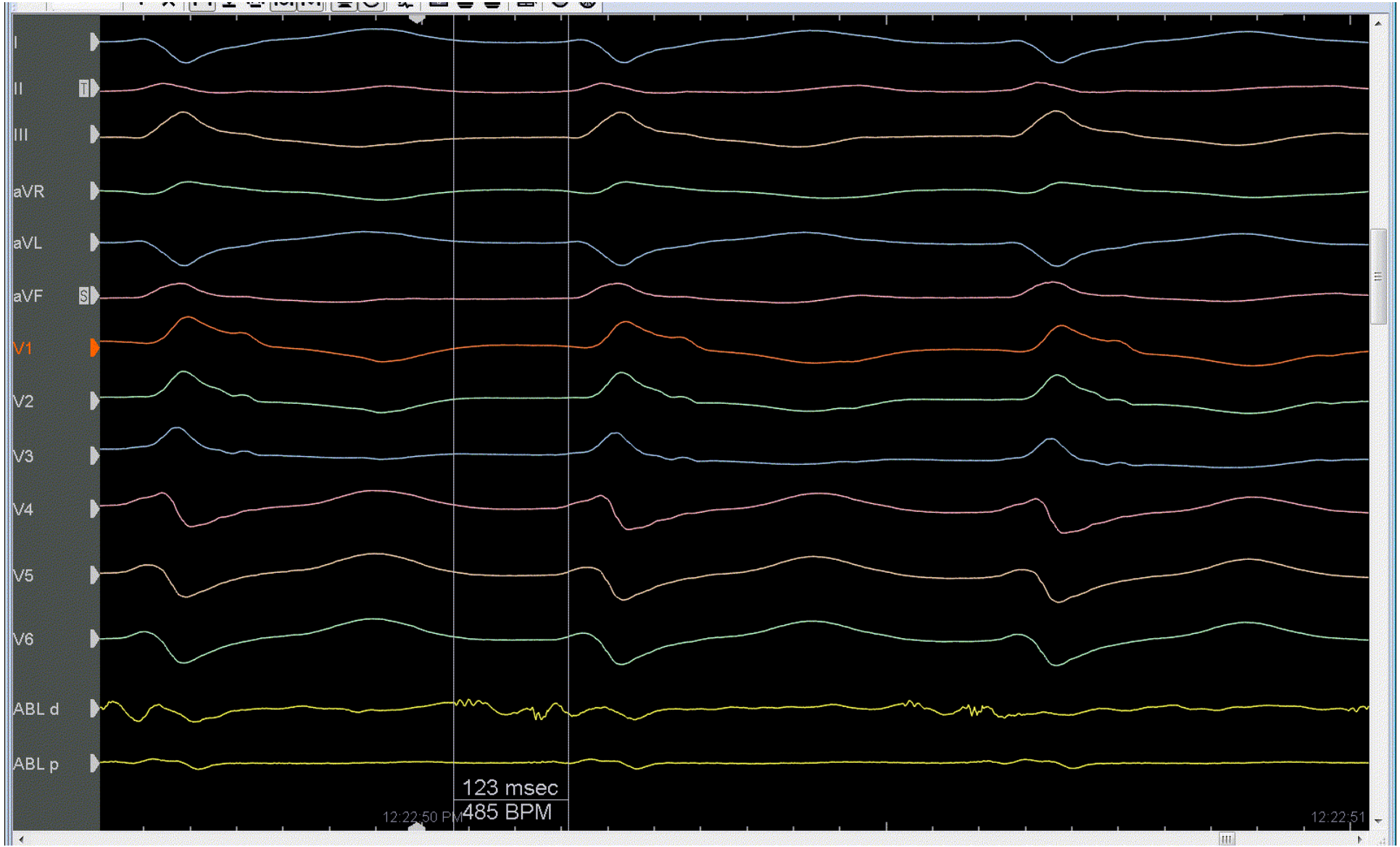


ICE image during ablation





Good signals during ablation



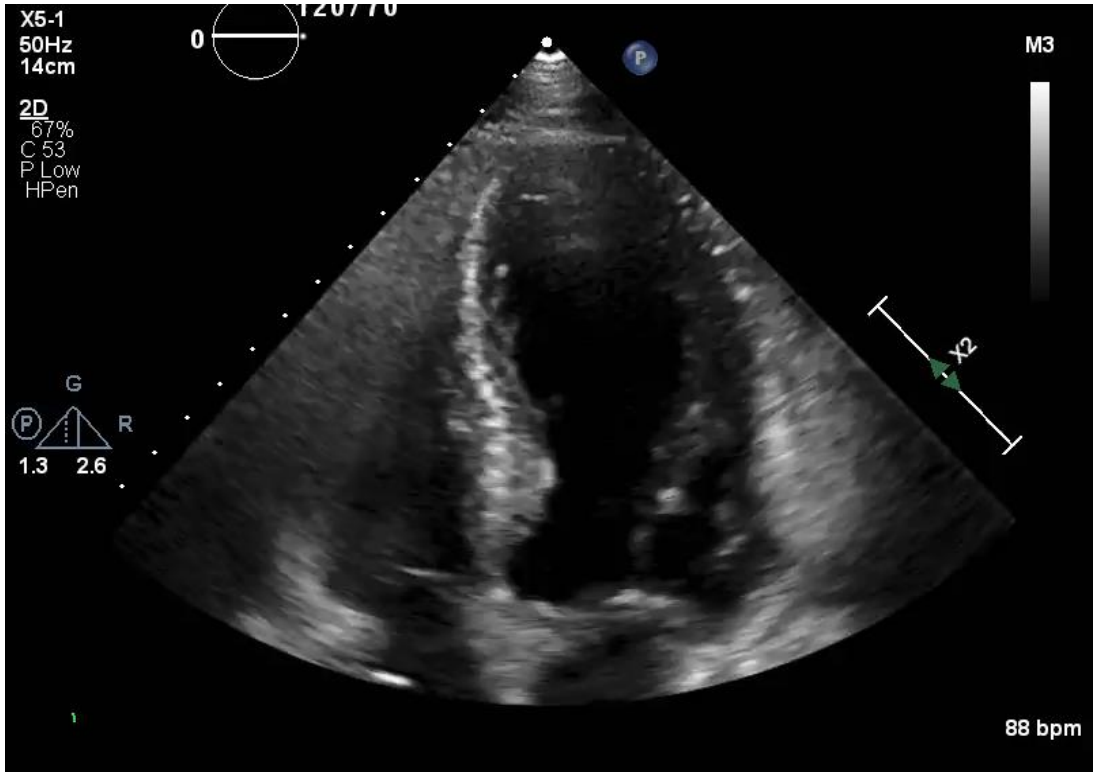
증례 4

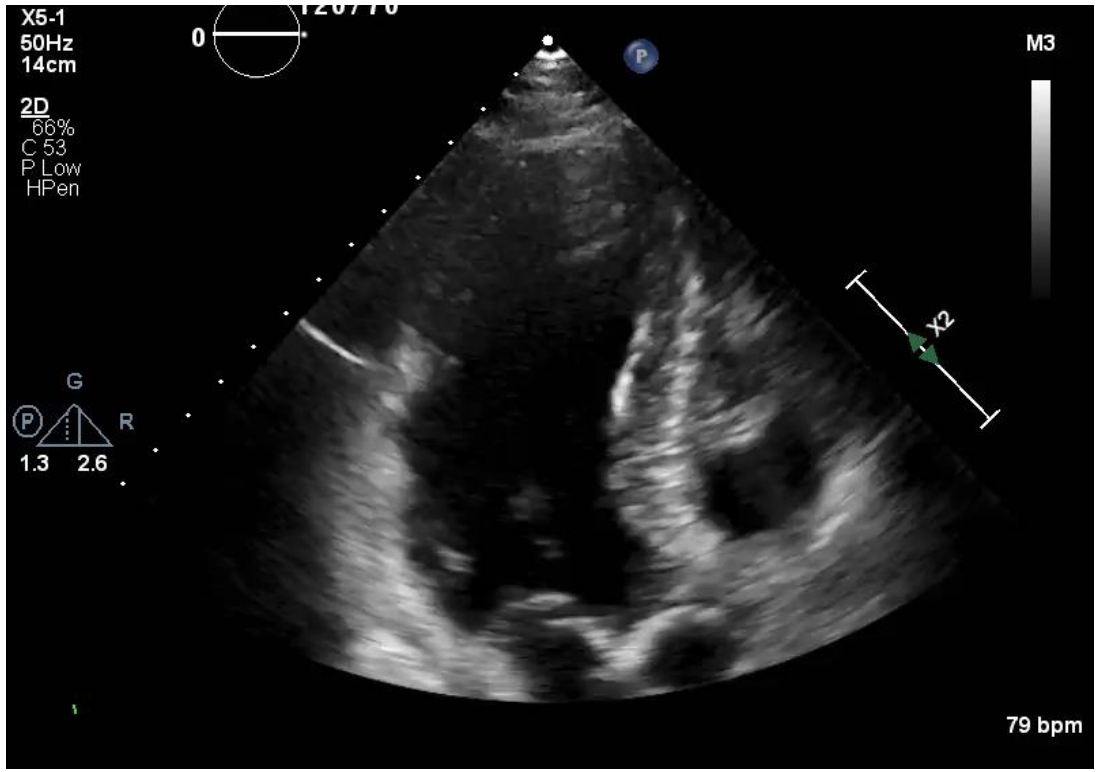
M/77

- Palpitations

- s/p PCI on dRCA (2007)
- s/p PCI on LM bifurcation, pLAD & D1 bifurcation
    - Double crushed stenting technique (15.12.8)
- s/p PPM d/t CAVB (17.9.19)
- s/p DEB on pLCx (18.10.16)
- s/p PCI on p-mRCA, DEB on Dx, LCx (19.5.29)
- s/p PCI on mLAD (20.6.25)

TTE

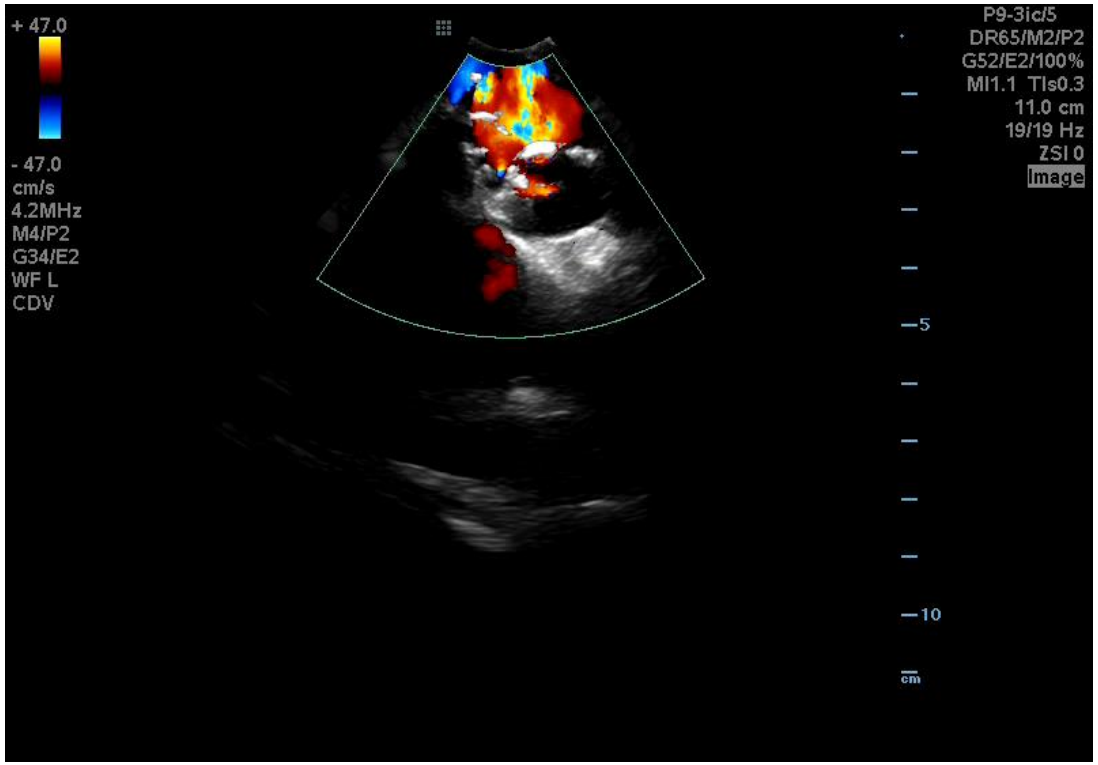

X5-1
50Hz
14cm
2D
67%
C 53
P Low
HPen
M3
X2
G
R
1.3
2.6
88 bpm

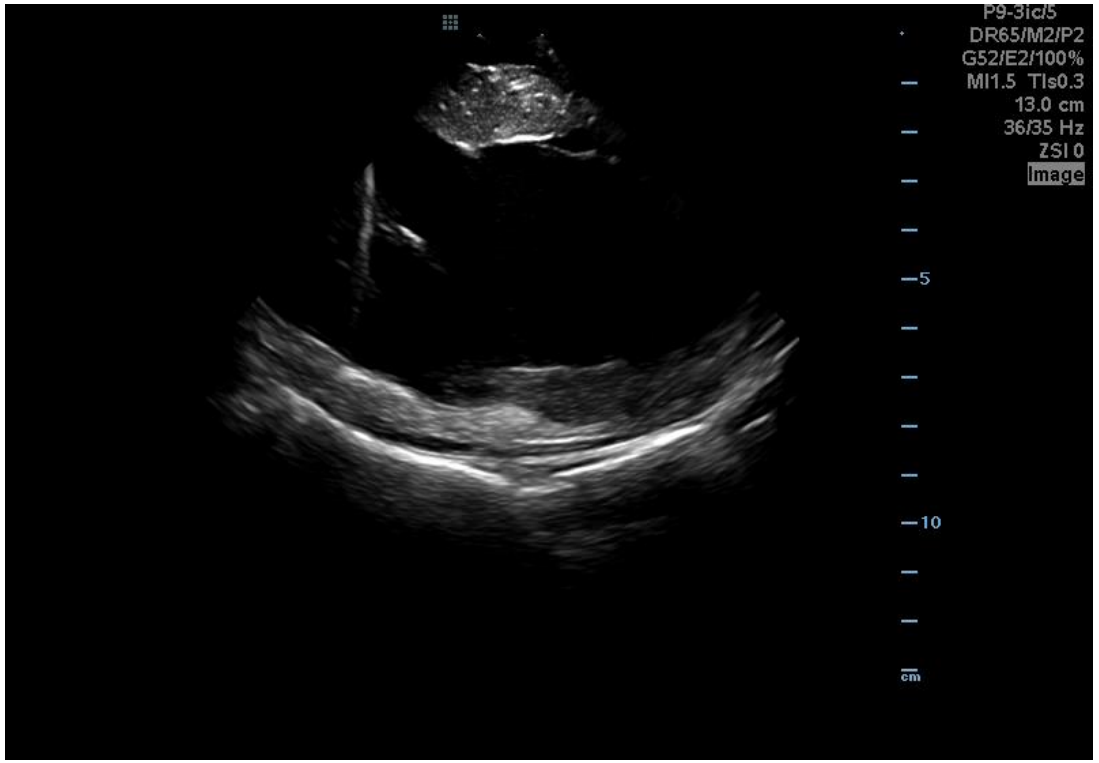

X5-1
50Hz
14cm
2D
66%
C 53
P Low
HPen
M3
X2
G
R
1.3
2.6
79 bpm

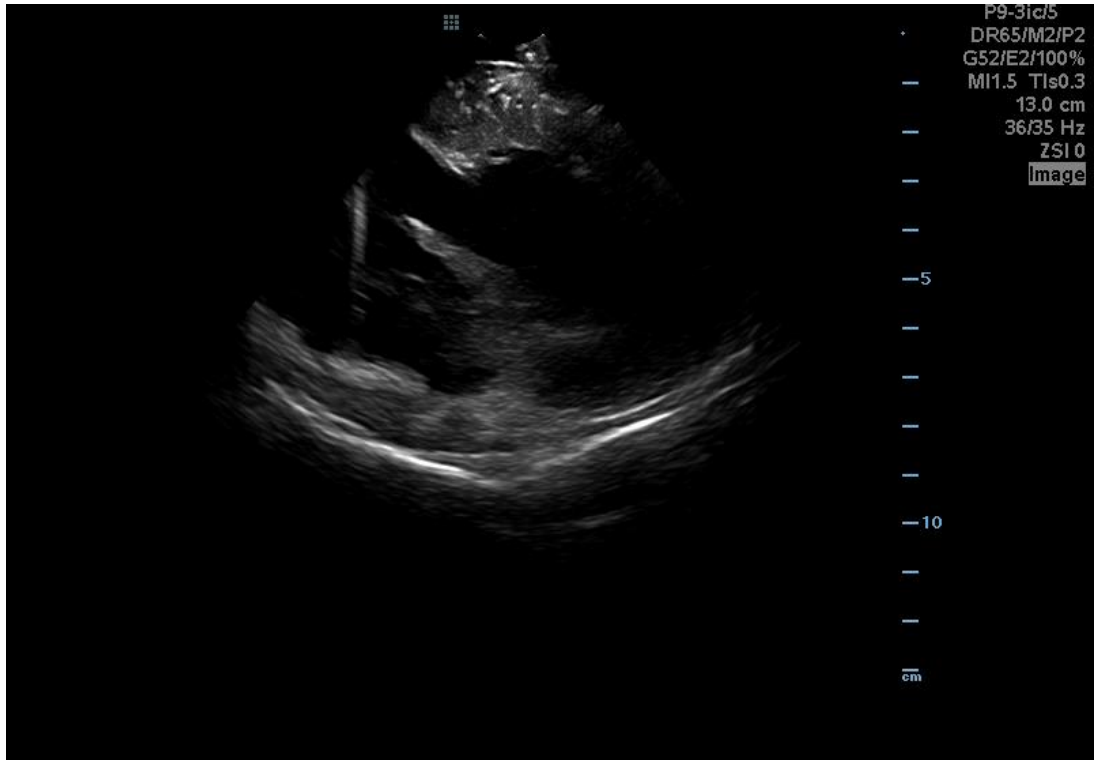
20.6.26 ECG


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

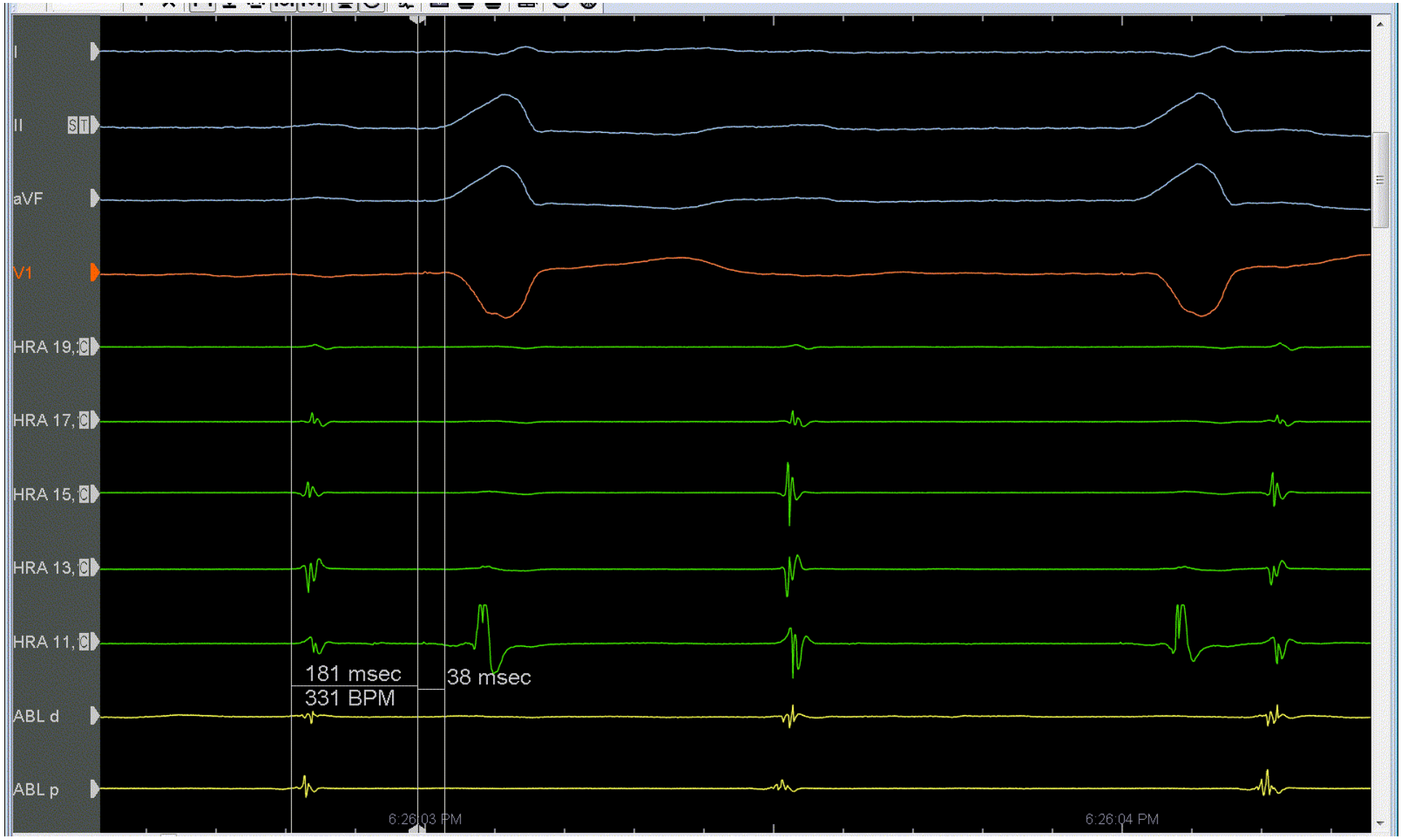
Difficult to introduce an ablation catheter into LV



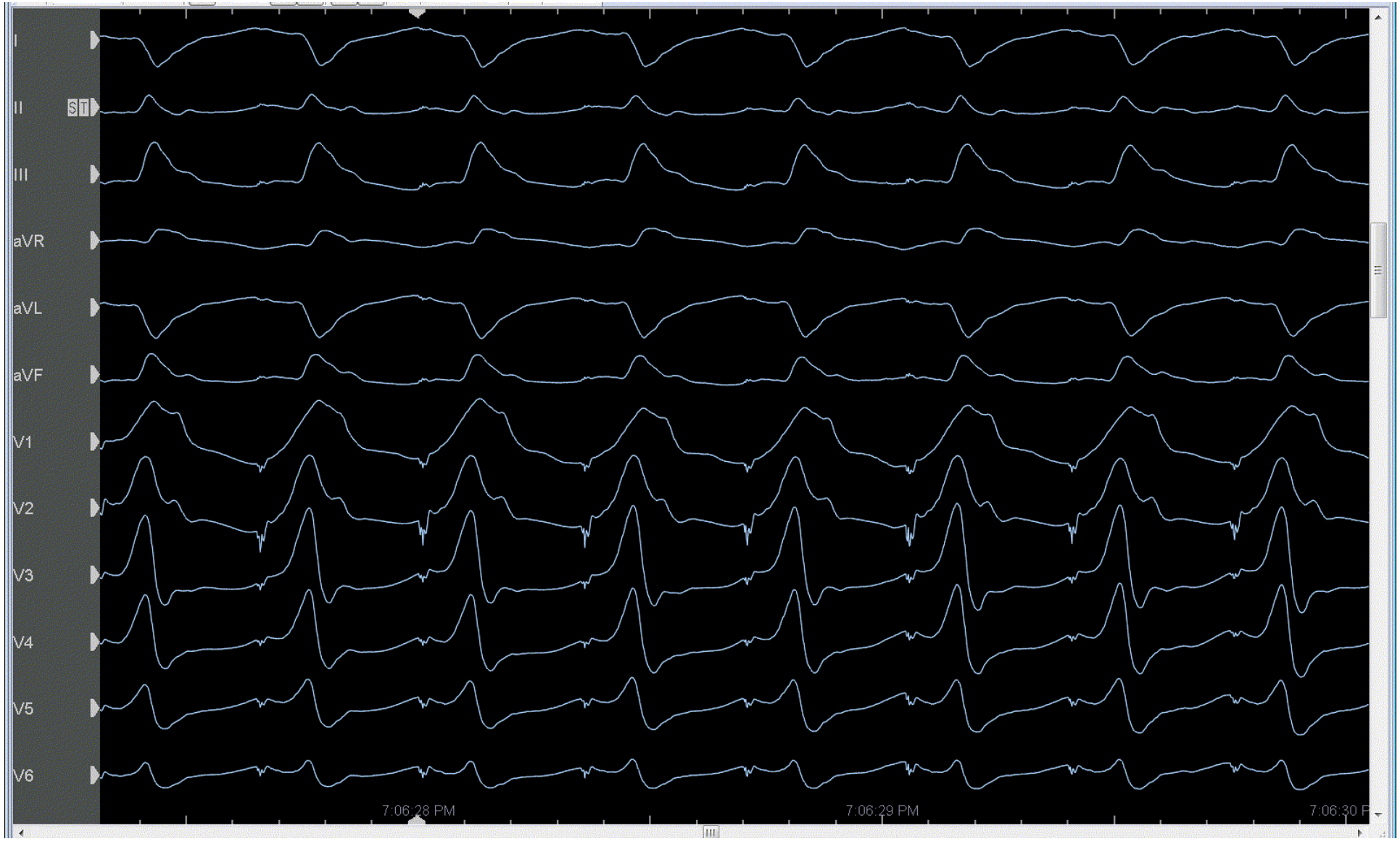

P9-3ic/5
DR65/M2/P2
G52/E2/100%
MI1.5 TIs0.3
13.0 cm
36/35 Hz
ZSI 0
Image
5
10
cm

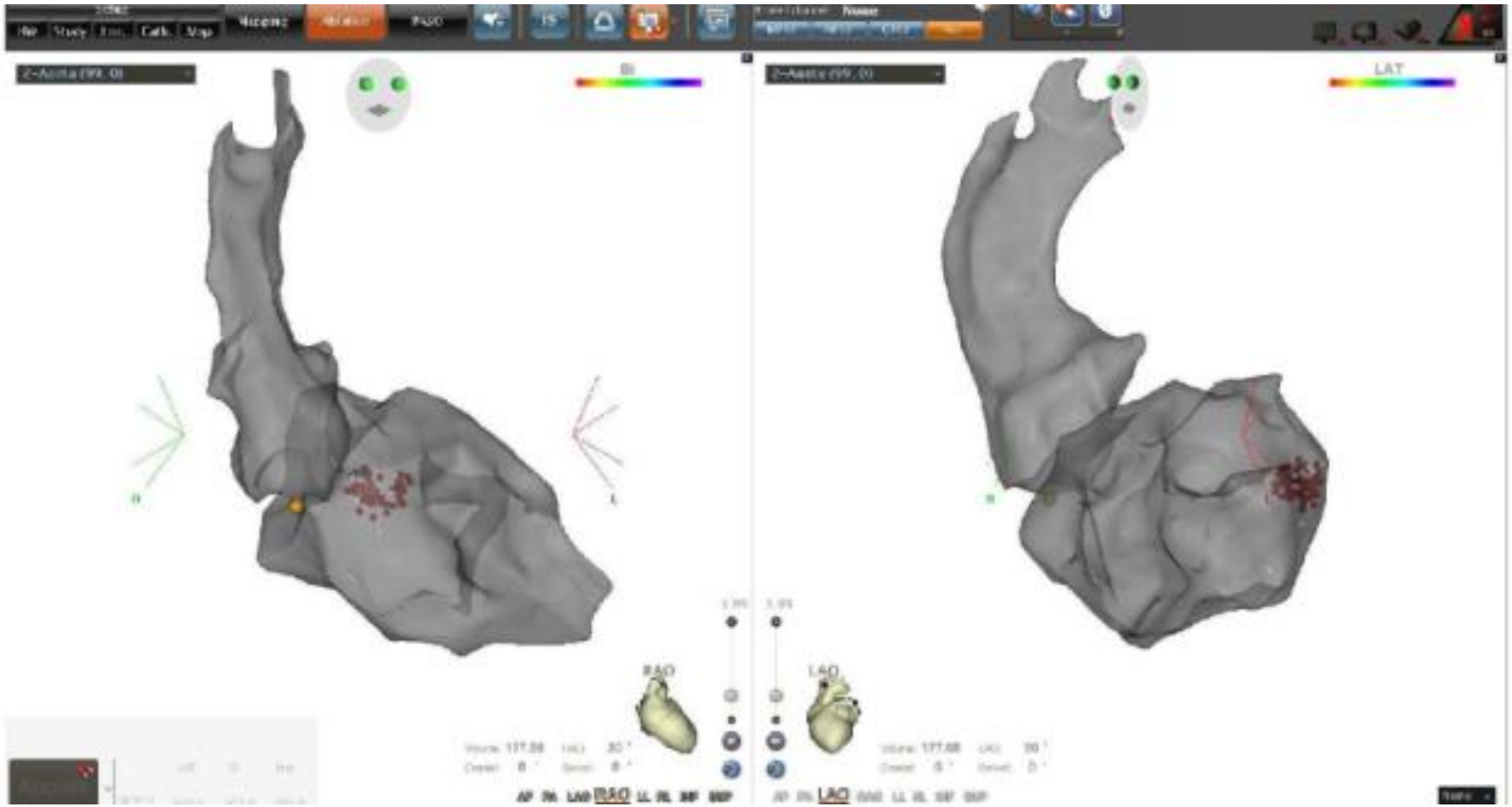

P9-3ic/5
DR65/M2/P2
G52/E2/100%
MI1.5 TIs0.3
13.0 cm
36/35 Hz
ZSI 0
Image
5
10
cm

EP study


I
II
ST
aVF
V1
HRA 19, C
HRA 17, C
HRA 15, C
HRA 13, C
HRA 11, C
181 msec
331 BPM
38 msec
ABL d
ABL p
6:26:03 PM
6:26:04 PM

Pacemap during EP study




RAO
LAO
LAT

Arrhythmia Review Course 4

Minsu Kim

Division of Cardiology,
Chungnam National University,
Chungnam National University Sejong Hospital,
Sejong, Korea

Korean Heart Rhythm Society

COI Disclosure

Name of First Author:

Minsu Kim

The authors have no financial conflicts of interest to disclose concerning the presentation

증례 1.

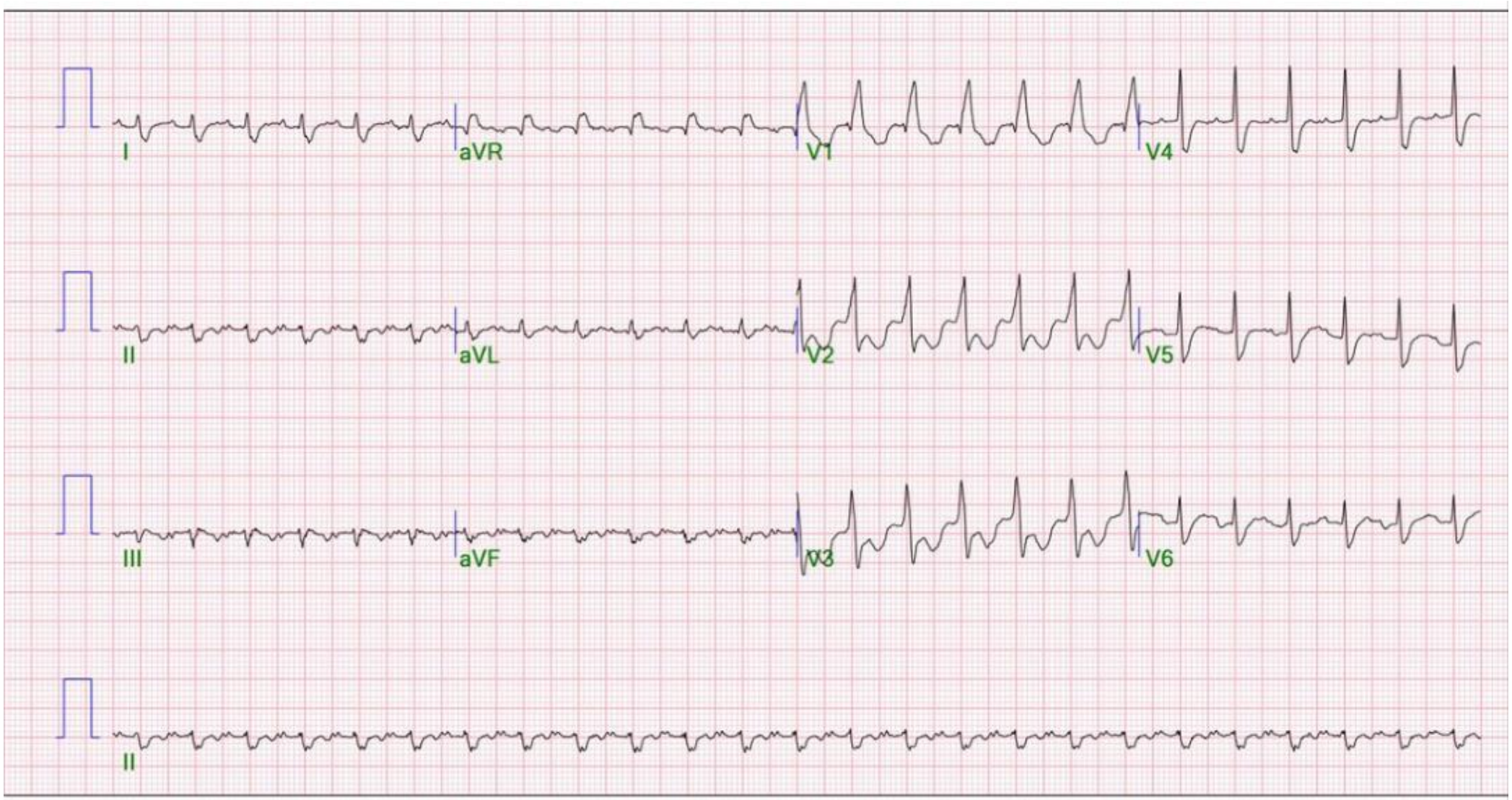
AVRT with pre-existing RBBB

증례

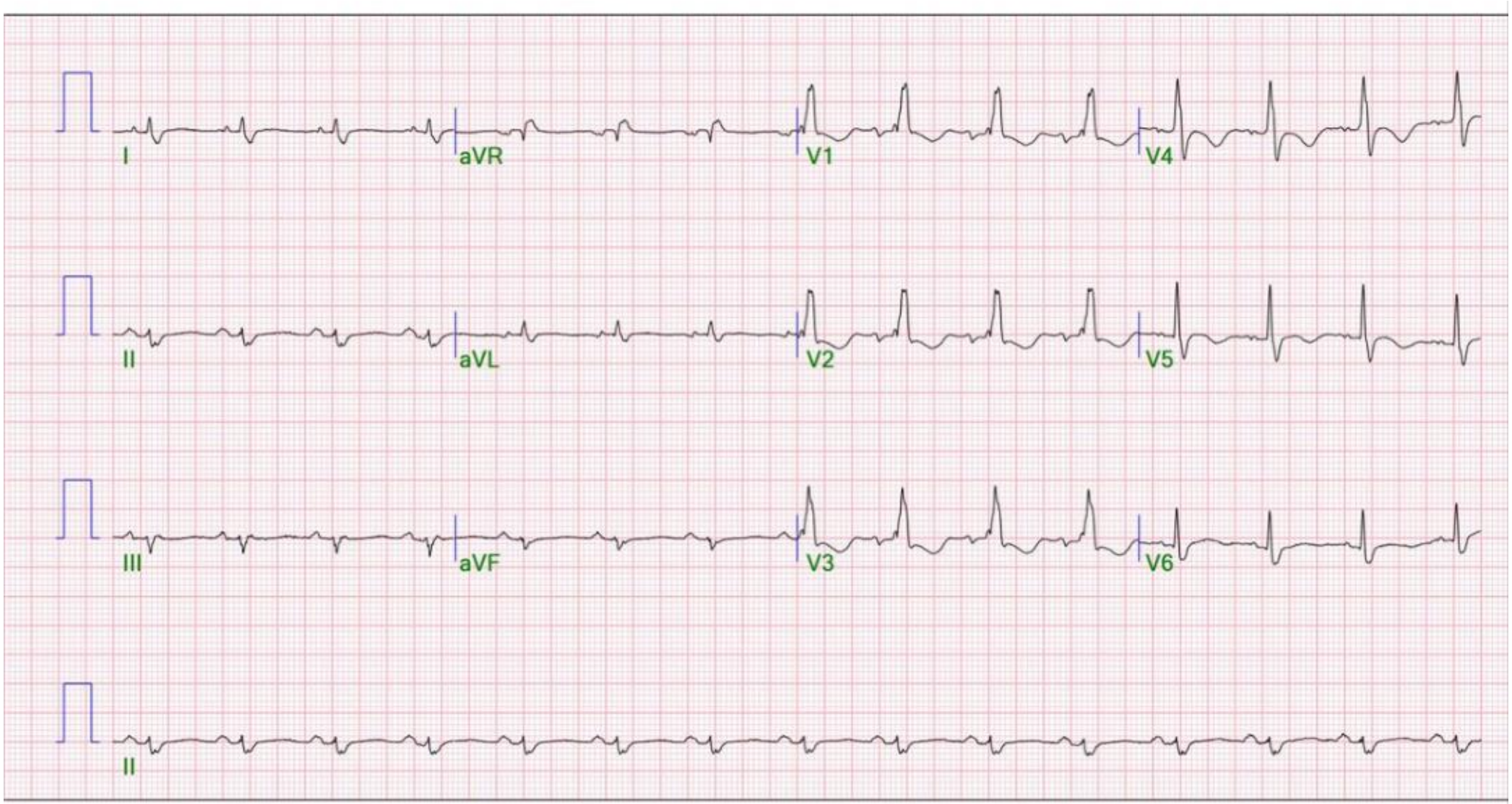
60/M

5년 전 고혈압 진단을 받고 amlodipine 5mg 복약 중
1시간 전부터 발생한 두근거림을 주소로 응급실 내원 하였다
혈압 120/80 mmHg, 맥박 150 회/분, 호흡 20 회/분, 체온 36.7°C 였다
내원 당시 촬영한 심전도(사진) 이다

ECG with symptom



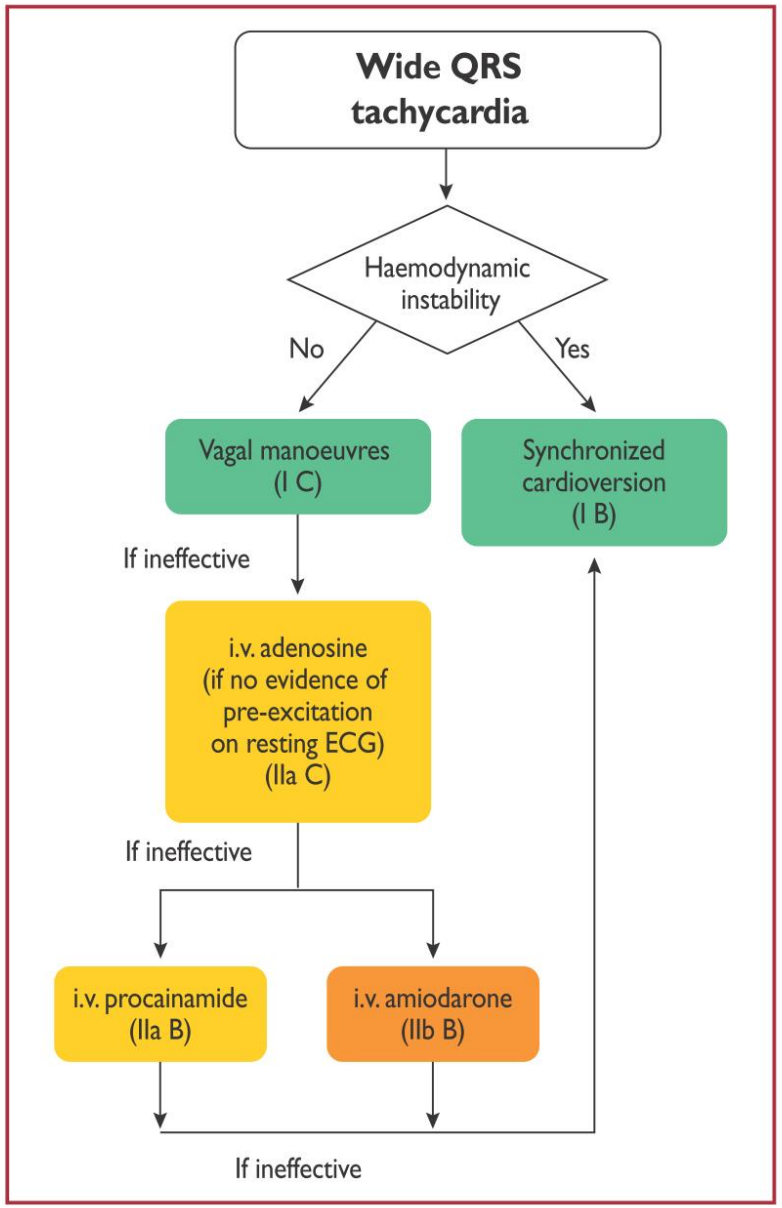
ECG without symptom



증상 있을 때 가장 적절한 처치는?

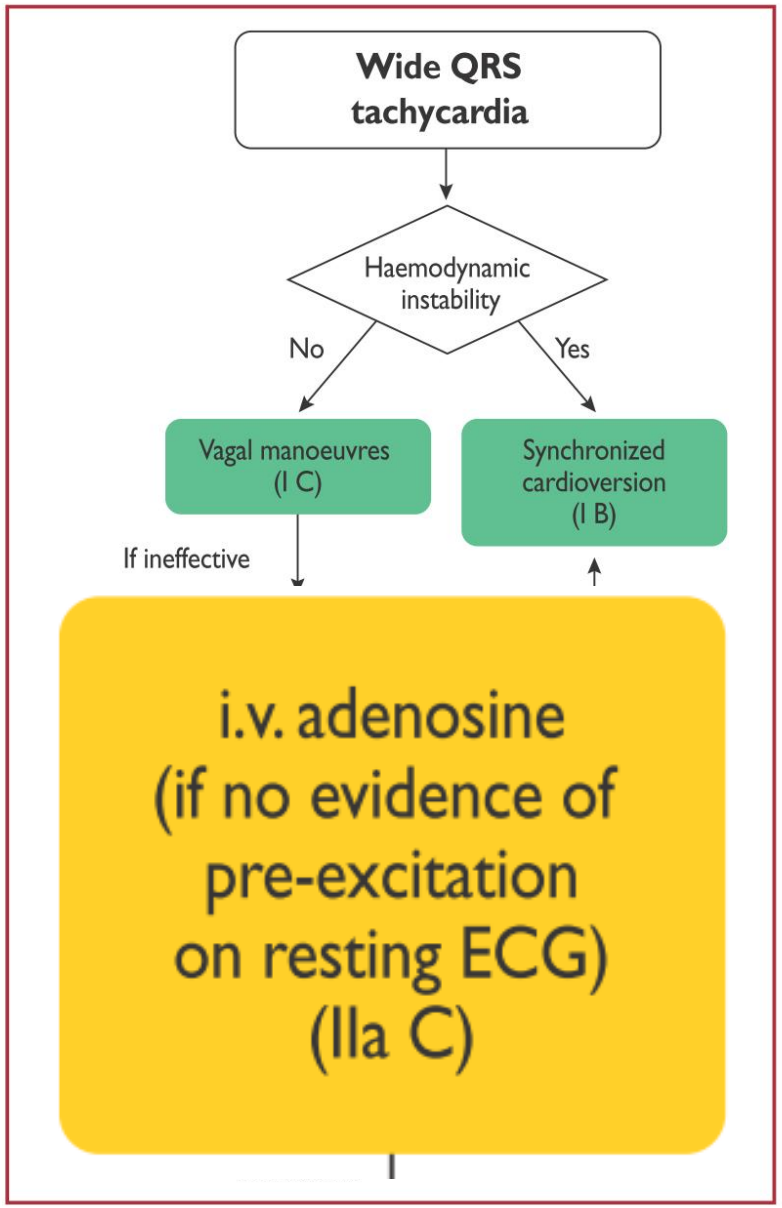
1. Vagal maneuver
2. Amiodarone
3. Procainamide
4. D/C cardioversion

Differential diagnosis of regular wide QRS tachycardia



2019 ESC guideline for SVT

Differential diagnosis of regular wide QRS tachycardia

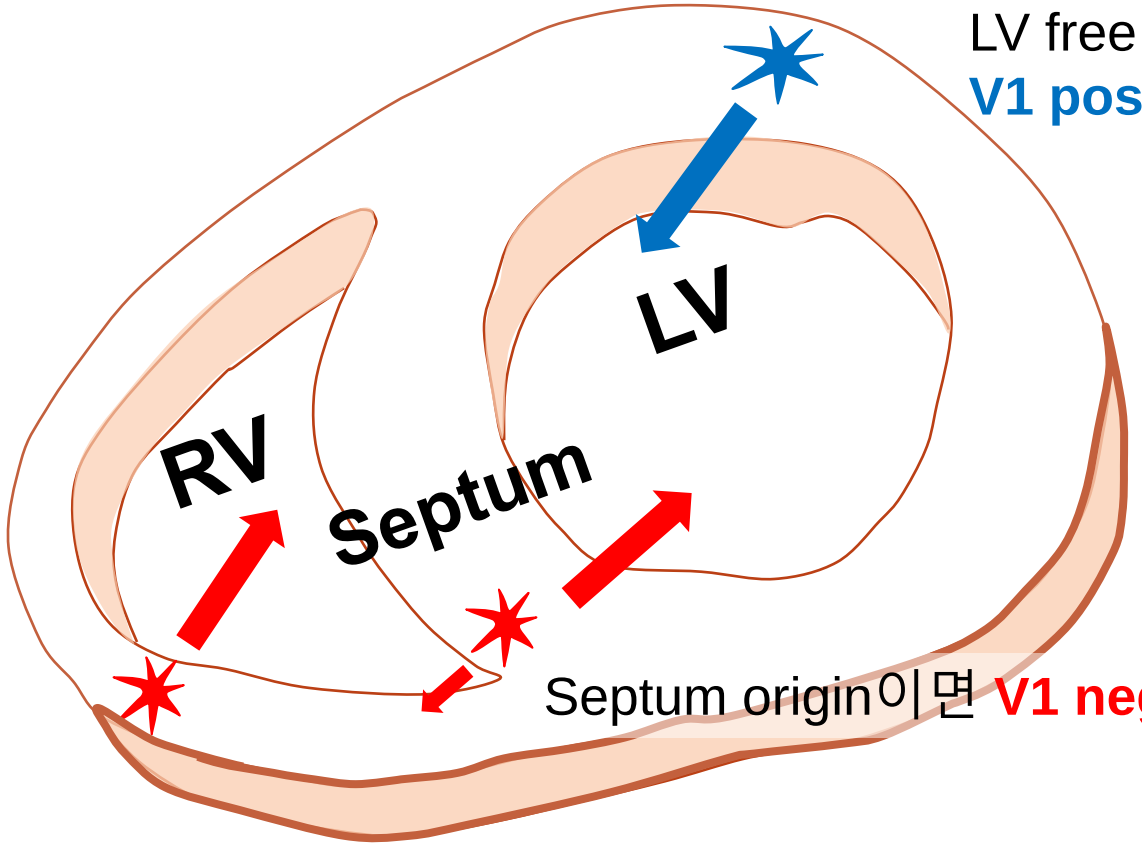


Due to

- Adenosine **induced AF** in WPW syndrome, which can cause VF
- Adenosine producing a **coronary steal syndrome**, which can cause VT → VF

2019 ESC guideline for SVT

RBBB vs. LBBB



LV free wall origin 이면
V1 positive (RBBB pattern)

Septum origin이면 **V1 negative** (LBBB pattern)

RV free wall origin 이면 **V1 negative** (LBBB pattern)

V 6

V1

V2

Morphologic criteria for RBBB

RBBB pattern (V1 positive)

TABLE VIII Configuration of Right Bundle Branch Block-Shaped QRS Complexes in Lead V_1 During Tachycardia

	Type Complex	QRS Configuration in Lead V_1: Aberrant	Ventricular Tachycardia
VT	1	–	12
	2	7	9
SVT	3	12	2
	4	28	2
	5	–	4
VT	6	1	12
	7	–	4
		48	45

TABLE IX Configuration of Right Bundle Branch Block-Shaped QRS Complexes in Lead V_6 During Tachycardia

Type Complex	Aberrant	Ventricular Tachycardia
1	31	2
2	15	10
3	2	18
4	–	11
5	–	3
6	–	1
	48	45

Wellens et al. Am J Med. 1978 Jan;64(1):27-33

Morphologic criteria for LBBB

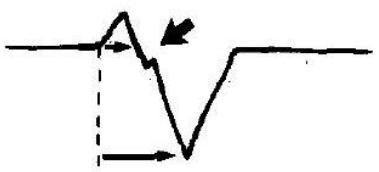
LBBB pattern (V1 negative)

TABLE II Specificity of Electrocardiographic Criteria for Ventricular Tachycardia

Criteria	All (n = 27)	LAD (n = 16)	Normal or RAD (n = 11)
(1) R >30 ms in V_1 or V_2 (%)	100	100	100
(2) Any Q in V_6 (%)	96	94	100
(3) >60 ms to S nadir in V_1 or V_2 (%)	96	94	100
(4) Notched downstroke S wave in V_1 or V_2 (%)	96	94	100

LAD = left axis deviation; RAD = right axis deviation.

V_1 or V_2 ; *Notch (Josephson's sign)*
→ *scar area 가 있다*

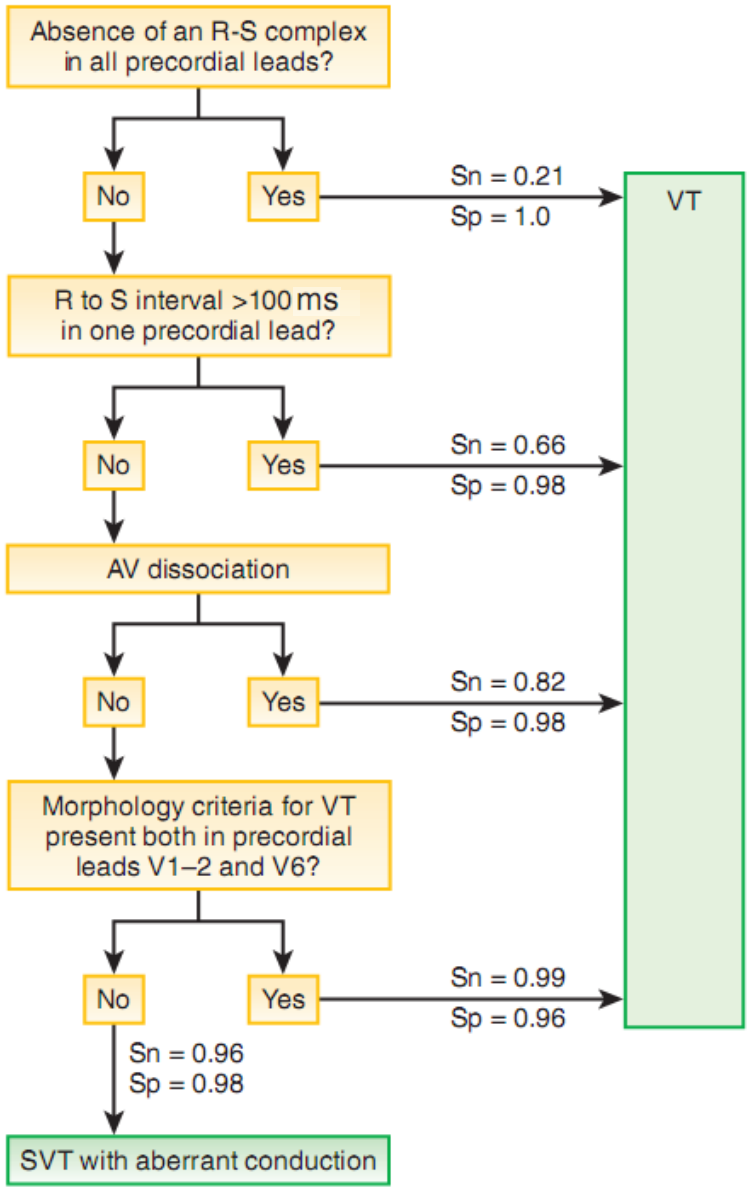


V_6 ; *V6 에서 Q wave 가 있다*
→ *AV node conduction with LBBB 일때는 septal Q wave가 사라진다*

RS interval >60ms, R > 30ms
→ *Myocardial conduction 을 시사*

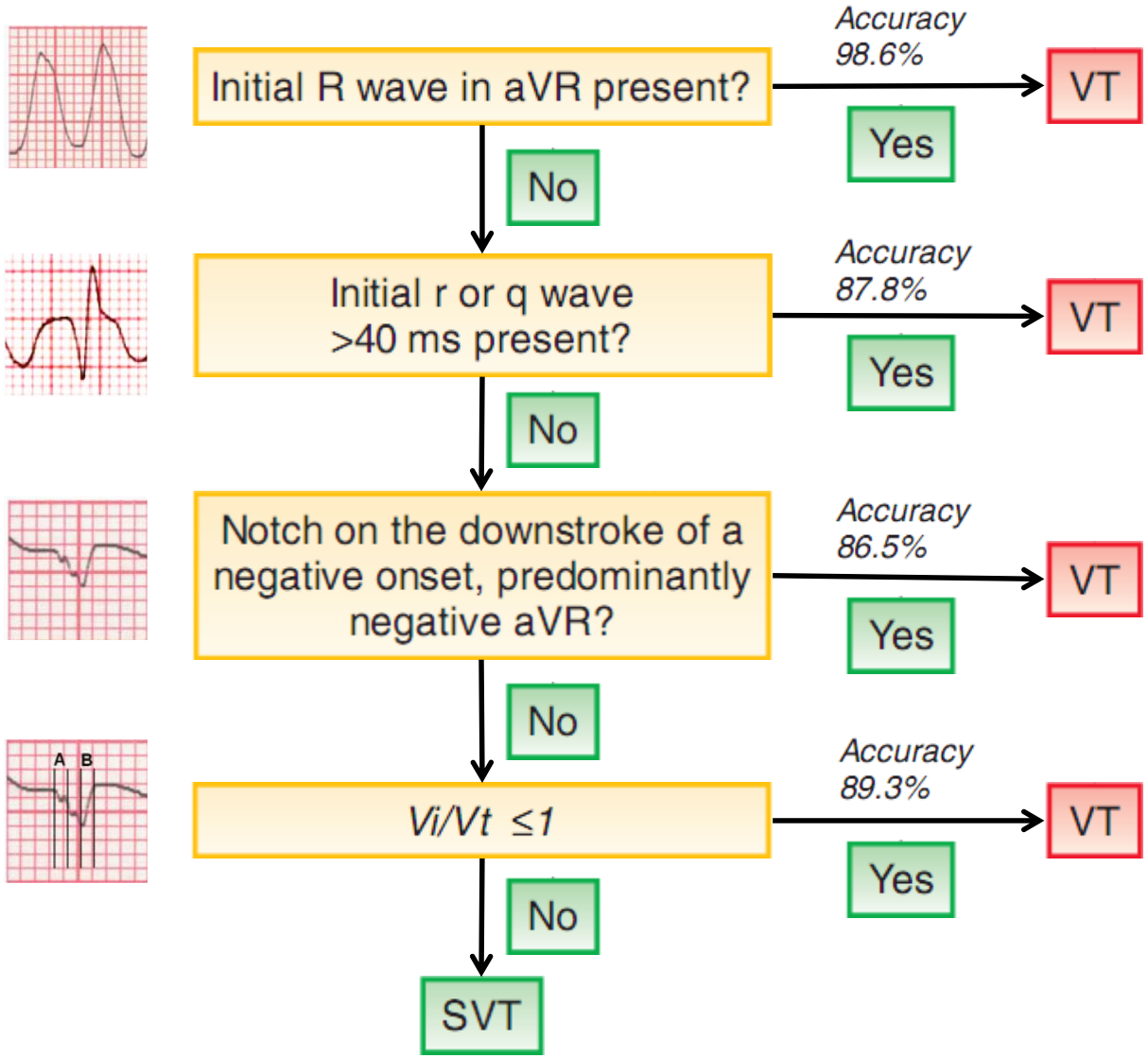
Kindwall et al. Am J Cardiol 1988;61:1279-1283

Brugada algorithm



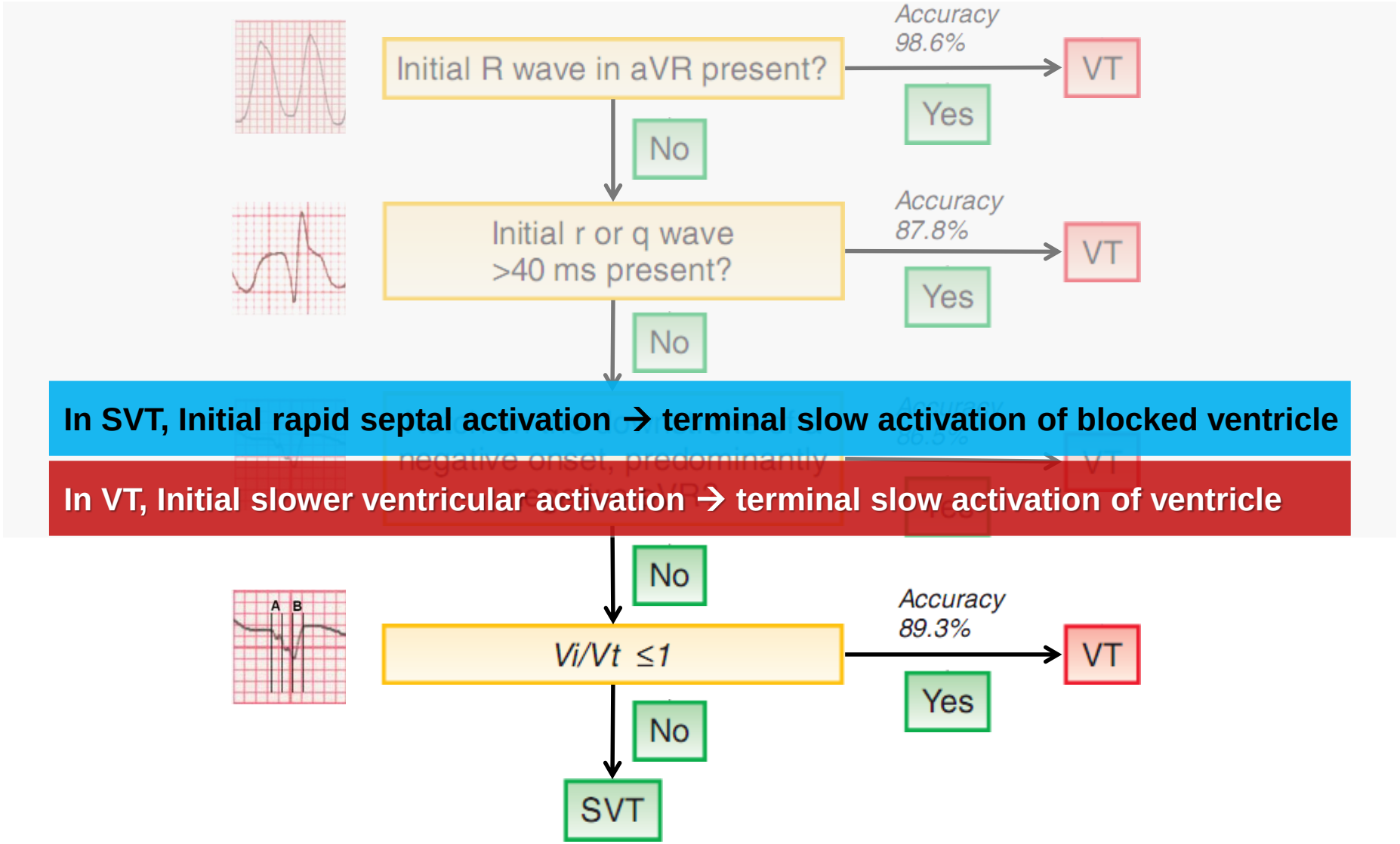
Brugada, et al. Circulation 1991;83:1649-1659

New aVR algorithm



Vereckei, et al. Heart rhythm 2008;5:89-98

New aVR algorithm



Vereckei, et al. Heart rhythm 2008;5:89-98

KHRS 2023

증례 2.

Antidromic AVRT

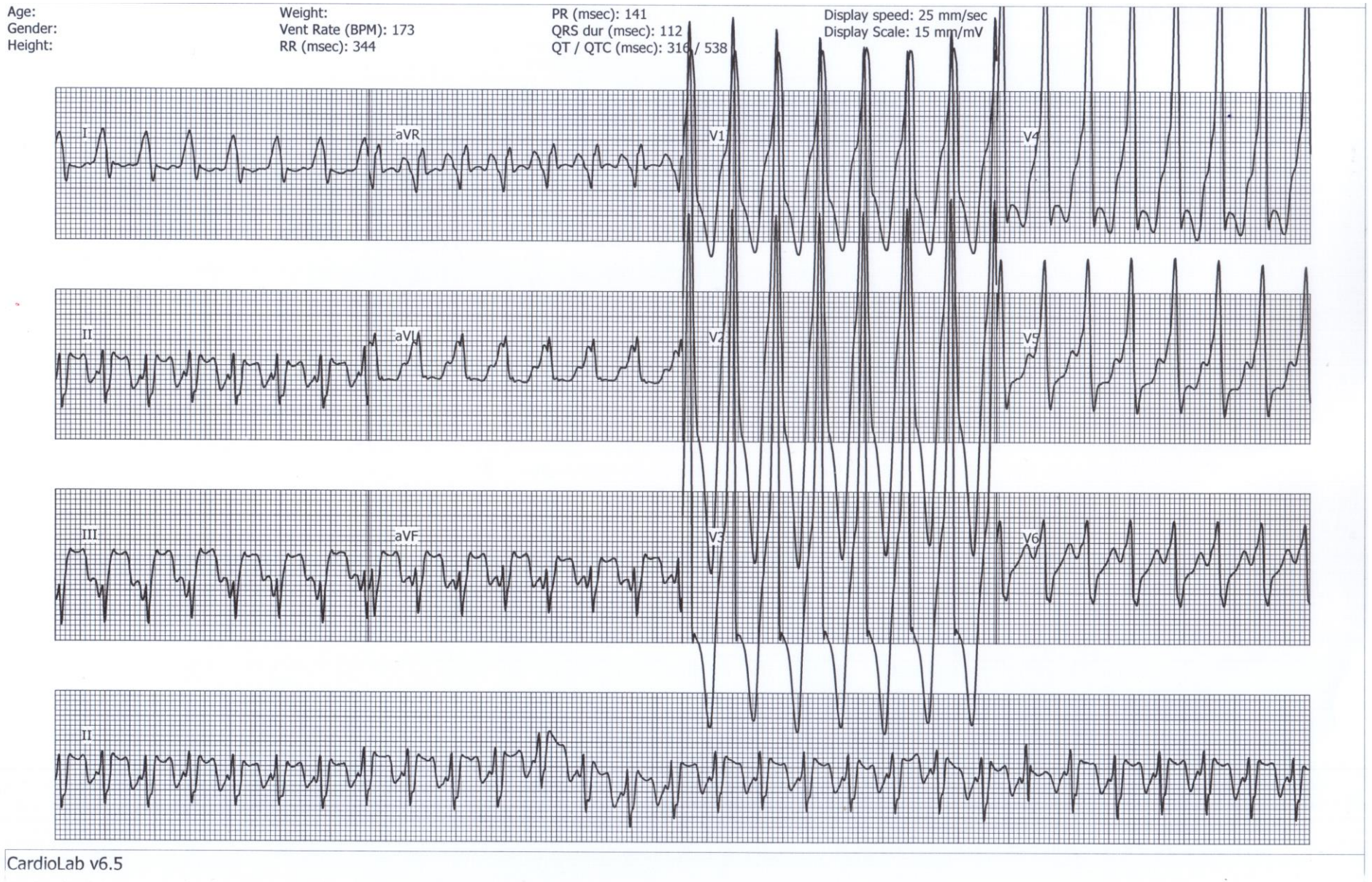
증례

20/M

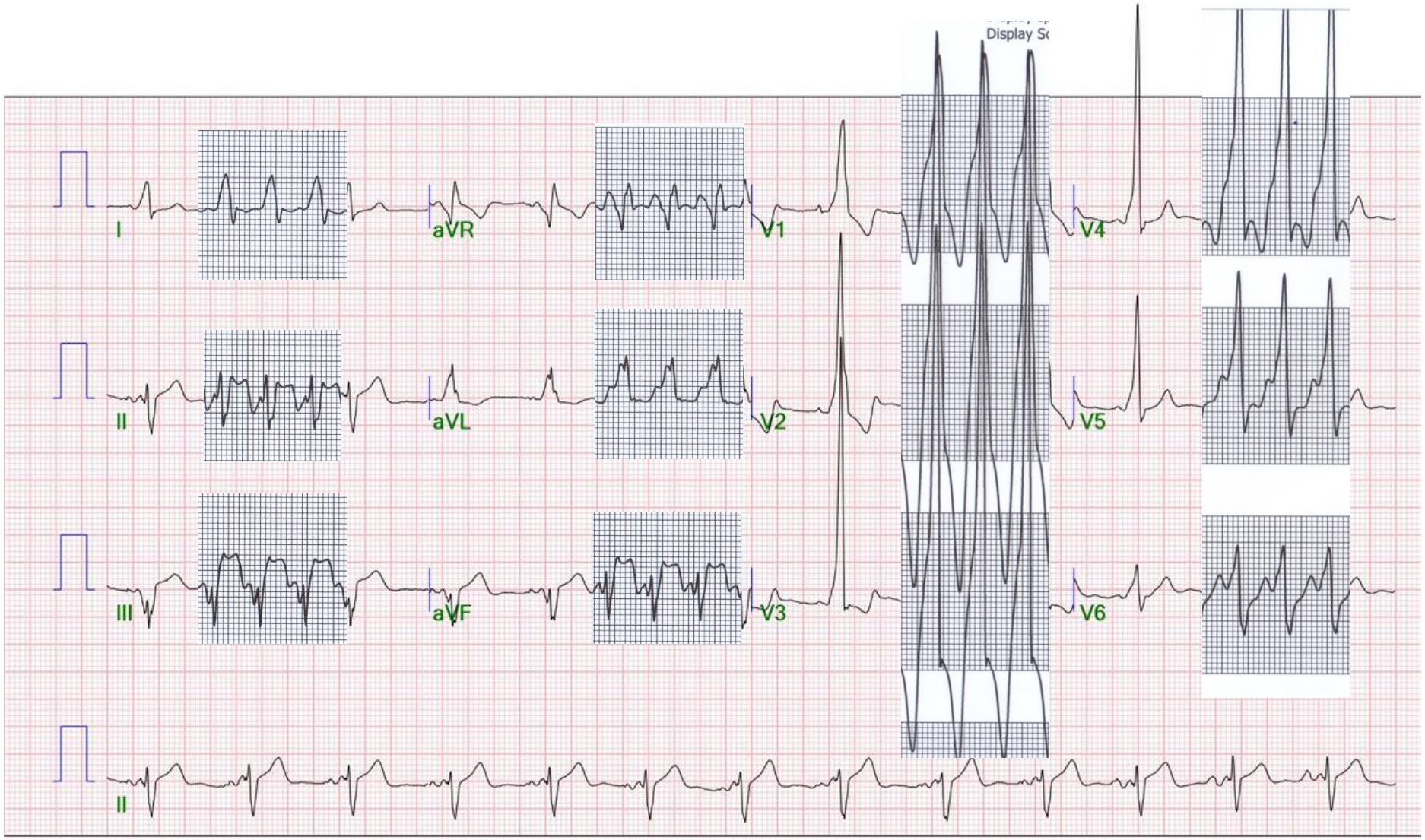
내원 2년 전부터 간헐적으로 가슴 답답함 호소
개인병원 내원하여 촬영한 심전도 검사에서 delta wave 가 있어서 진료 의뢰 됨

Baseline ECG

Induced tachycardia in EP lab



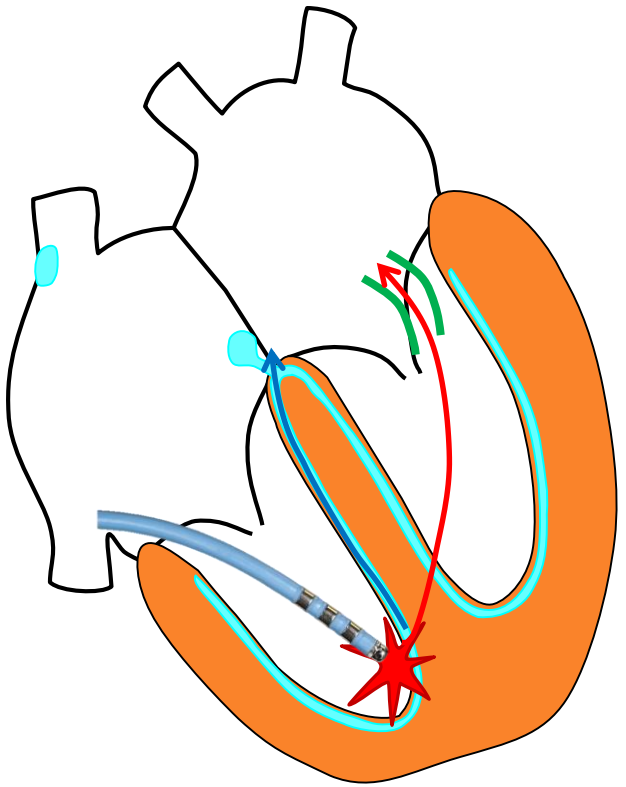
Induced tachycardia in EP lab



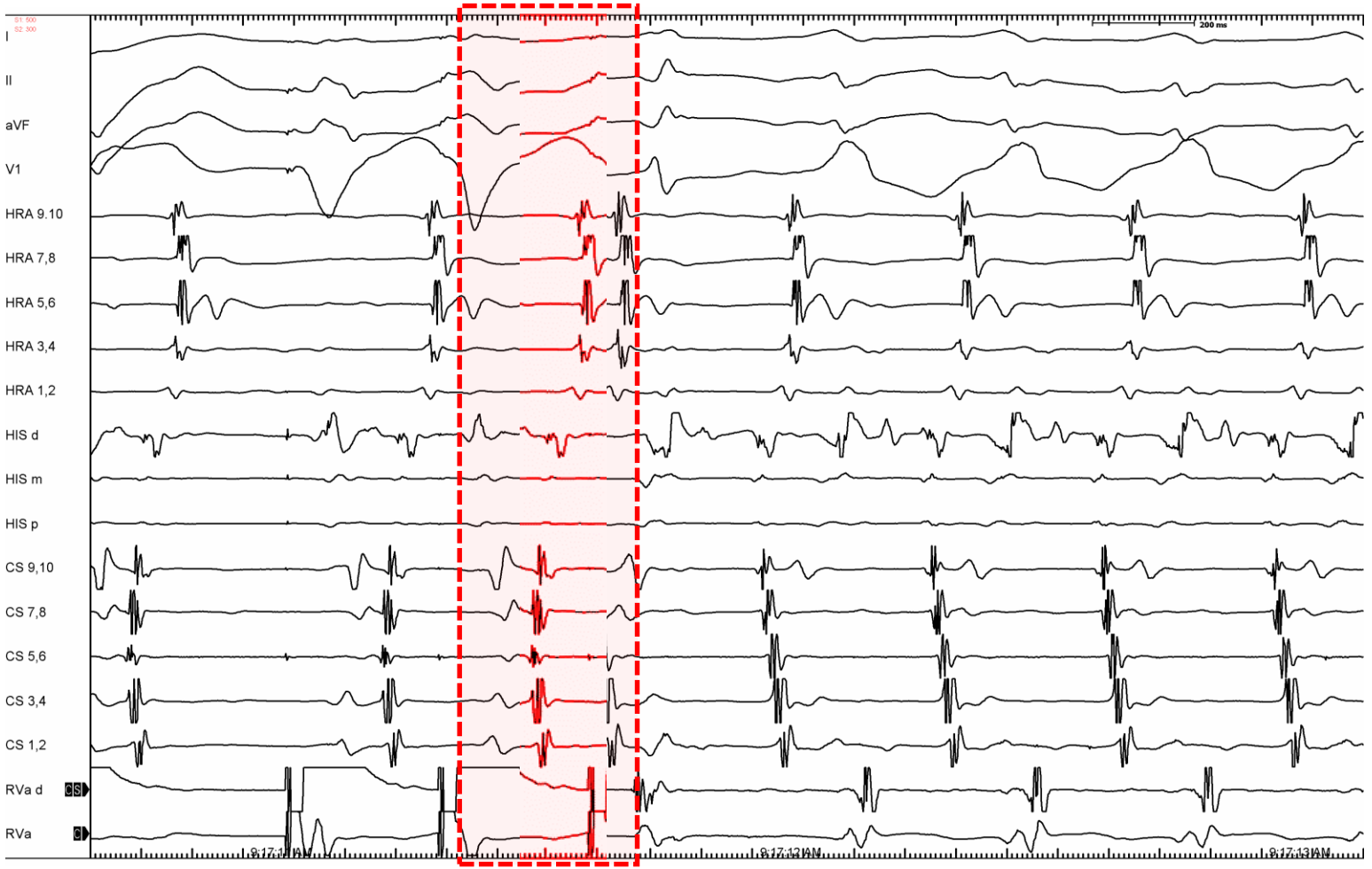
가능성이 높은 진단은?

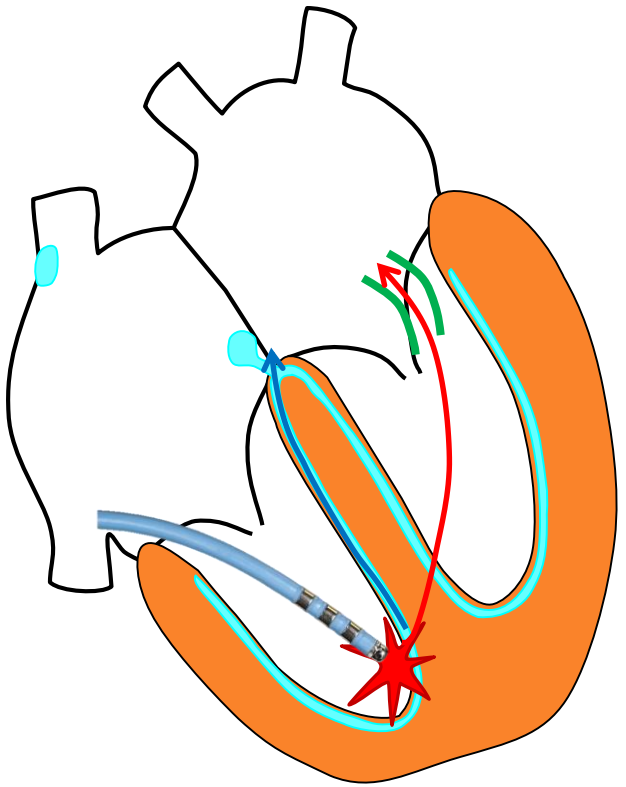
1. SVT with pre-existing bundle branch block
2. Antidromic AVRT
3. Ventricular tachycardia with 1 to 1 VA conduction
4. Need more data

Antidromic AVRT by ventricular extra stimulation

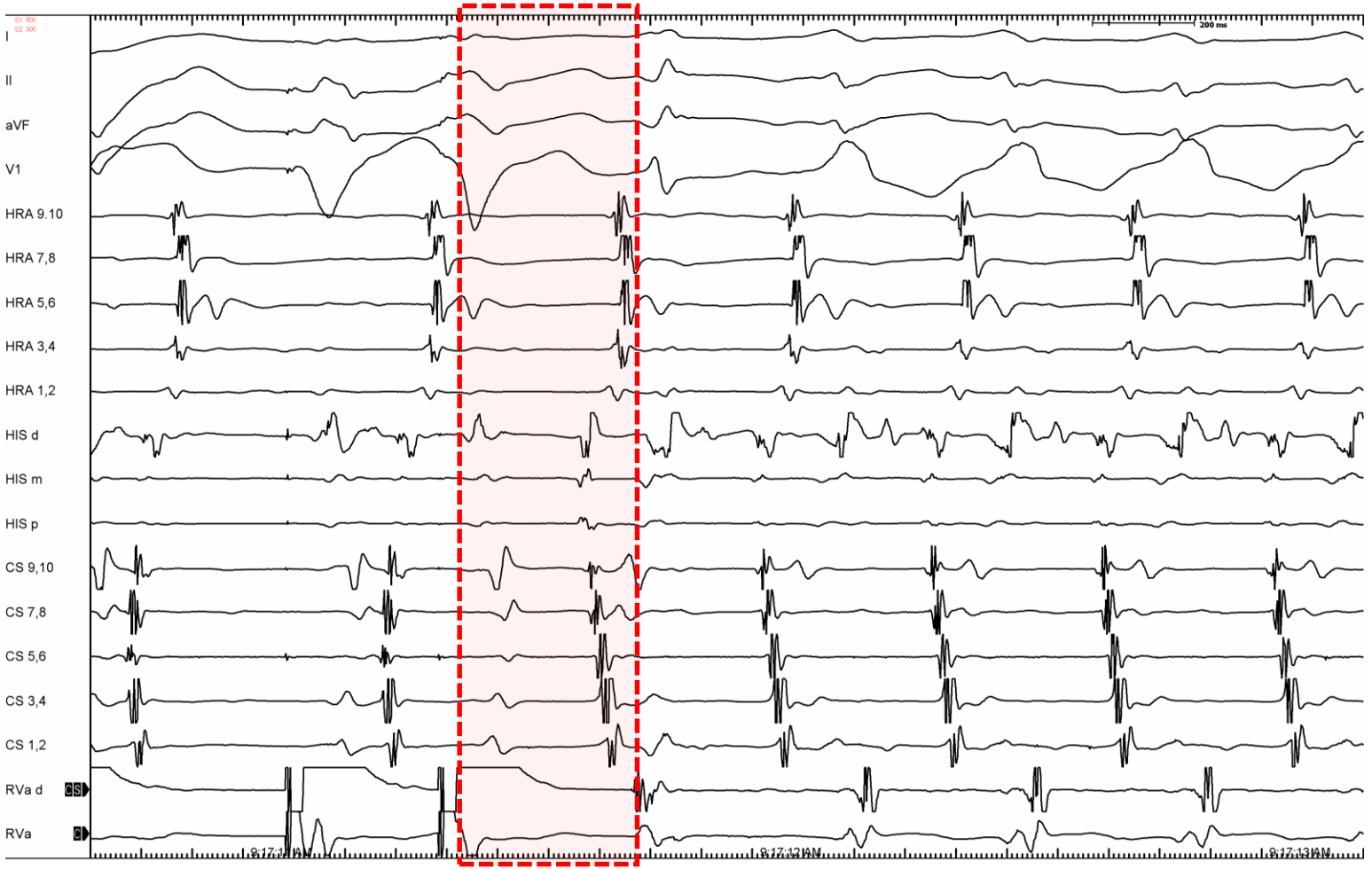


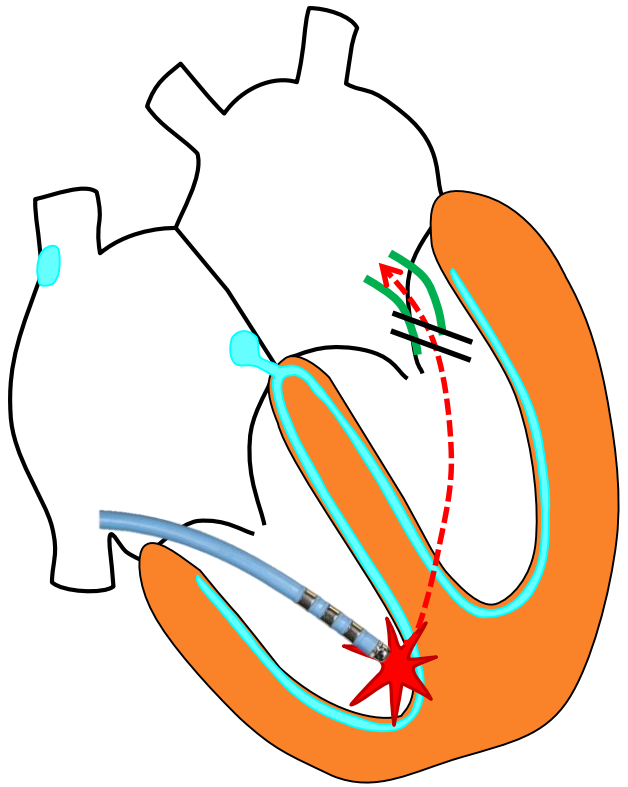
Antidromic AVRT by ventricular extra stimulation





Antidromic AVRT by ventricular extra stimulation

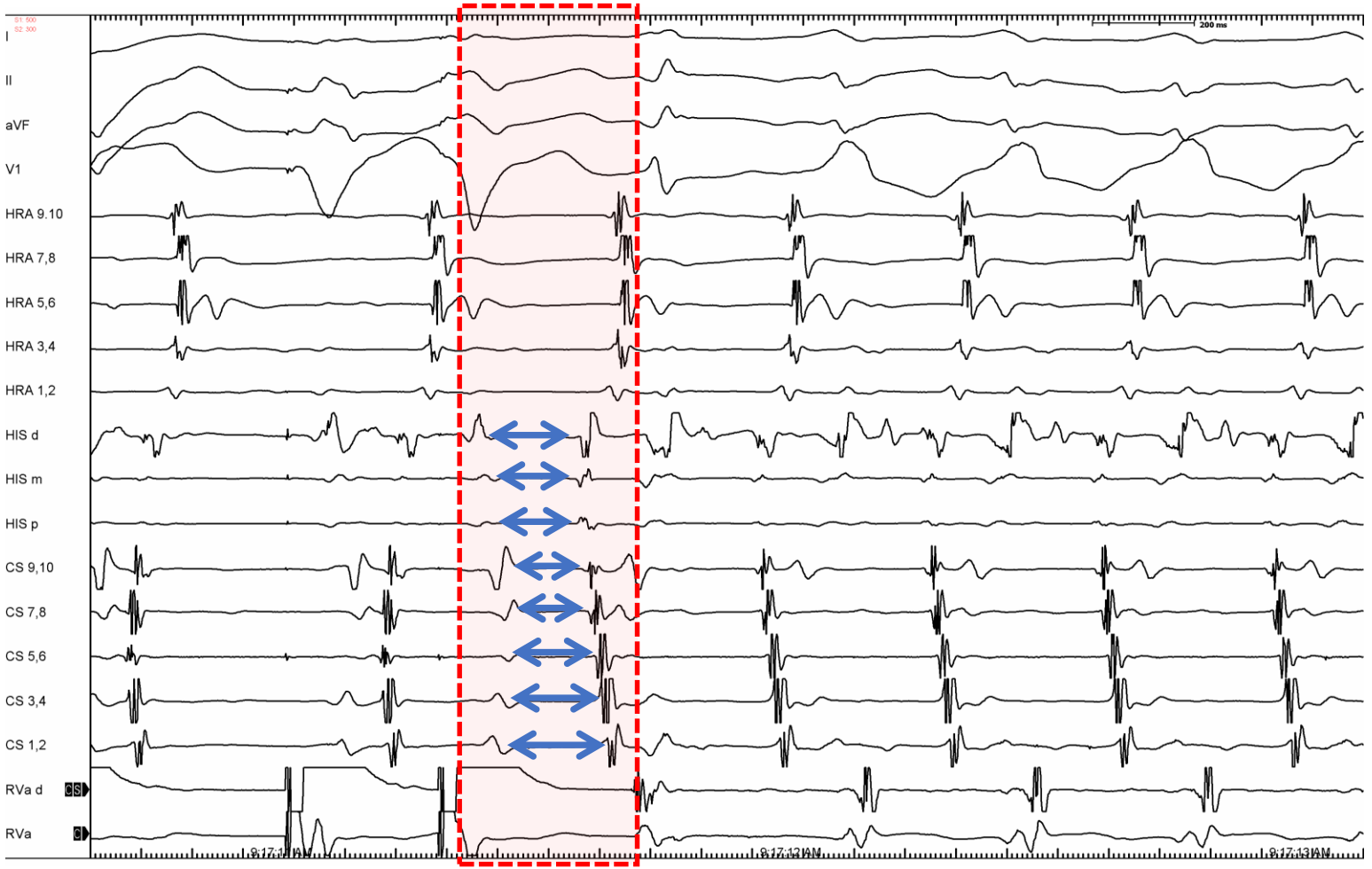


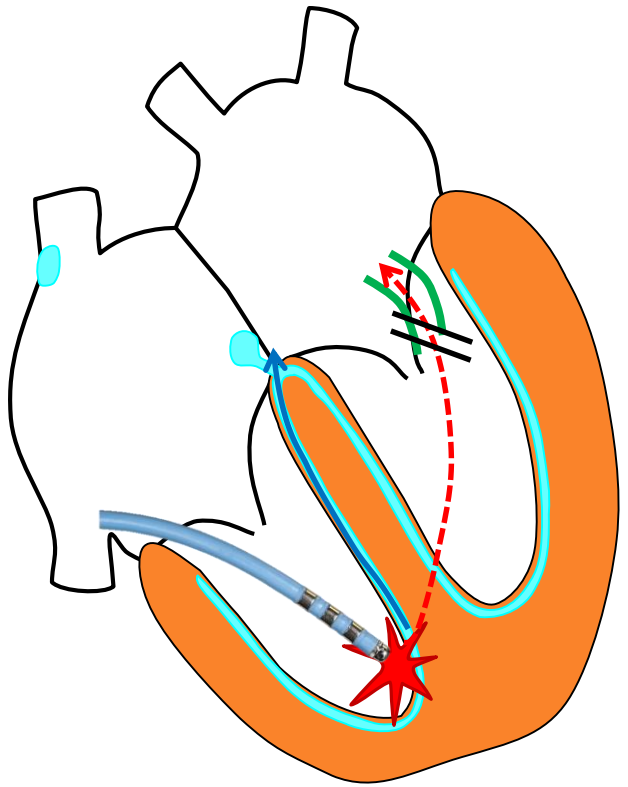


VA block via bypass tract

KHRS 2023

Antidromic AVRT by ventricular extra stimulation

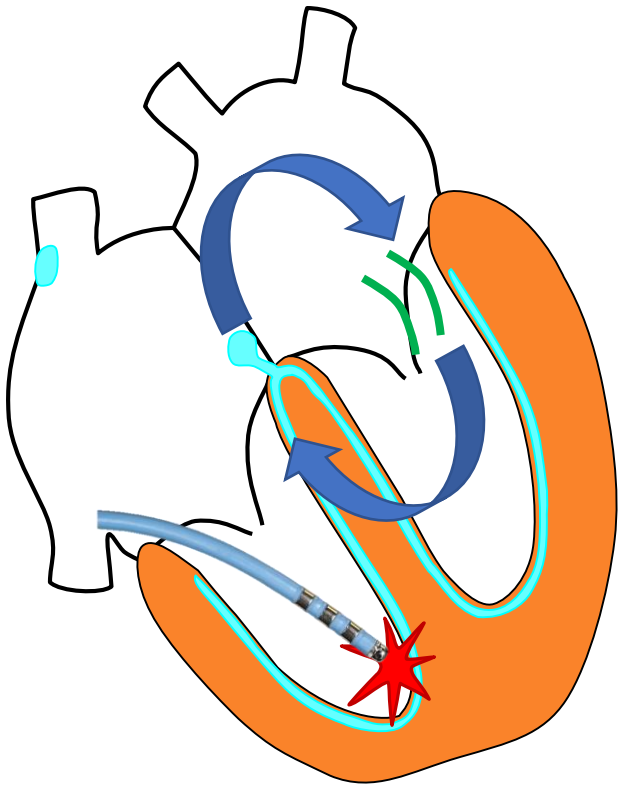




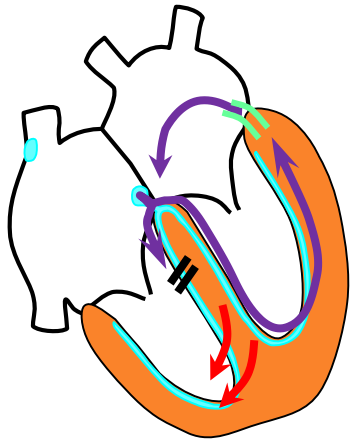
VA block via bypass tract
+ Slow concentric VA conduction

KHRS 2023

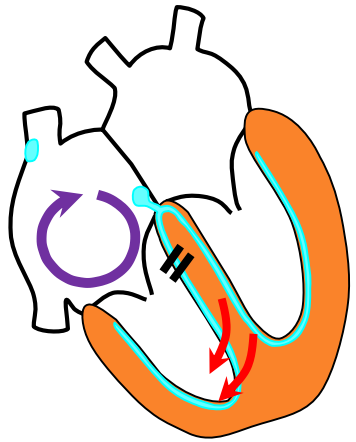
Antidromic AVRT by ventricular extra stimulation



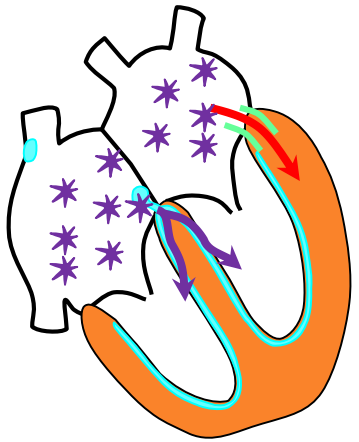
Types of wide QRS tachycardia



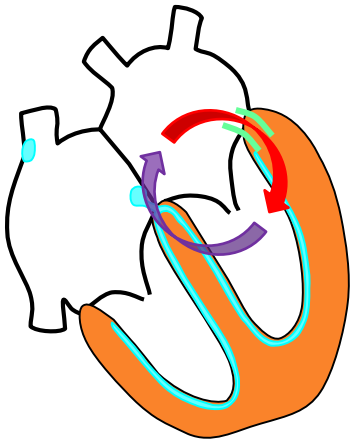
SVT with aberrancy pre-existing BBB



AFL with aberrancy pre-existing BBB

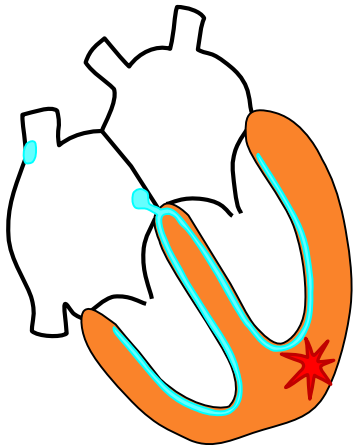


AF/AFL with WPW



Antidromic AVRT

VS.

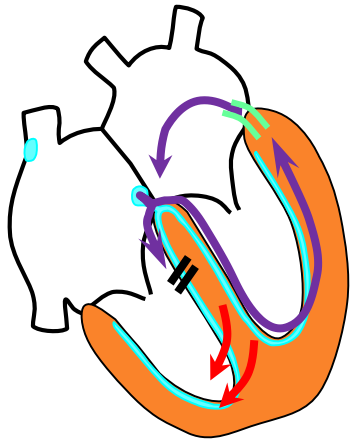


Ventricular tachycardia

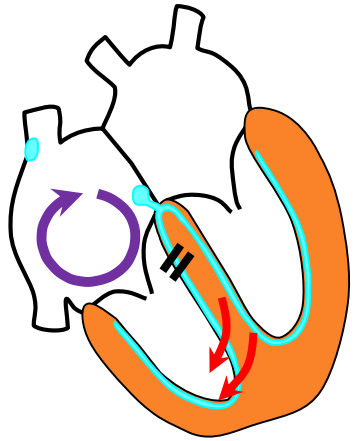
AF; atrial fibrillation
AFL; atrial flutter
AVRT; atrioventricular reentrant tachycardia
BBB; bundle branch block
SVT; supraventricular tachycardia

KHRS 2023

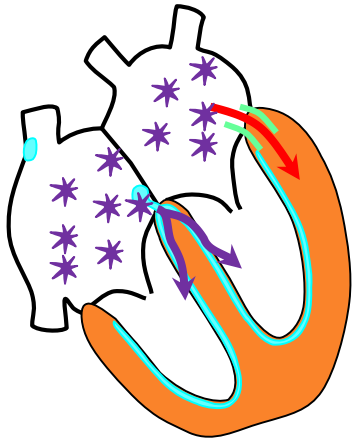
Types of wide QRS tachycardia



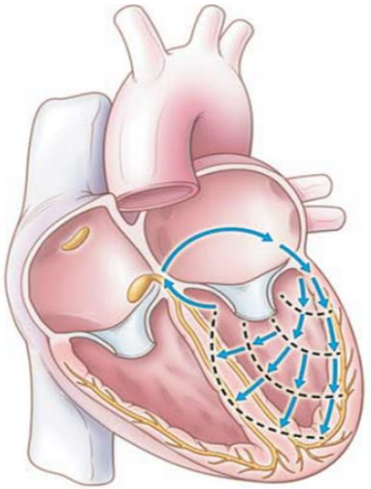
SVT with aberrancy pre-existing BBB



AFL with aberrancy pre-existing BBB

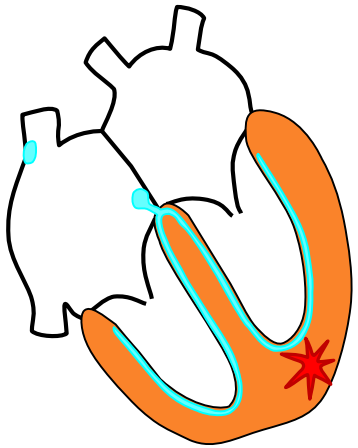


AF/AFL with WPW



Antidromic AVRT

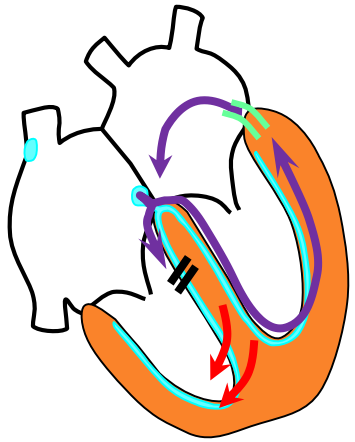
VS.



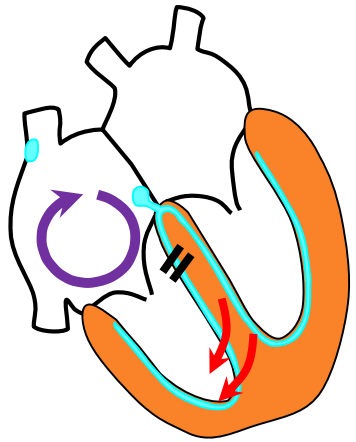
Ventricular tachycardia

AF; atrial fibrillation
AFL; atrial flutter
AVRT; atrioventricular reentrant tachycardia
BBB; bundle branch block
SVT; supraventricular tachycardia

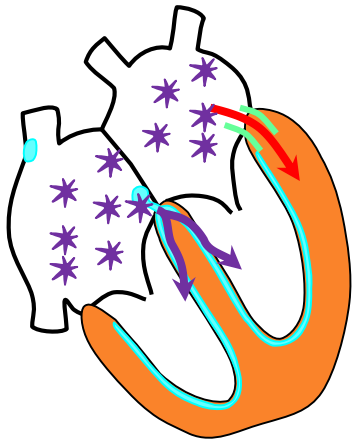
Types of wide QRS tachycardia



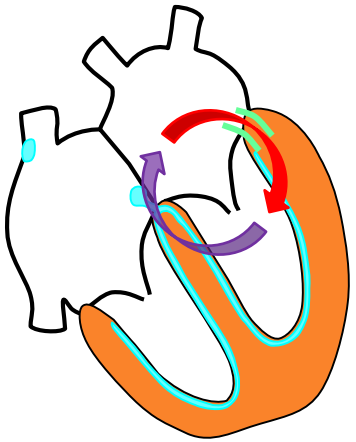
SVT with aberrancy pre-existing BBB



AFL with aberrancy pre-existing BBB



AF/AFL with WPW

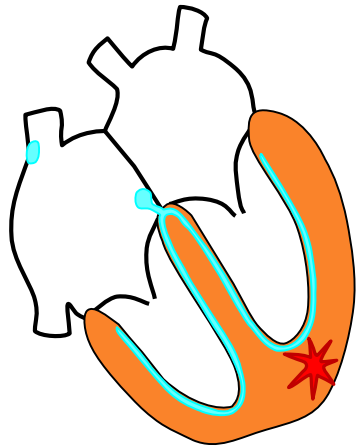


Antidromic AVRT

20% cases

*;**VT**로 오진 시 → Overtreatment (제세동기 시술)*
AF/AFL 환자에서 항응고치료를 하지 않게 되어서 stroke 발생 가능

VS.



Ventricular tachycardia

80% cases

*;**SVT**로 오진 시 → life threatening*

KHRS 2023

증례 3.

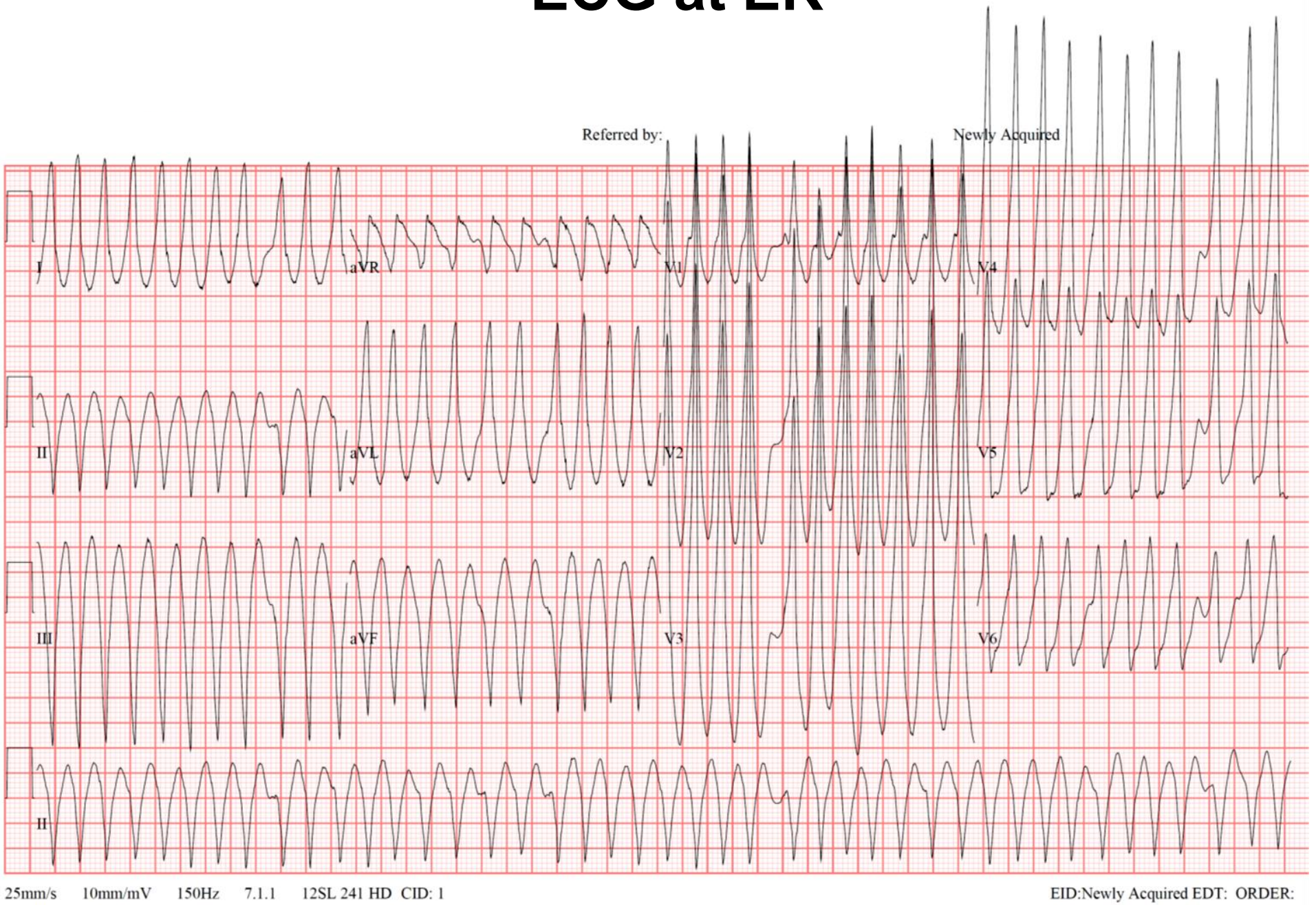
AF in WPW syndrome

증례

31/M

과거력 (-)
1시간 전부터 갑자기 발생한 두근거림을 주소로 응급실로 내원하였다
혈압 110/70 mmHg, 맥박 258 회/분, 호흡 20 회/분, 체온 36.5℃ 였다
내원 당시 촬영한 심전도(사진) 이다

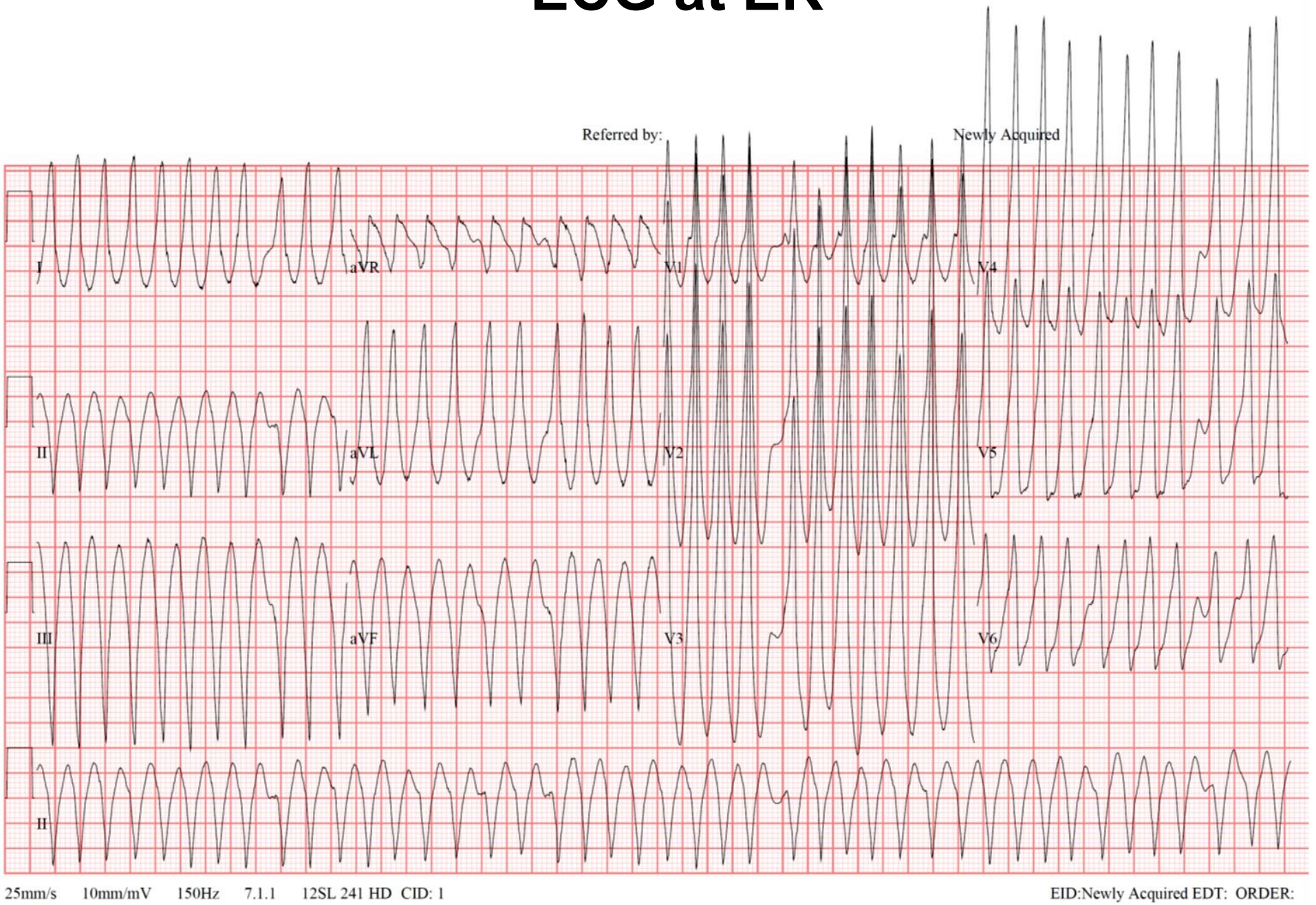
ECG at ER


Referred by:
Newly Acquired
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
H
25mm/s 10mm/mV 150Hz 7.1.1 12SL 241 HD CID: 1
EID:Newly Acquired EDT: ORDER:

가장 적절한 처치는?

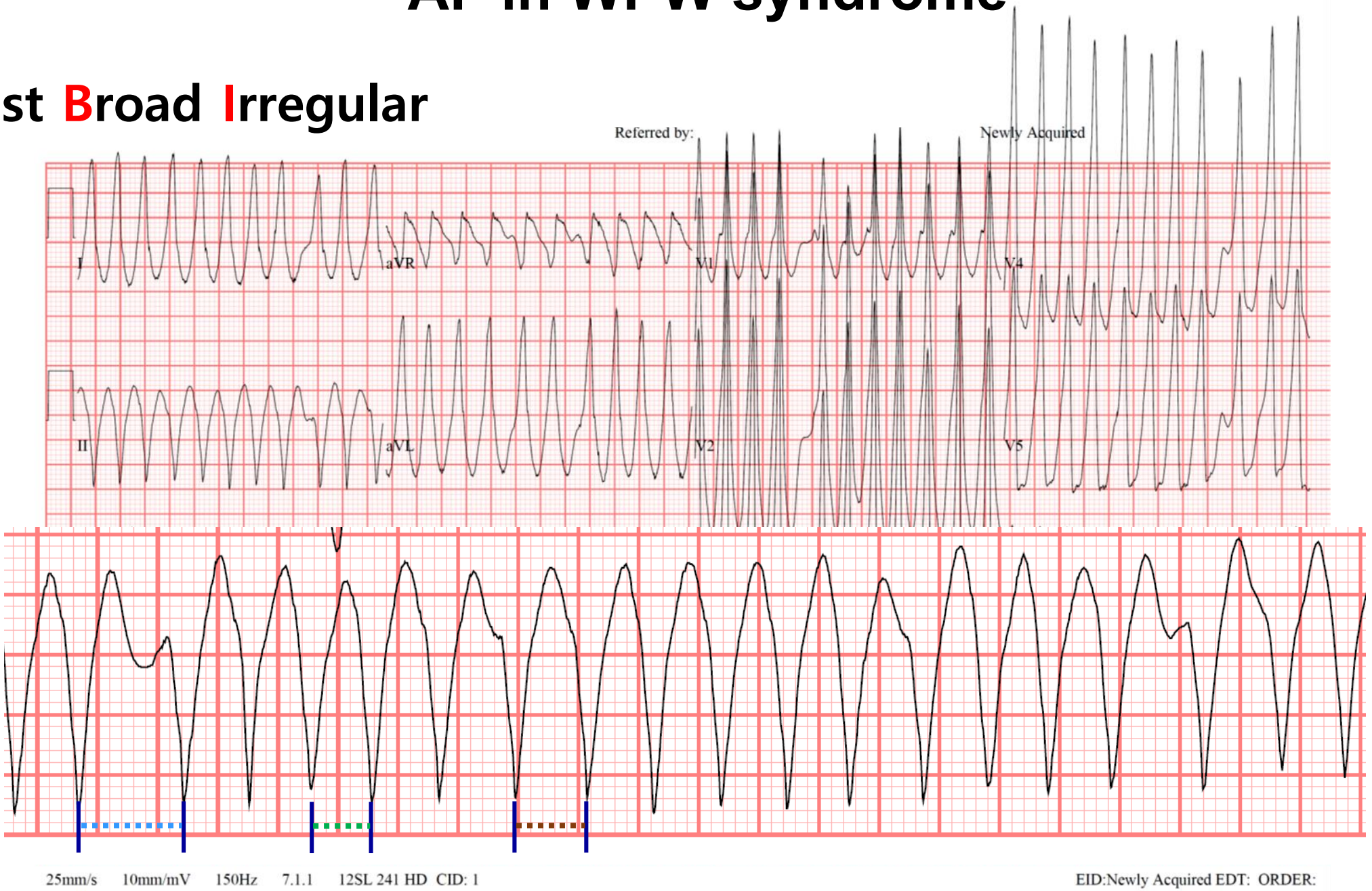
1. Adenosine
2. Esmolol
3. Verapamil
4. D/C cardioversion

ECG at ER


Referred by:
Newly Acquired
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
H
25mm/s 10mm/mV 150Hz 7.1.1 12SL 241 HD CID: 1
EID:Newly Acquired EDT: ORDER:

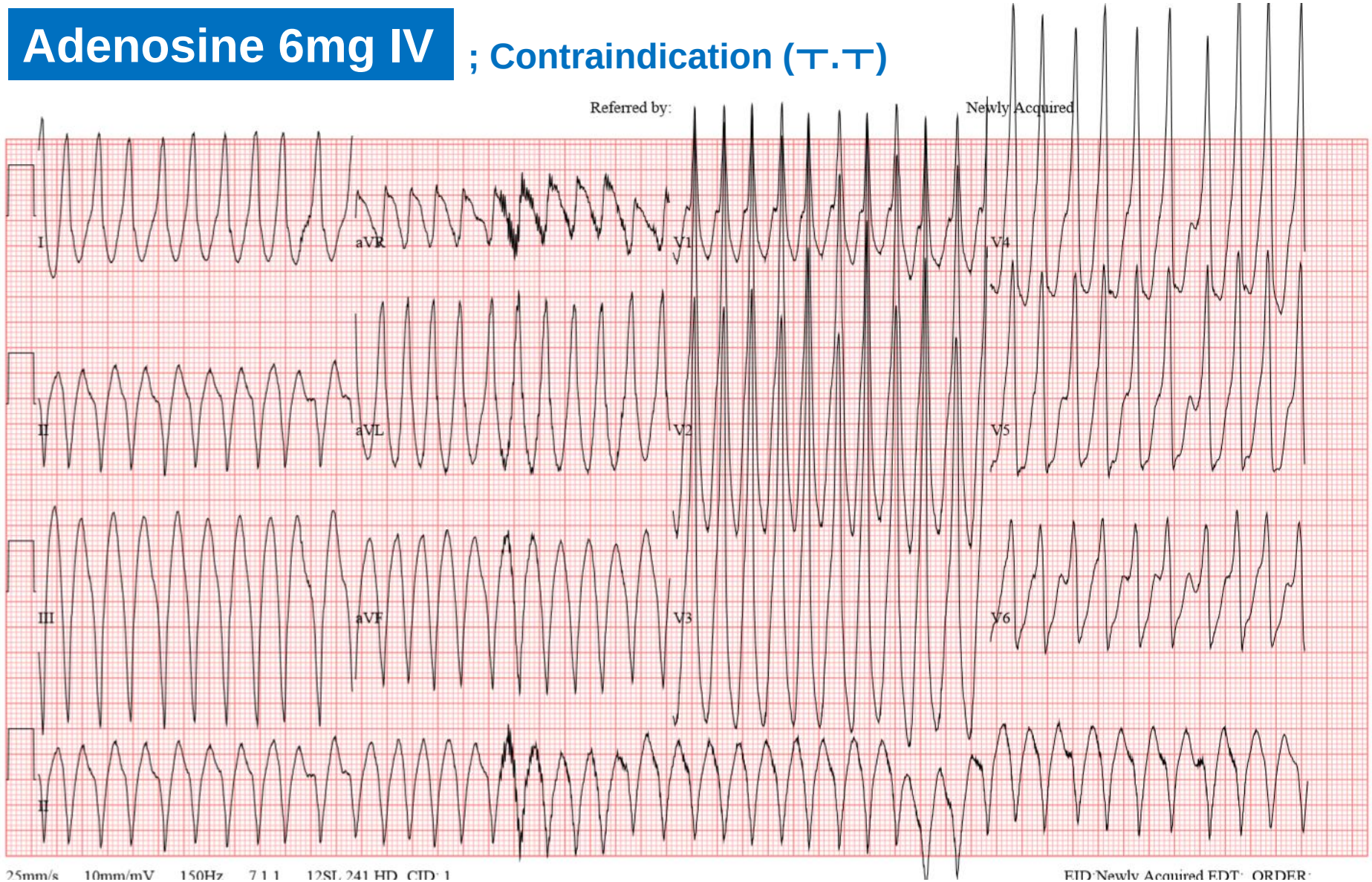
AF in WPW syndrome

Fast Broad Irregular



ECG during adenosine infusion

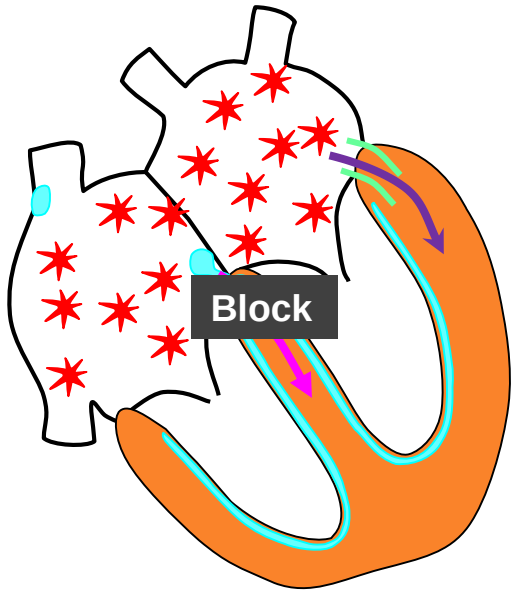
Adenosine 6mg IV ; Contraindication (ㅜ.ㅜ)



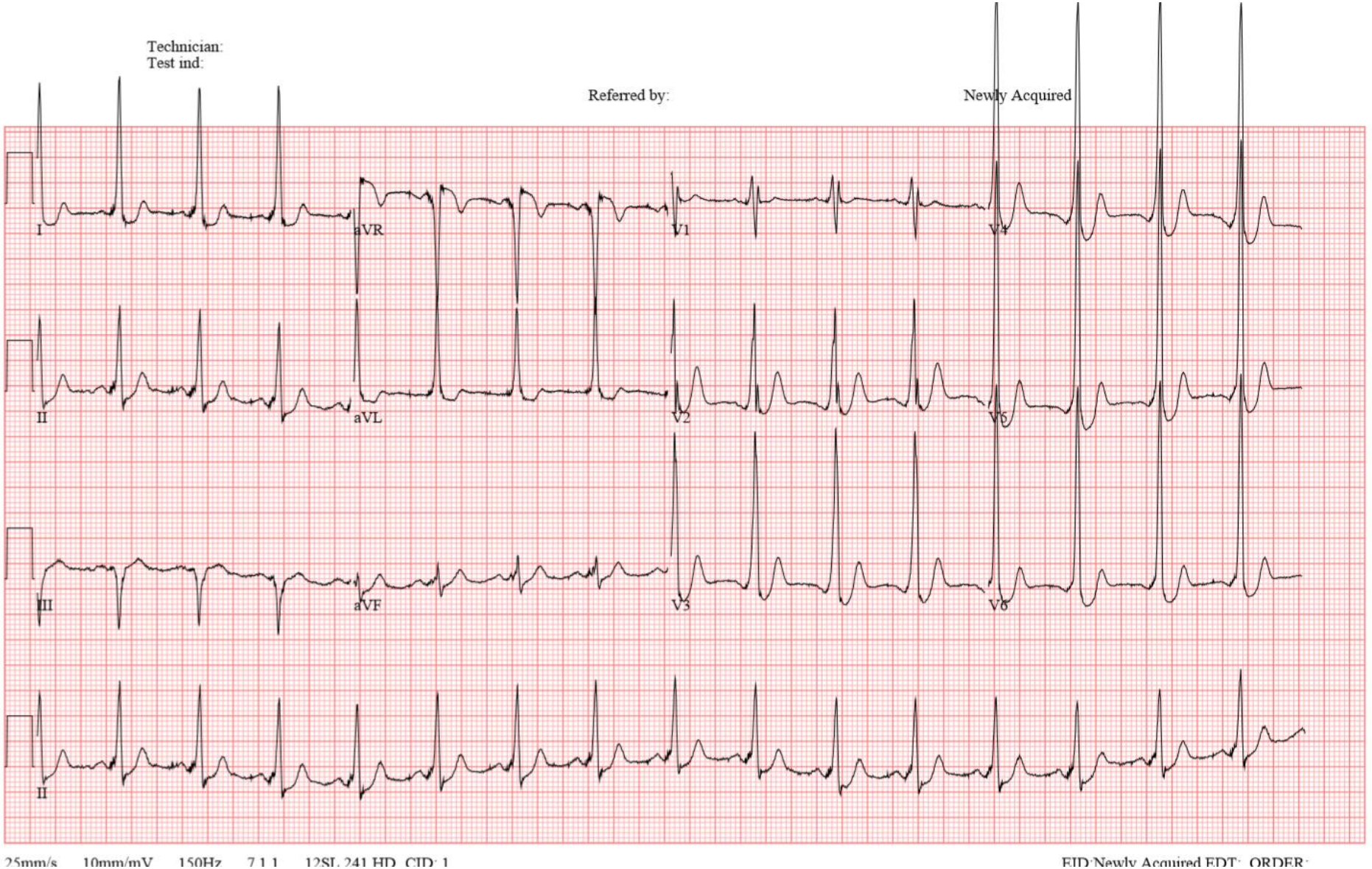
KHRS 2023

ECG during adenosine infusion

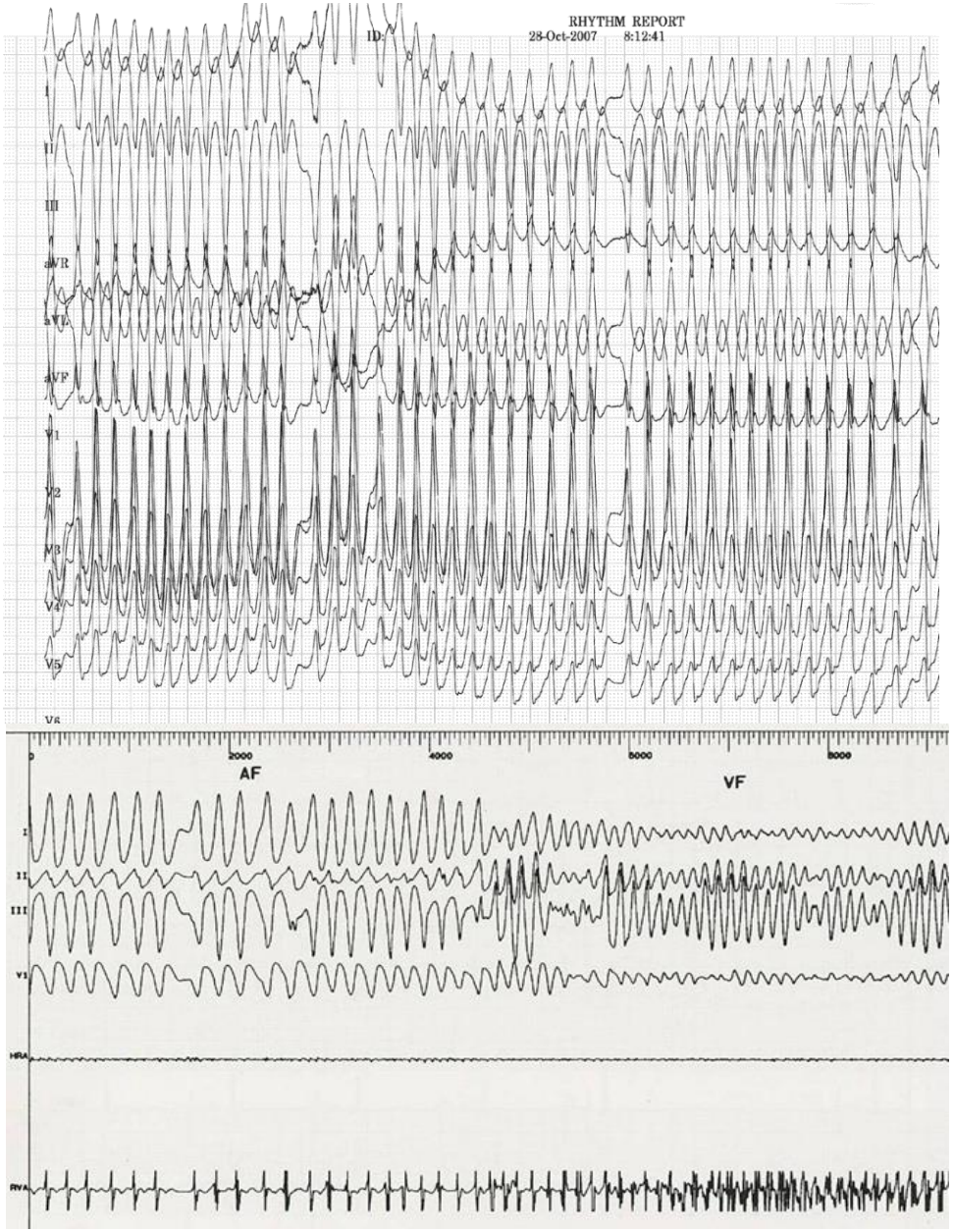
Adenosine 6mg IV → **Relatively regular**



ECG after DC cardioversion



AF degenerated to VF after verapamil infusion



증례 4.

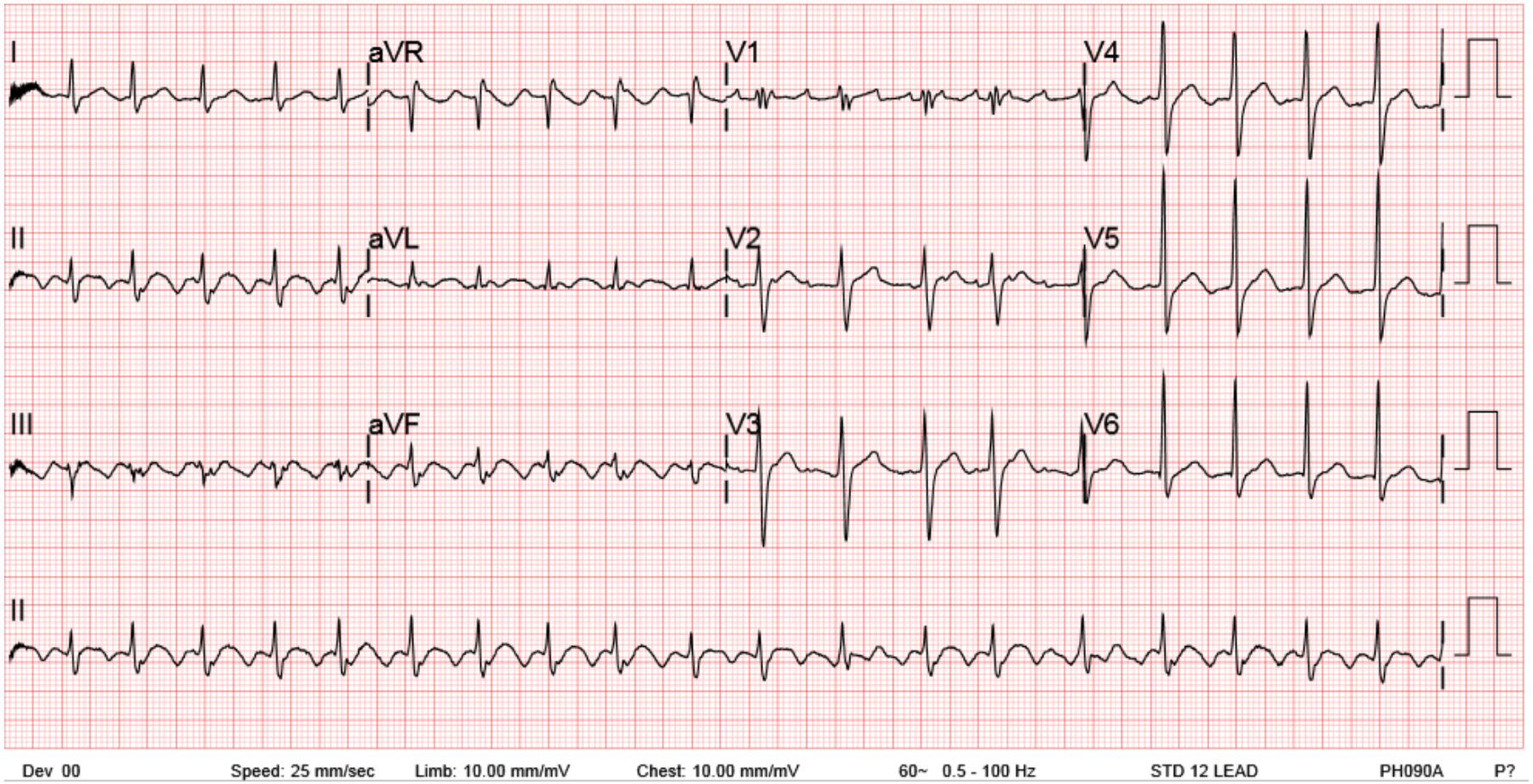
Flutter 1 to 1 conduction with aberrancy

증례

47/M

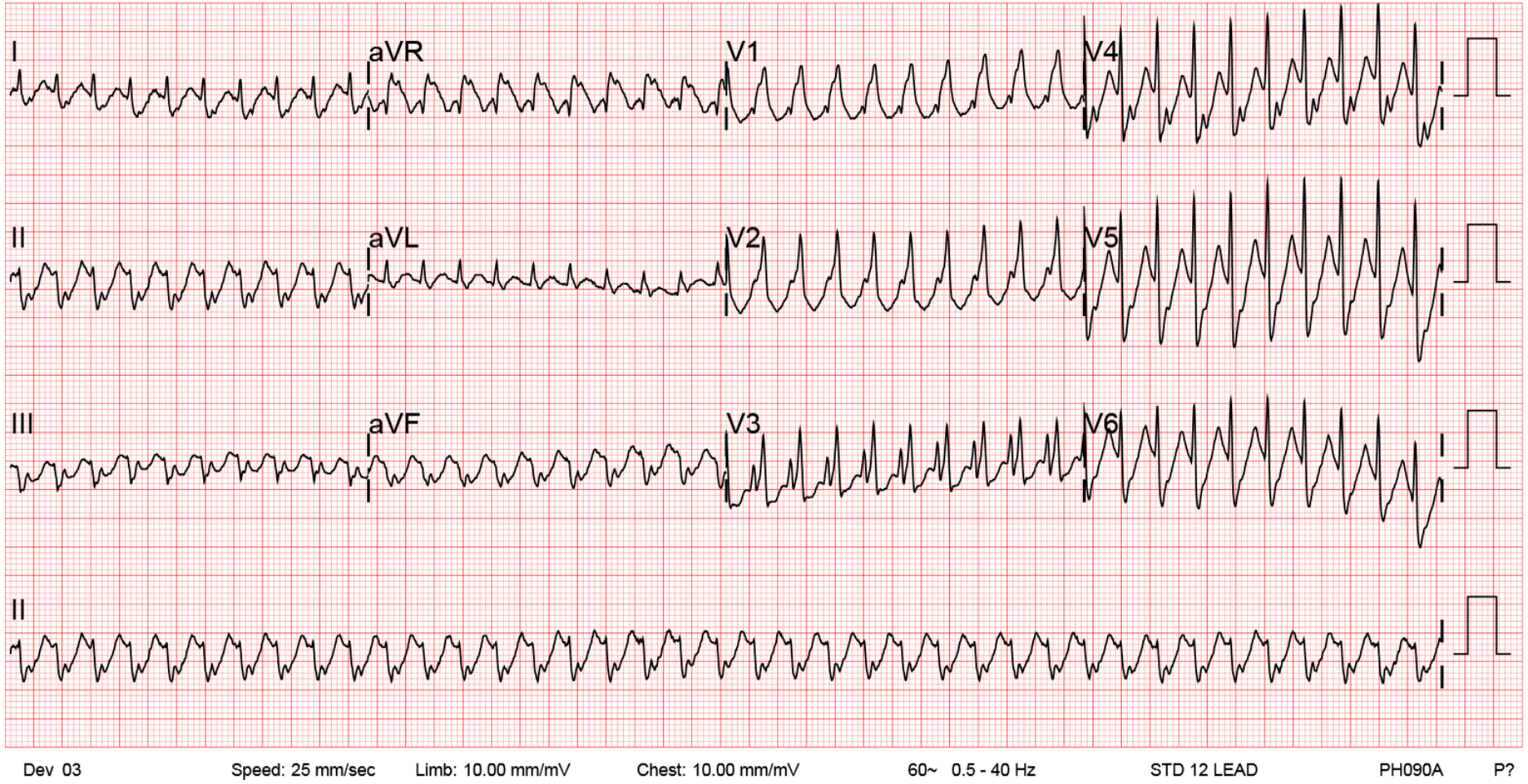
과거력 (-)
1시간 전부터 갑자기 발생한 두근거림을 주소로 응급실로 내원하였다
혈압 120/70 mmHg, 맥박 120 회/분, 호흡 20 회/분, 체온 36.5℃ 였다
내원 당시 촬영한 심전도(사진) 이다

ECG at admission

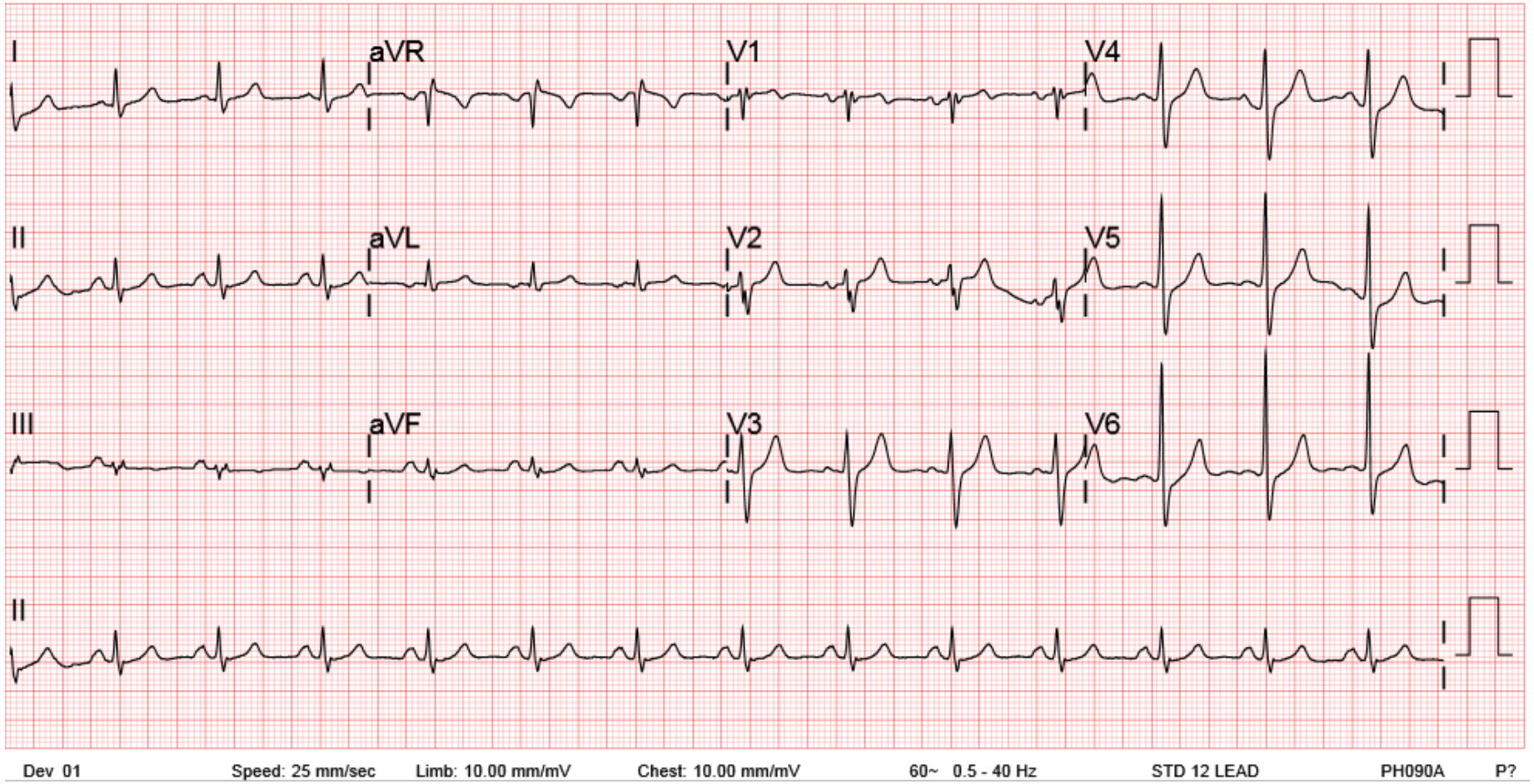


Wide QRS tachycardia with aggravated symptom

혈압 70/40 mmHg, 맥박 234 회/분



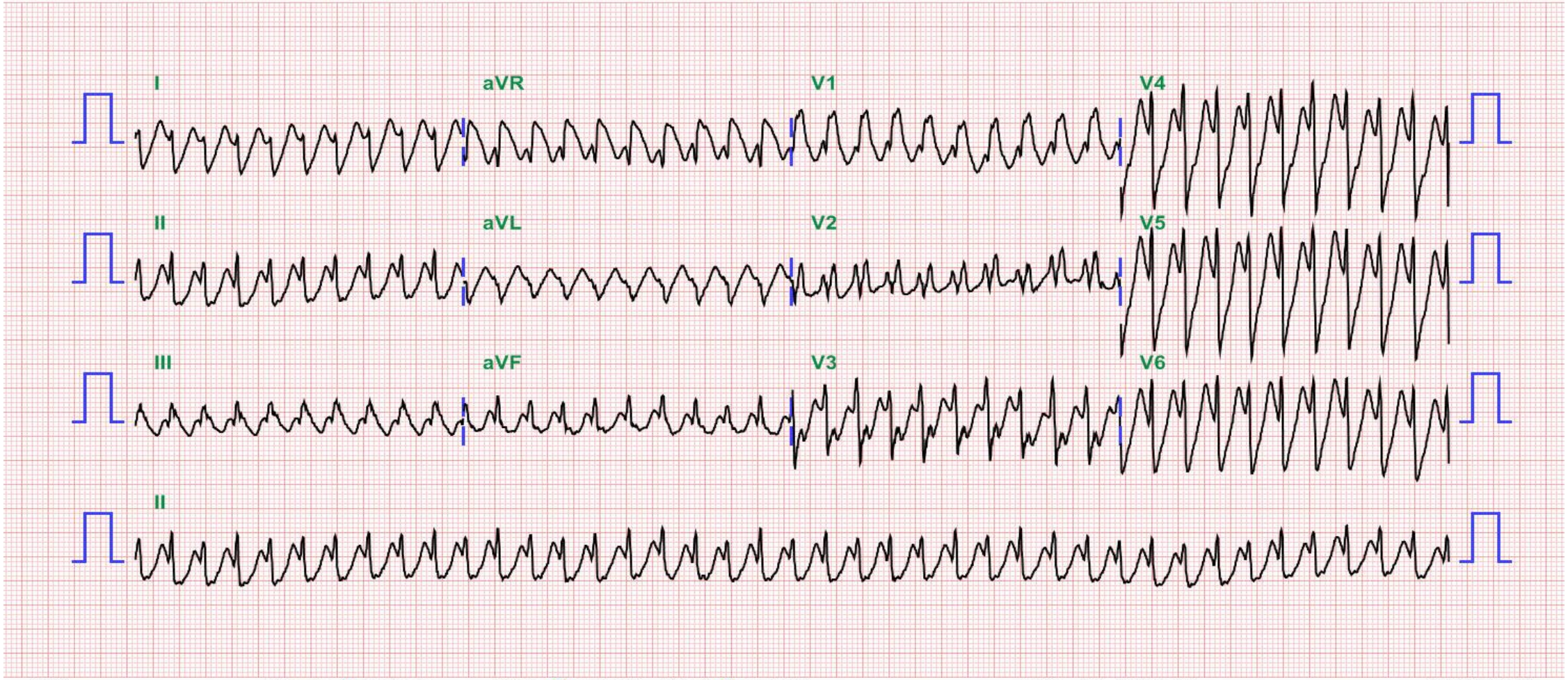
ECG after DC cardioversion



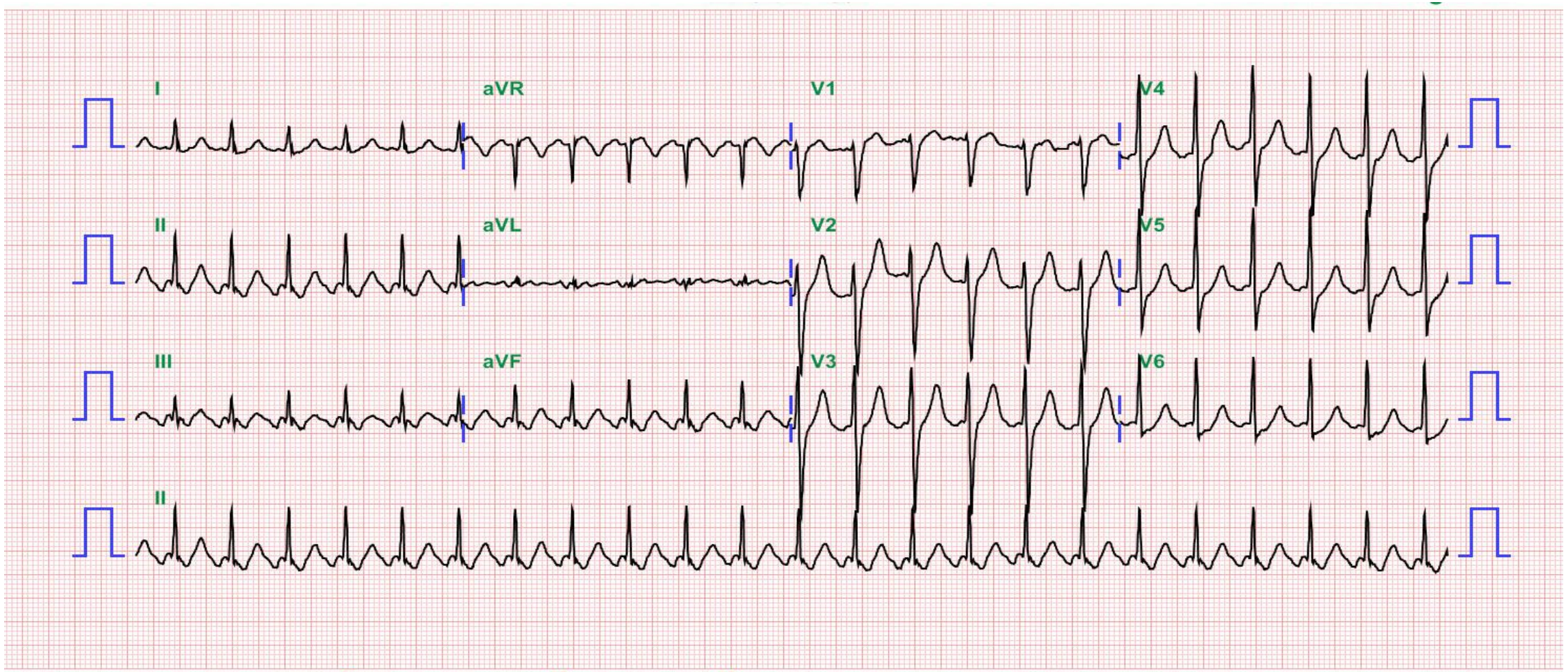
Wide QRS tachycardia 의 진단은?

1. Flutter 1 to 1 AV conduction with aberrancy
2. Antidromic AVRT
3. Fascicular ventricular tachycardia
4. Need more data

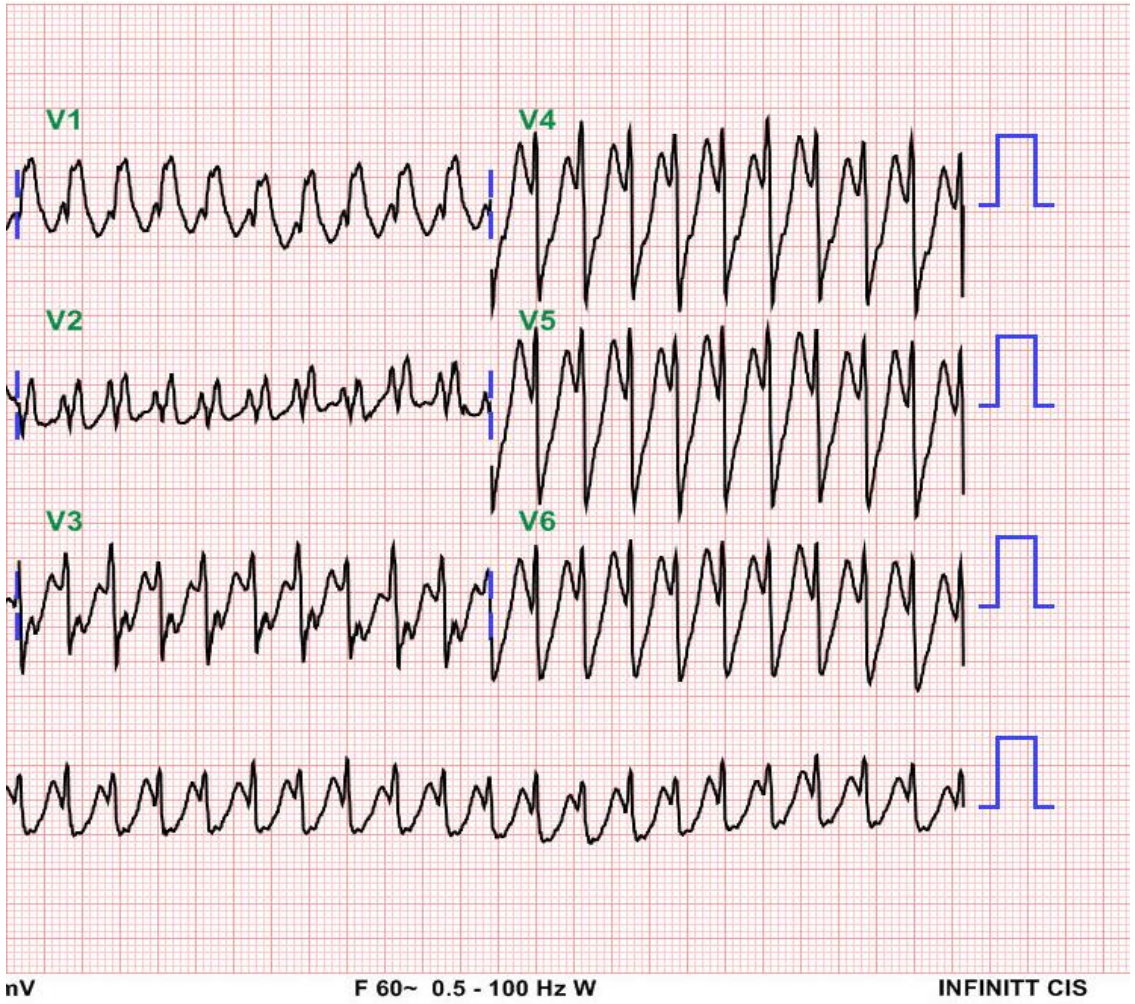
VT vs SVT ?

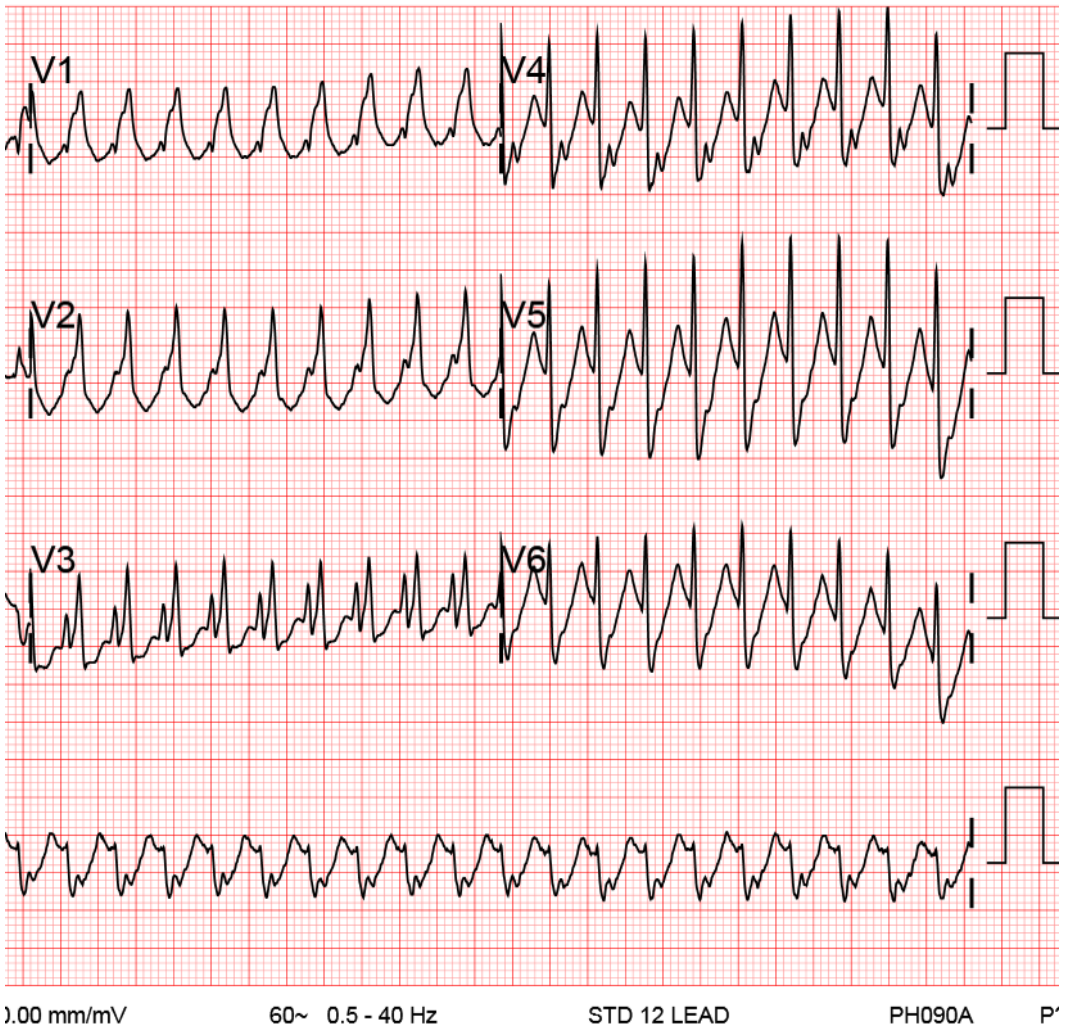

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
FDA
Speed: 25 mm/sec
Limb: 10 mm/mV
Chest: 10 mm/mV
F 60~ 0.5 - 100 Hz W
INFINITT CIS

VT vs SVT ?

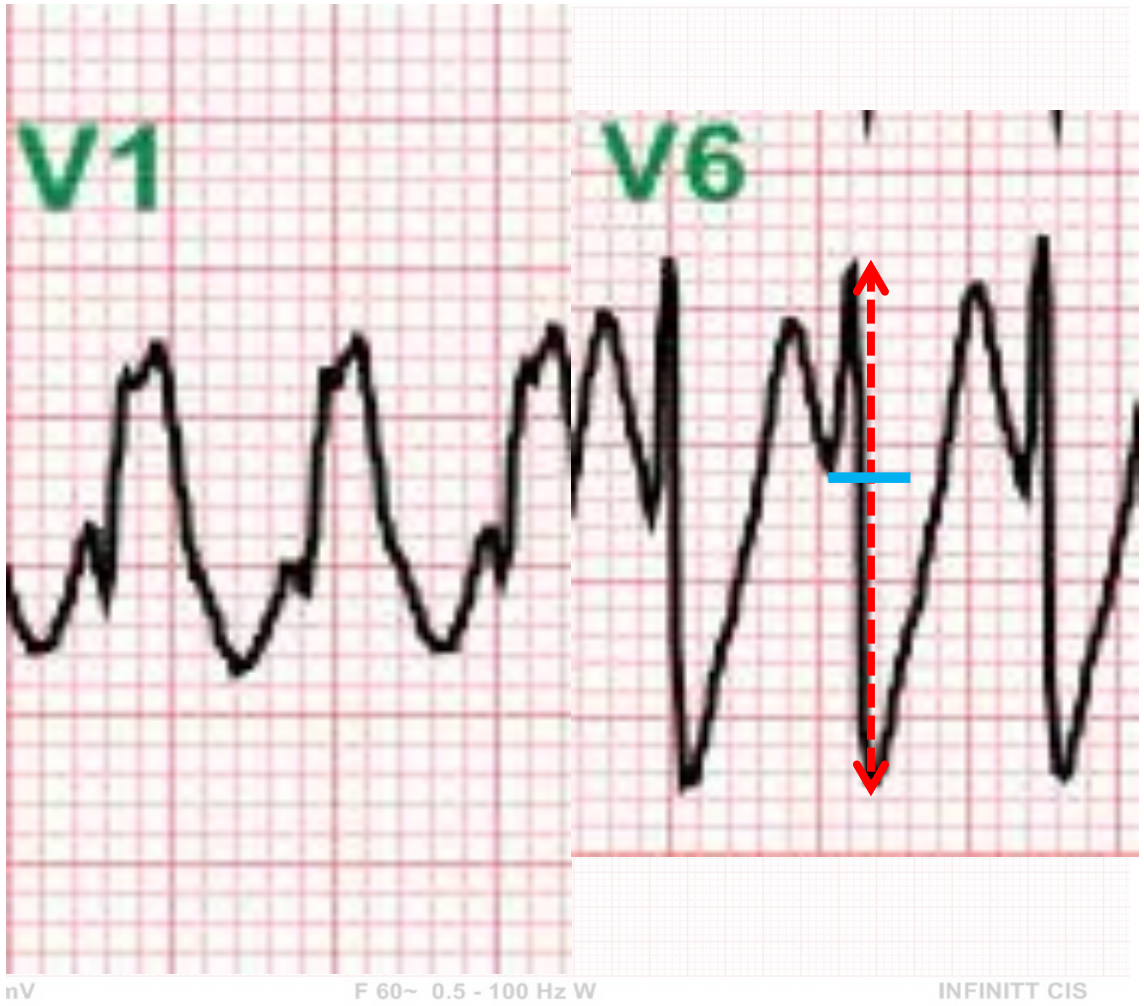

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
FDA
Speed: 25 mm/sec
Limb: 10 mm/mV
Chest: 10 mm/mV
F 60~ 0.5 - 100 Hz W
INFINITT CIS

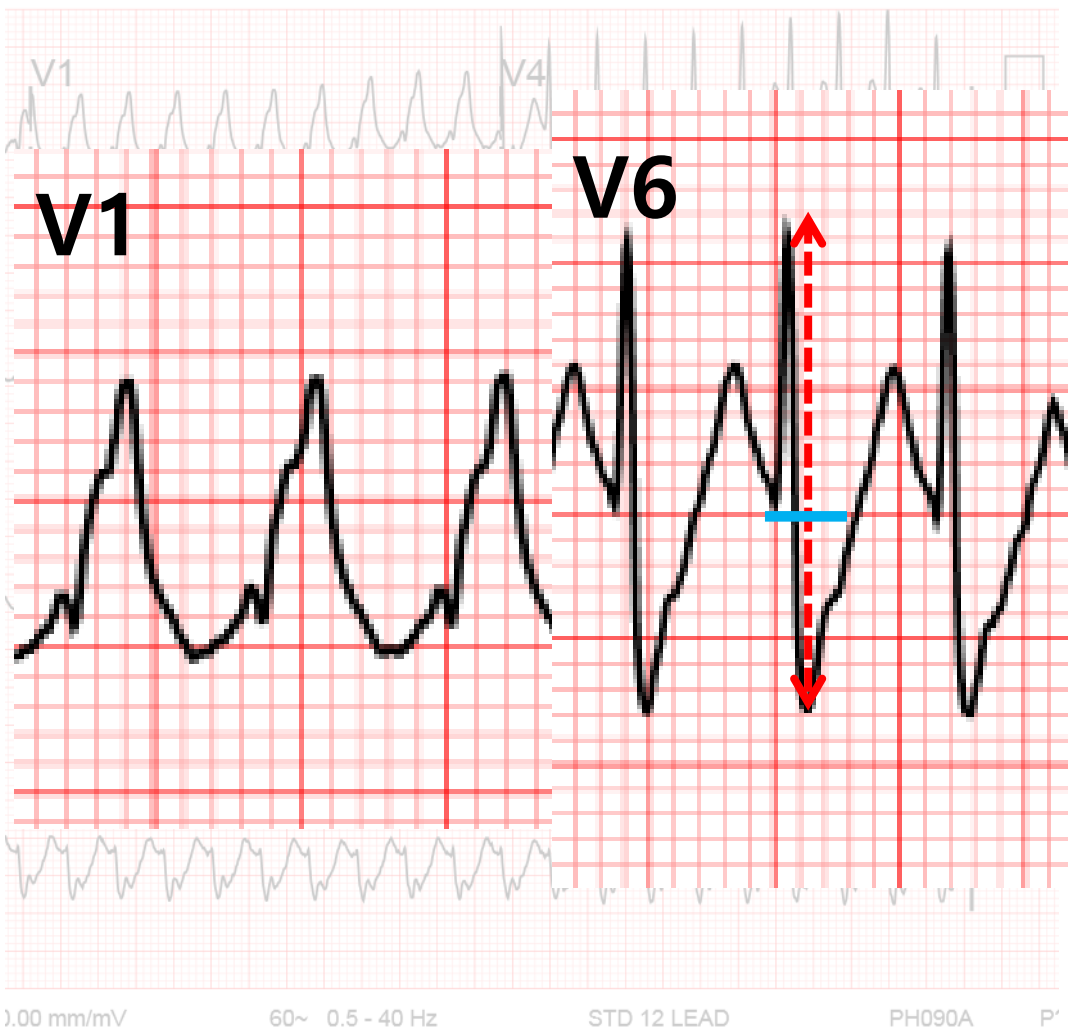
VT vs SVT ?


V1
V4
V2
V5
V3
V6
nV
F 60~ 0.5 - 100 Hz W
INFINITT CIS


V1
V4
V2
V5
V3
V6
.00 mm/mV
60~ 0.5 - 40 Hz
STD 12 LEAD
PH090A

VT vs SVT ?


V1
V6
nV
F 60~ 0.5 - 100 Hz W
INFINITT CIS


V1
V4
V1
V6
.00 mm/mV
60~ 0.5 - 40 Hz
STD 12 LEAD
PH090A

Long long time ago…

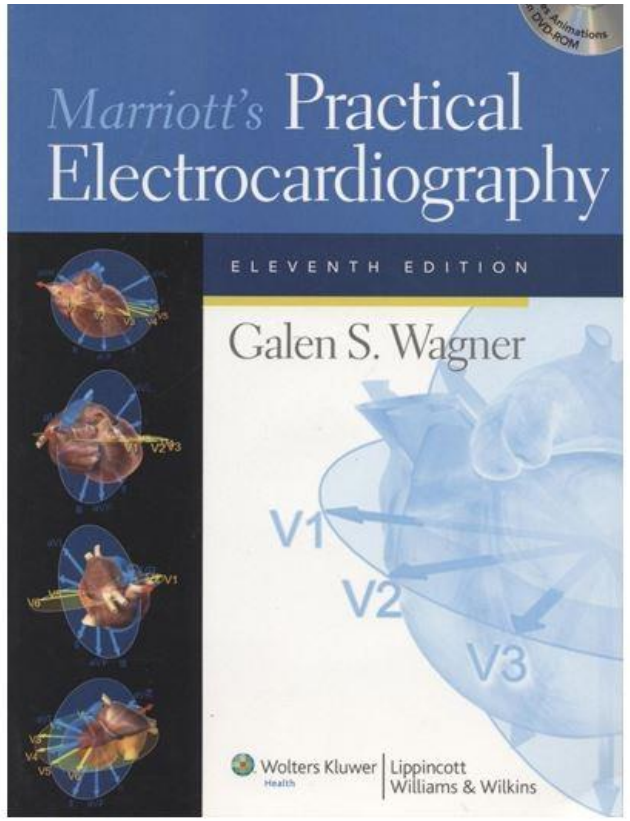
TO THE untutored Western eye, the faces of oriental gentlemen are strikingly alike. In a similar way, most of us are unable to distinguish at sight between the QRS-T pattern of bundle-branch block and the ectopic ventricular complex that simulates it. Yet the morphologic distinction could be of practical importance, since, especially in the presence of atrial fibrillation, it is often impossible by any other means to distinguish ectopic ventricular beats from aberrant ventricular conduction. Aberrant conduction is of little concern in either prognosis or treatment, whereas the presence of ventricular ectopic activity may significantly influence both. Since the great majority of aberrant beats show right bundle-branch block (RBBB), this pattern is of prime importance.

One promising approach to distinguish the Chinese from the Japanese from the Filipino would be to line up a number of each and empirically scan their features for generic differences. With the oriental gentlemen in mind, we decided to muster and scrutinize examples in V_1 of ventricular extrasystoles whose form resembled an RBBB pattern, actual RBBB, and aberrant ventricular conduction of RBBB type.

The Differential Morphology of Anomalous Ventricular Complexes of RBBB-Type in Lead V_1

Ventricular Ectopy versus Aberration

By I. Alberto Sandler, M.D., and Henry J. L. Marriott, M.D.



Sandler et al. Circulation. 1965 Apr;31:551-6

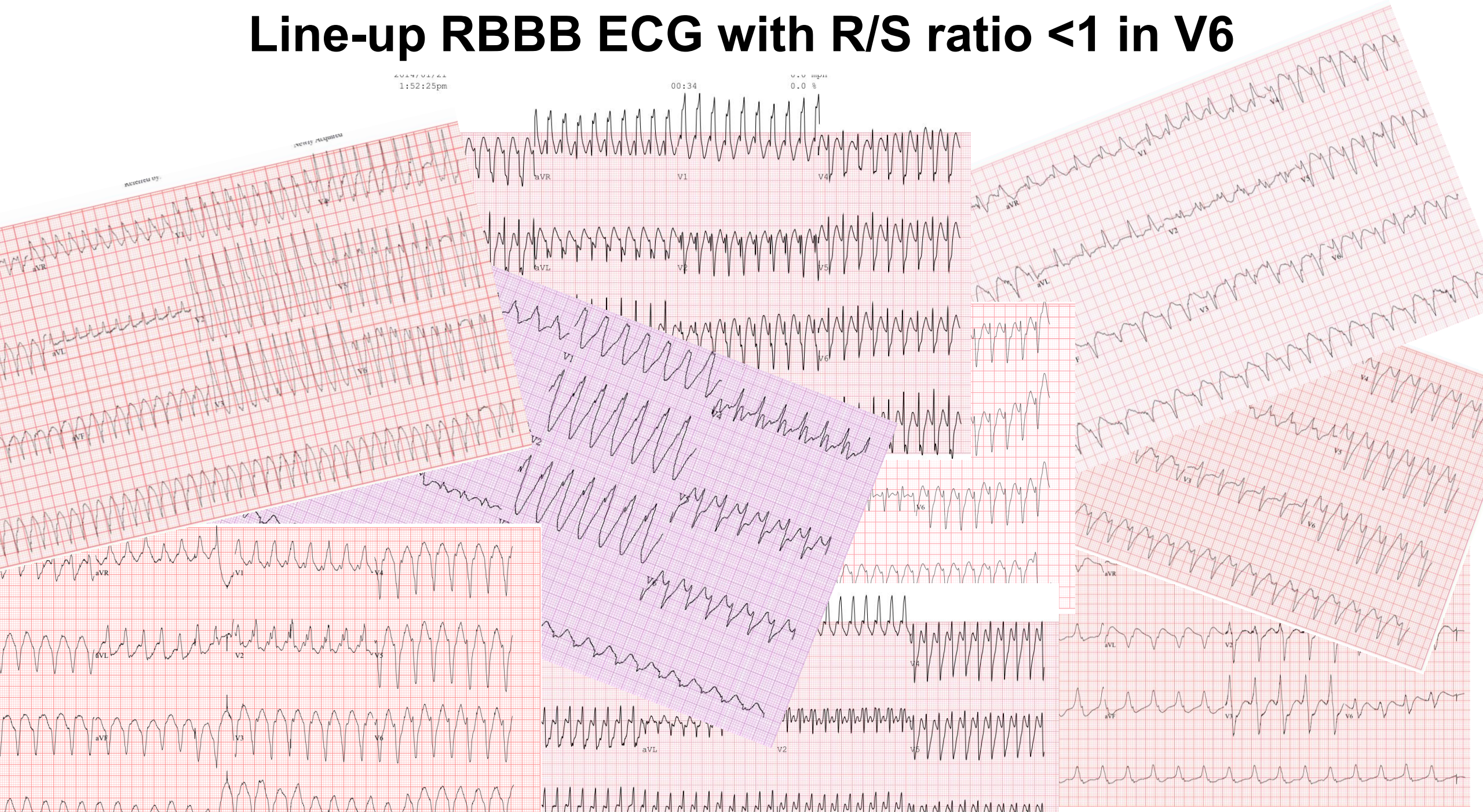
Long long time ago…

TO THE untutored Western eye, the faces of oriental gentlemen are strikingly alike. In a similar way, most of us are unable

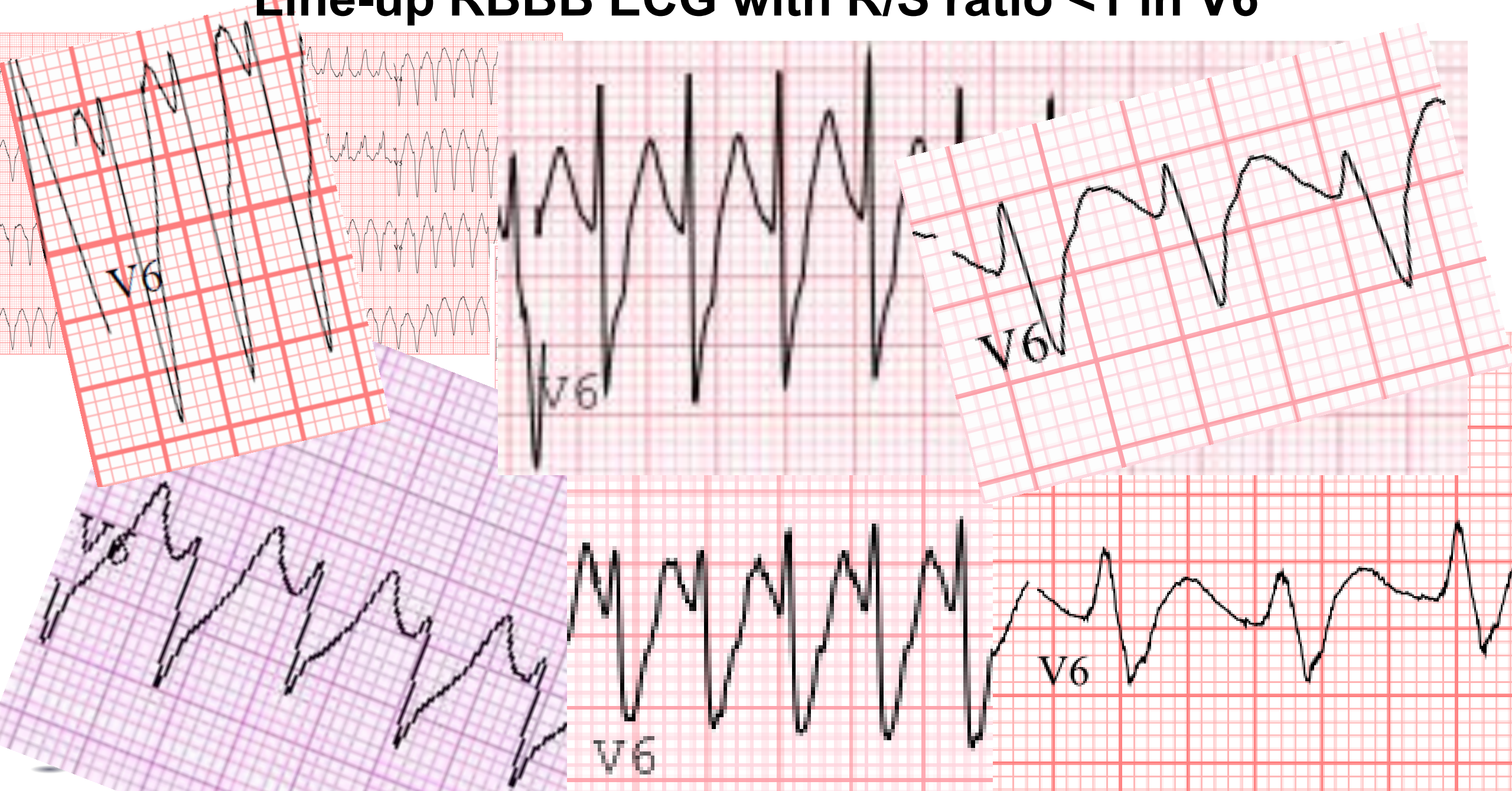
One promising approach to distinguish the Chinese from the Japanese from the Filipino would be to line up a number of each and empirically scan their features for generic differences. With the oriental gentlemen in

Sandler et al. Circulation. 1965 Apr;31:551-6

Line-up RBBB ECG with R/S ratio <1 in V6



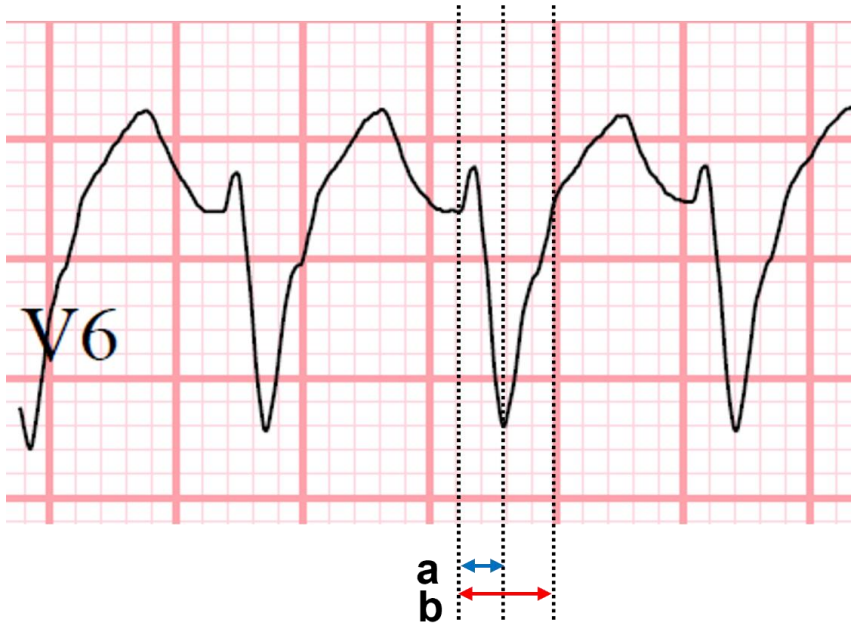
Line-up RBBB ECG with R/S ratio <1 in V6

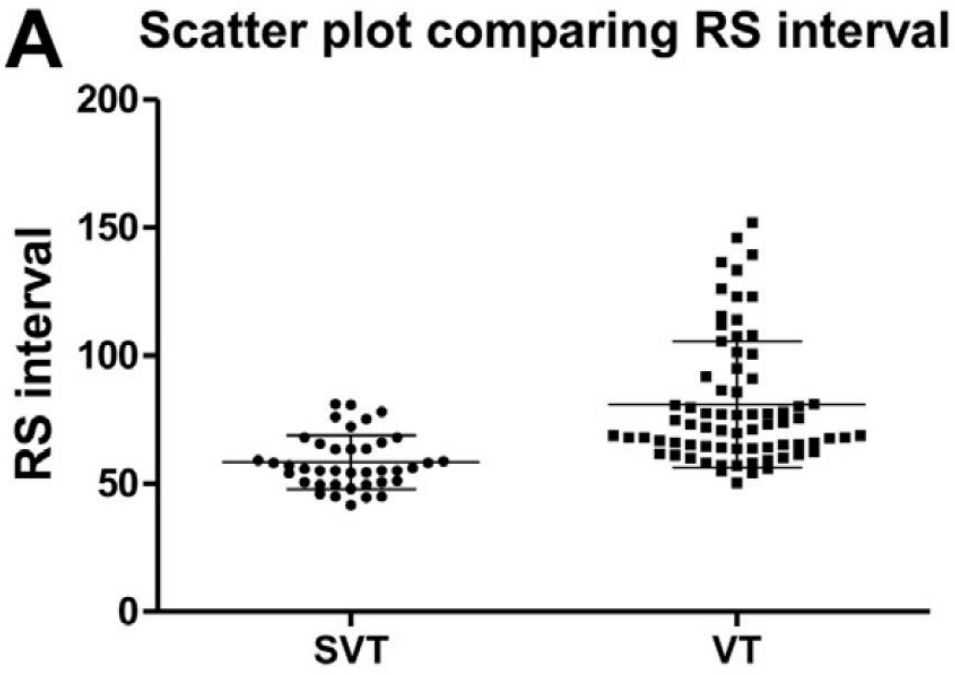


RS / QRS ratio in V6

Right bundle branch block–type wide QRS complex tachycardia with a reversed R/S complex in lead V_6: Development and validation of electrocardiographic differentiation criteria

Minsu Kim, MD,* Chang Hee Kwon, MD,† Ji Hyun Lee, MD,‡ Ki Won Hwang, MD,§ Hyung Oh Choi, MD,‖ Yong-Giun Kim, MD,¶ Kwang-No Lee, MD,# Jinhee Ahn, MD,** Hyoung-Seob Park, MD,†† Gi-Byoung Nam, MD‡‡





RS interval (a) = interval from onset of R wave to nadir of S wave

QRS width (b)

RS / QRS ratio = a/b

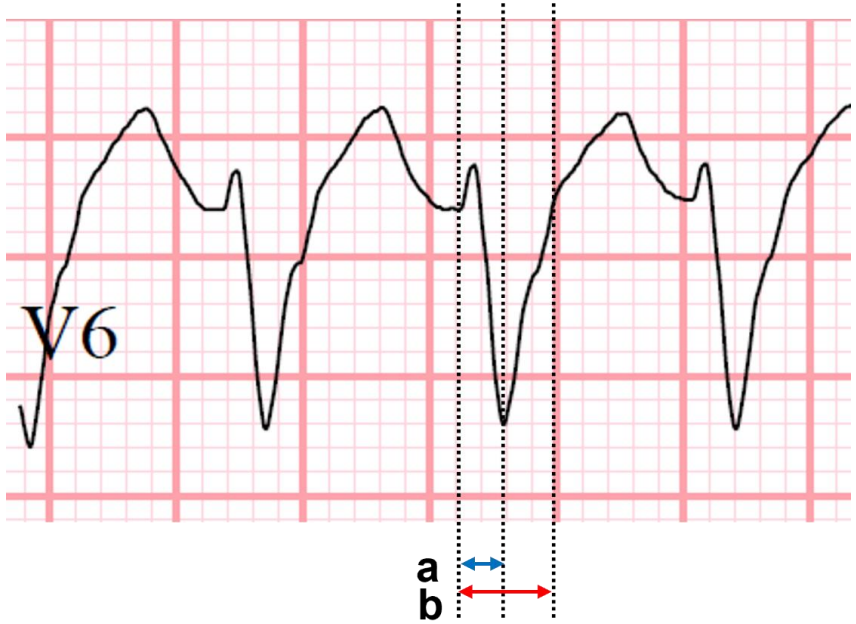
Kim et al. Heart Rhythm. 2021;18:181 – 188

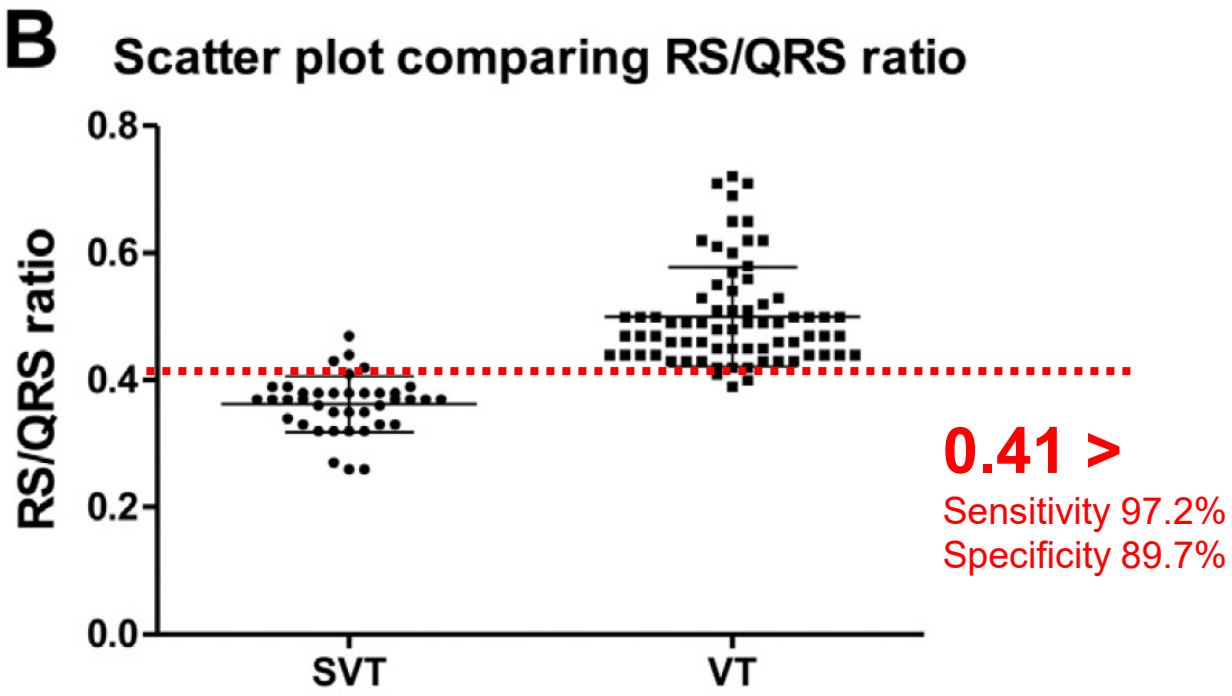
KHRS 2023

RS / QRS ratio in V6

Right bundle branch block–type wide QRS complex tachycardia with a reversed R/S complex in lead V_6: Development and validation of electrocardiographic differentiation criteria

Minsu Kim, MD,* Chang Hee Kwon, MD,† Ji Hyun Lee, MD,‡ Ki Won Hwang, MD,§ Hyung Oh Choi, MD,‖ Yong-Giun Kim, MD,¶ Kwang-No Lee, MD,# Jinhee Ahn, MD,** Hyoung-Seob Park, MD,†† Gi-Byoung Nam, MD‡‡





0.41 >

Sensitivity 97.2%

Specificity 89.7%

RS interval (a) = interval from onset of R wave to nadir of S wave

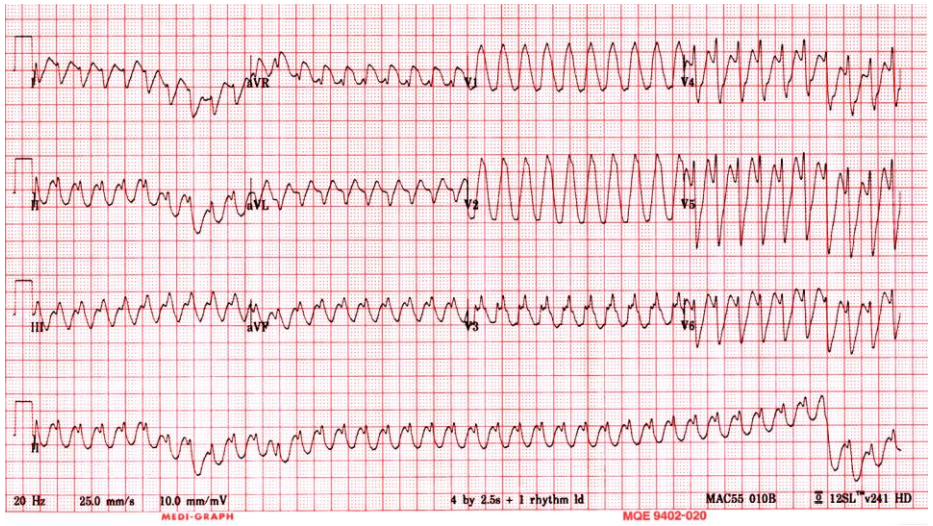
QRS width (b)

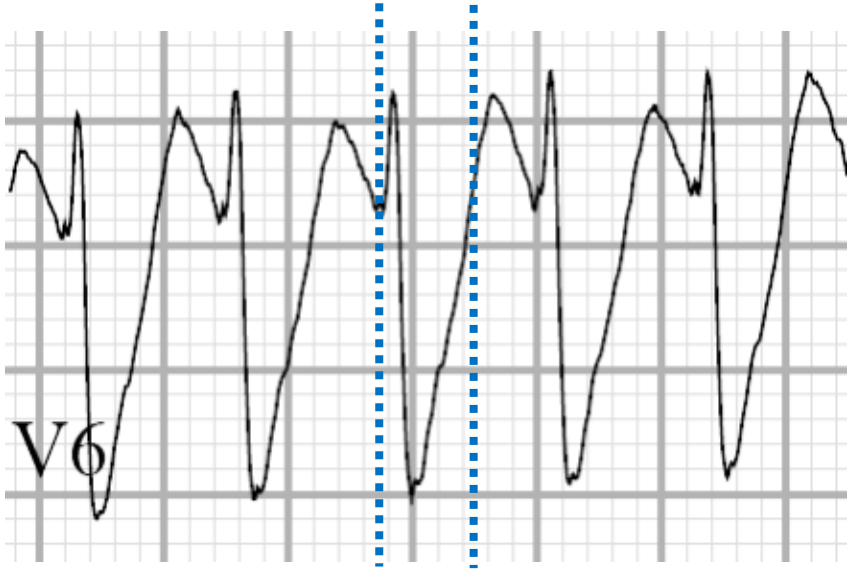
RS / QRS ratio = a/b

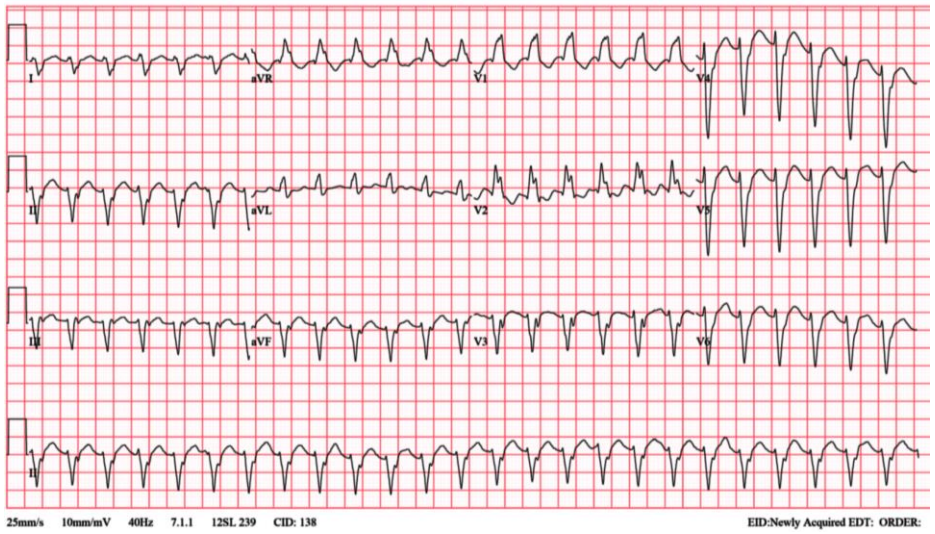
Kim et al. Heart Rhythm. 2021;18:181 – 188

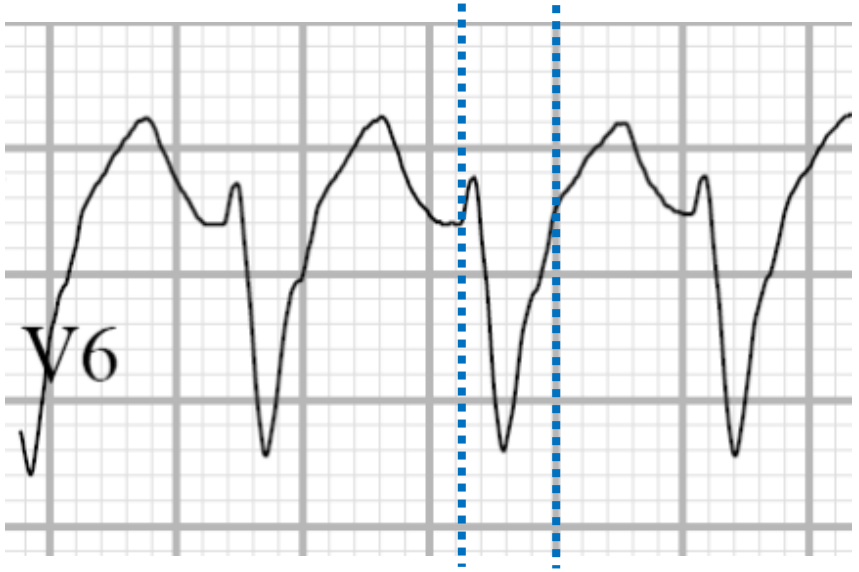
KHRS 2023

RS / QRS ratio in V6



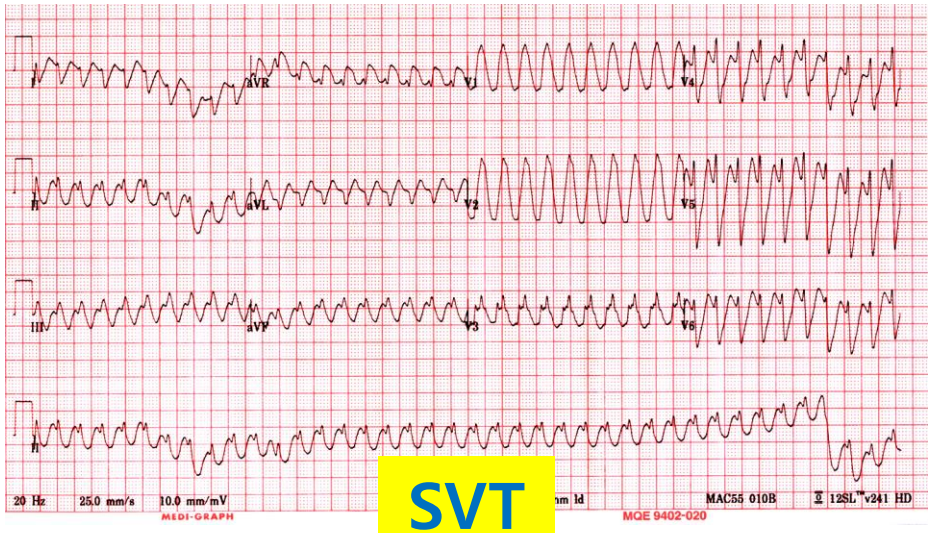


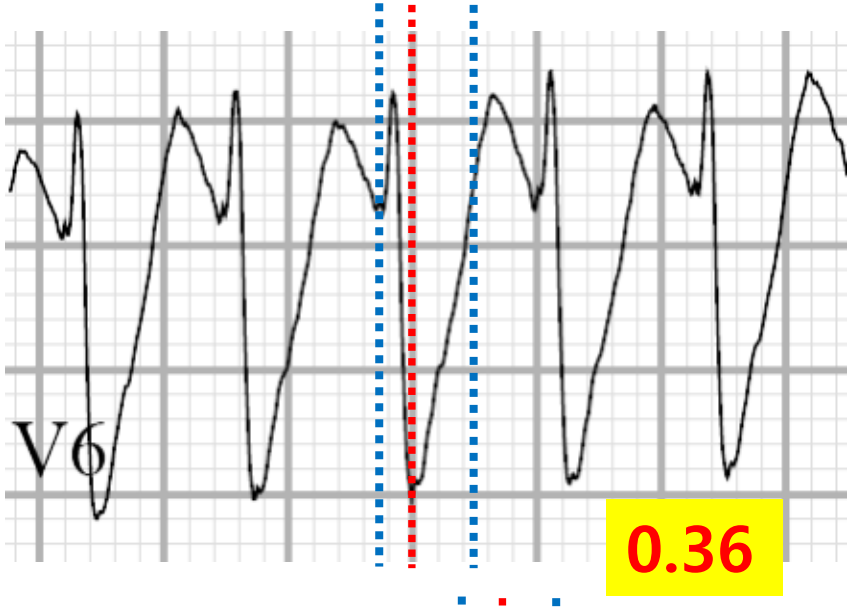


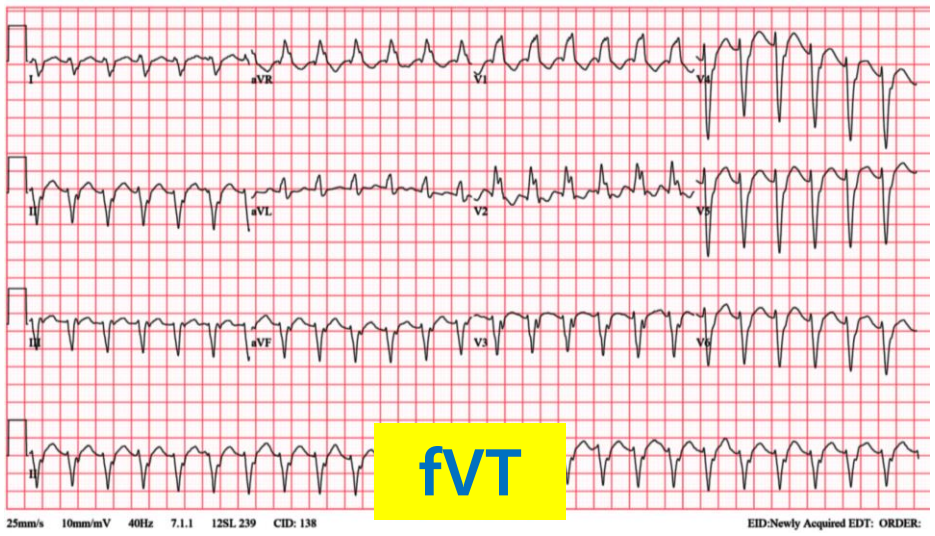


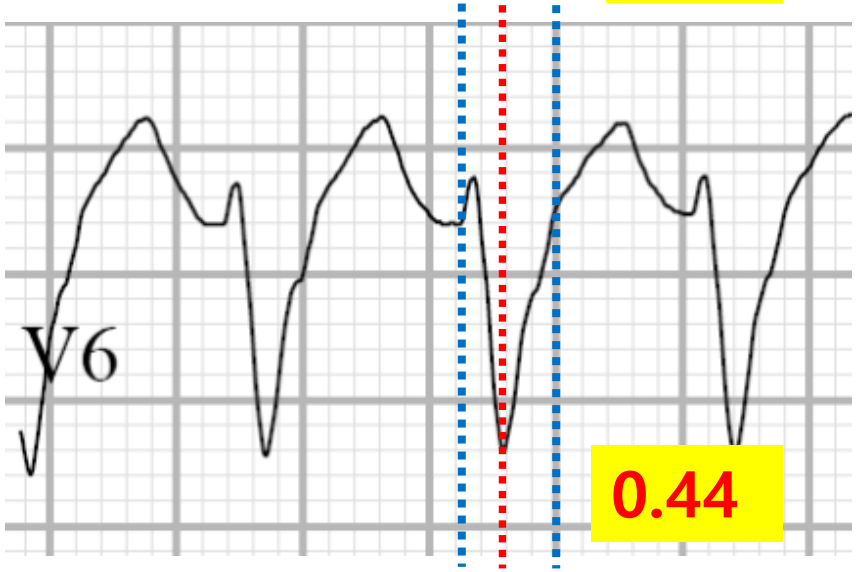
KHRS 2023

RS / QRS ratio in V6









fVT; fascicular VT

KHRS 2023

증례 5.

Ic flutter in atrial fibrillation

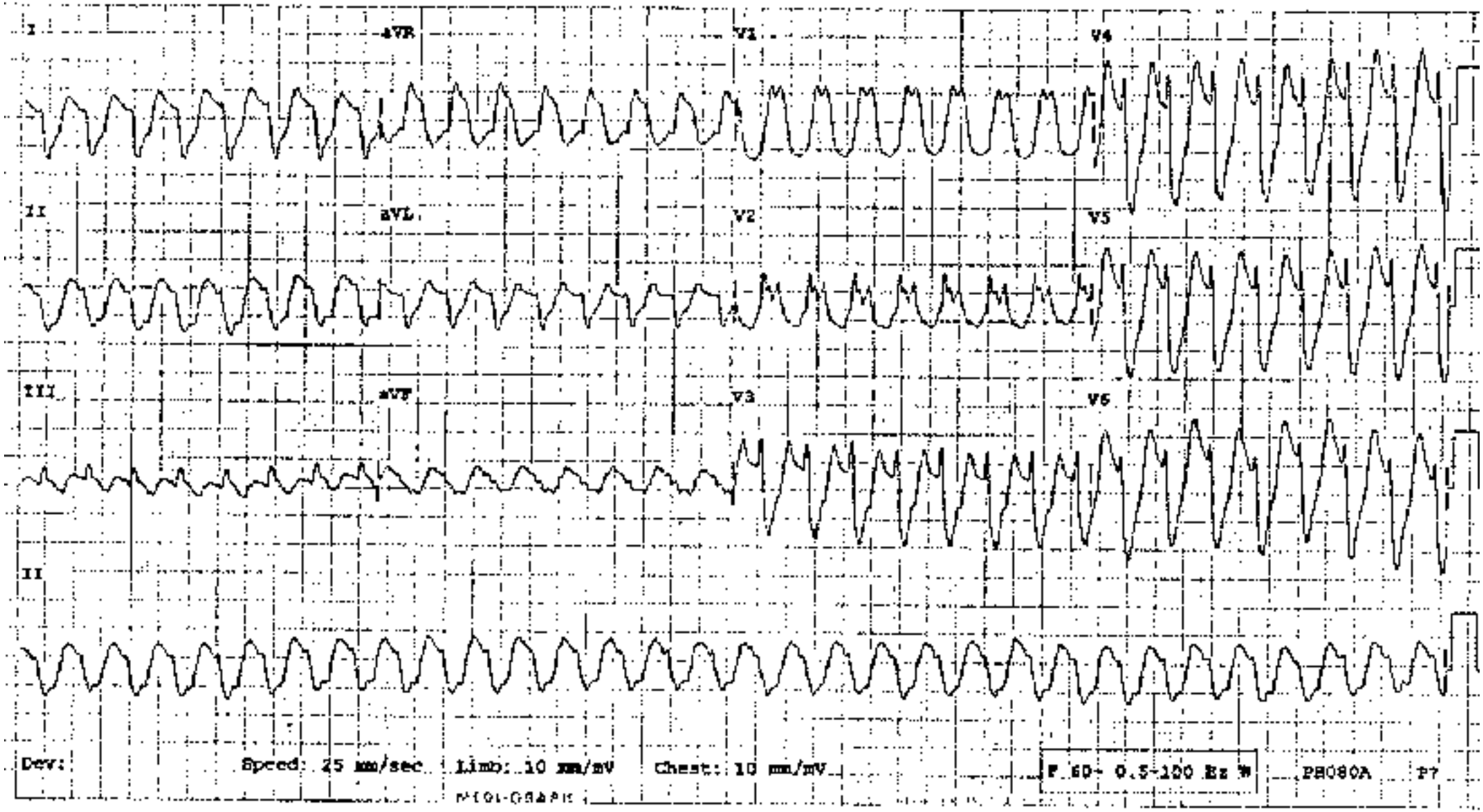
증례

58/M

3년 전 심방조동 및 세동 진단을 받고 타병원에서 flecainide 100mg 하루 2회, carvedilol 16mg 하루 1회 복약 중

두근거림을 주소로 타병원 응급실 내원하여 촬영한 심전도 검사에서 wide QRS tachycardia 가 진단되어서 DC cardioversion 후 ICD 삽입에 대해서 의뢰 되었다

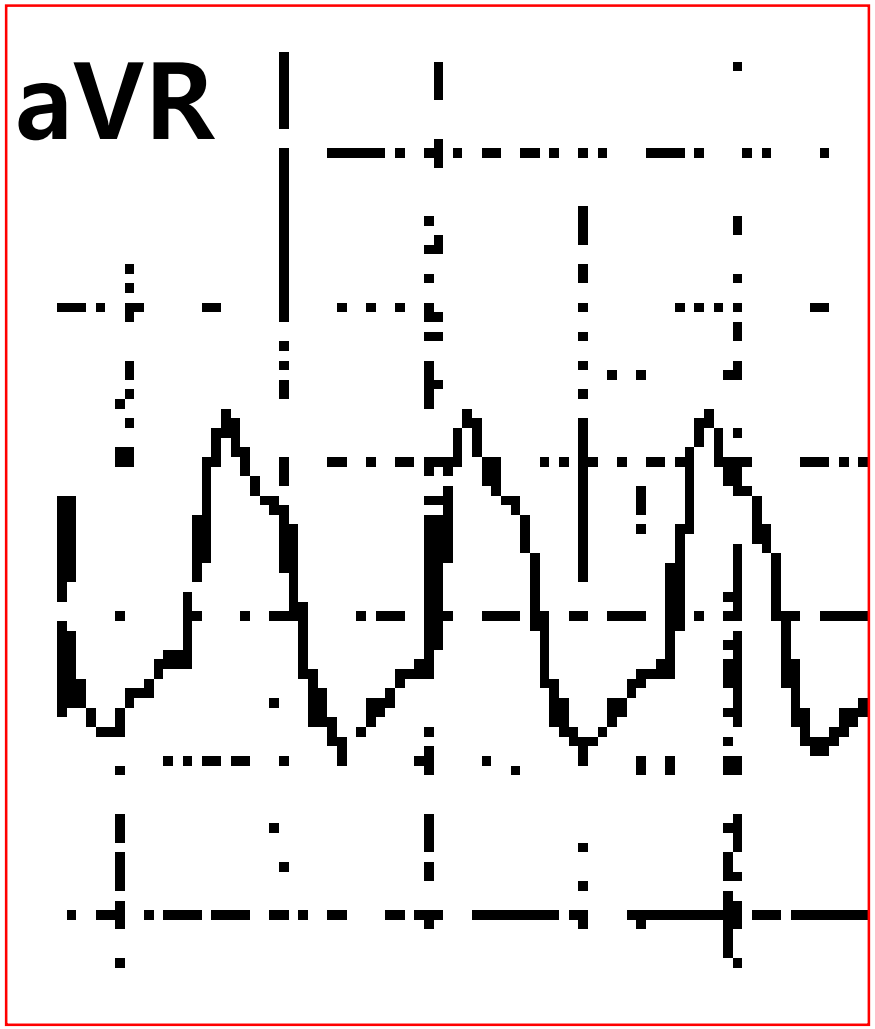
ECG with symptom

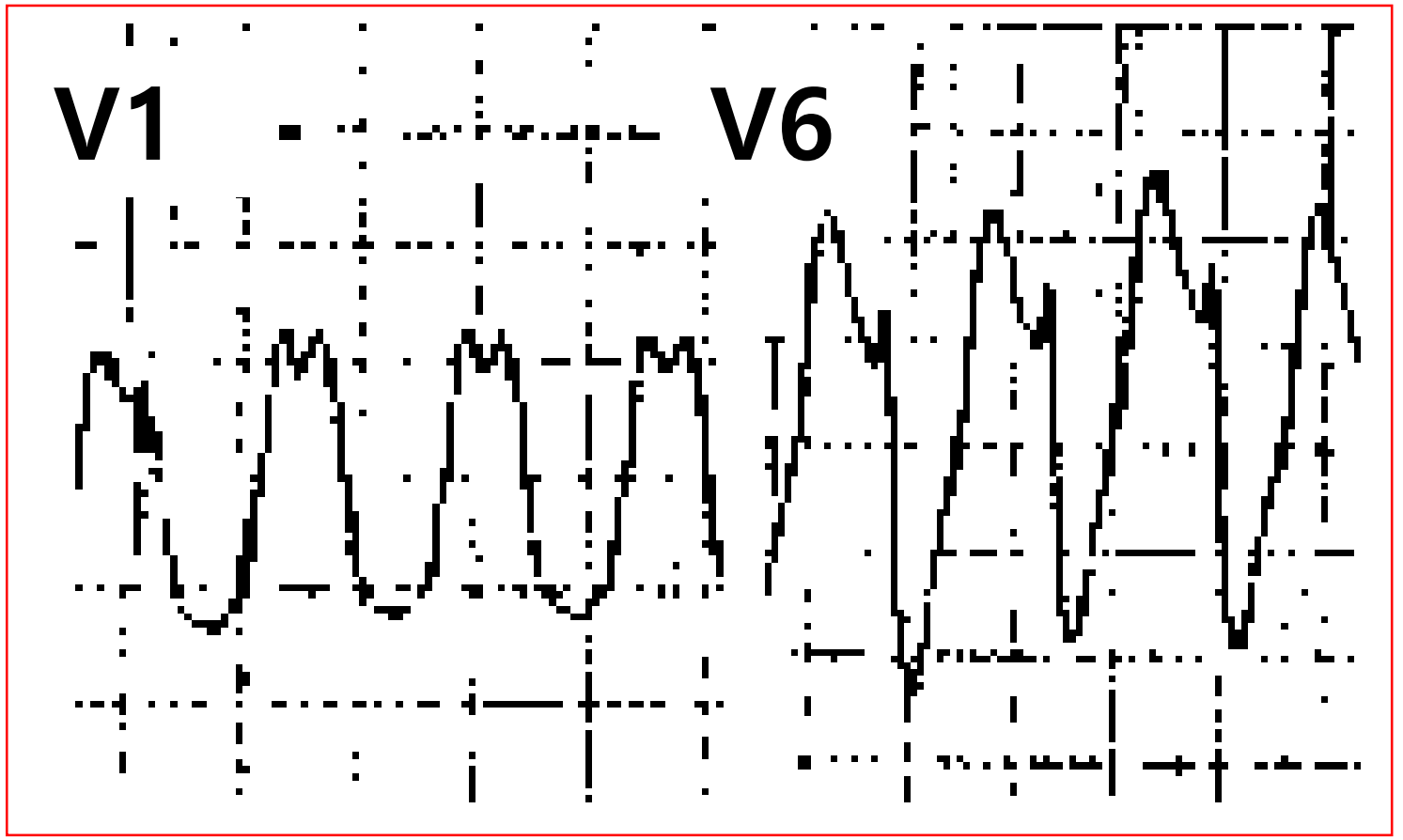


향후 가장 적절한 처치는?

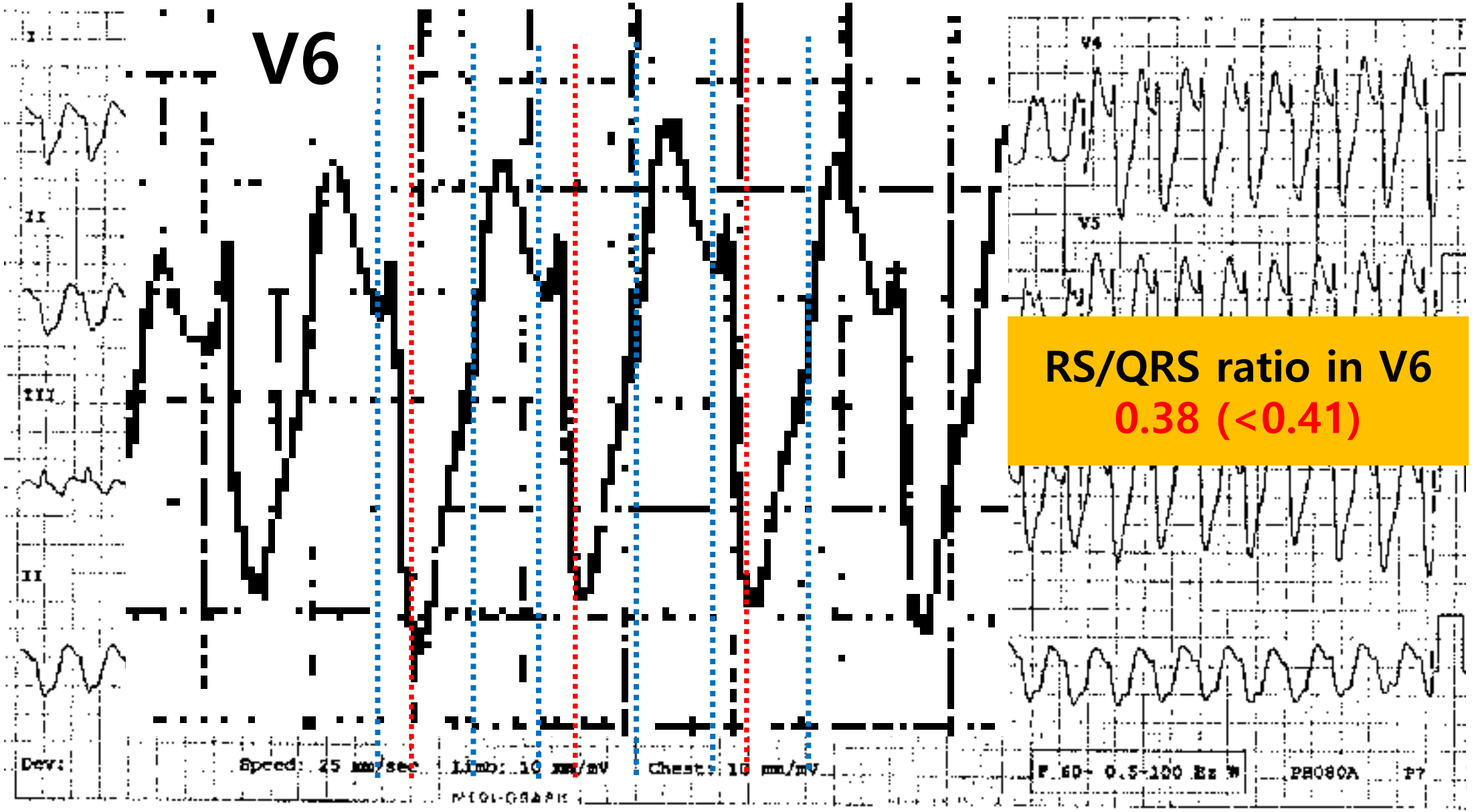
1. Amiodarone
2. VT ablation
3. ICD implantation
4. EP study + AF/AFL ablation

VT vs SVT ?





VT vs SVT ?



2023

Simulated Tachycardia

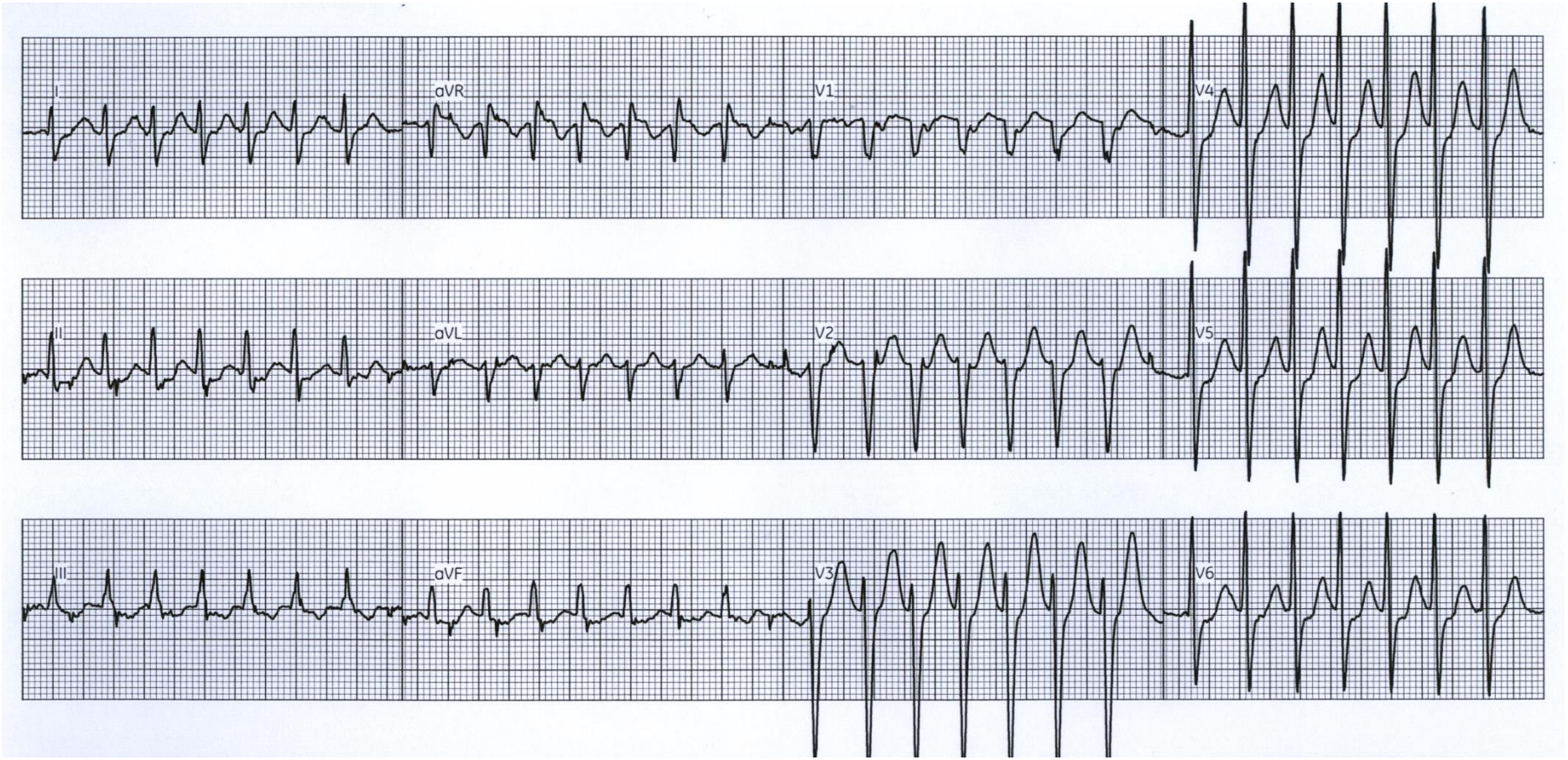
Reproduced by EP study → "Simulated tachycardia"

; Atrial overdrive pacing (@clinical tachycardia cycle length)

infusion isoproterenol (1 to 1 AV conduction)
& IV flecainide (2mg/kg for 10 min)

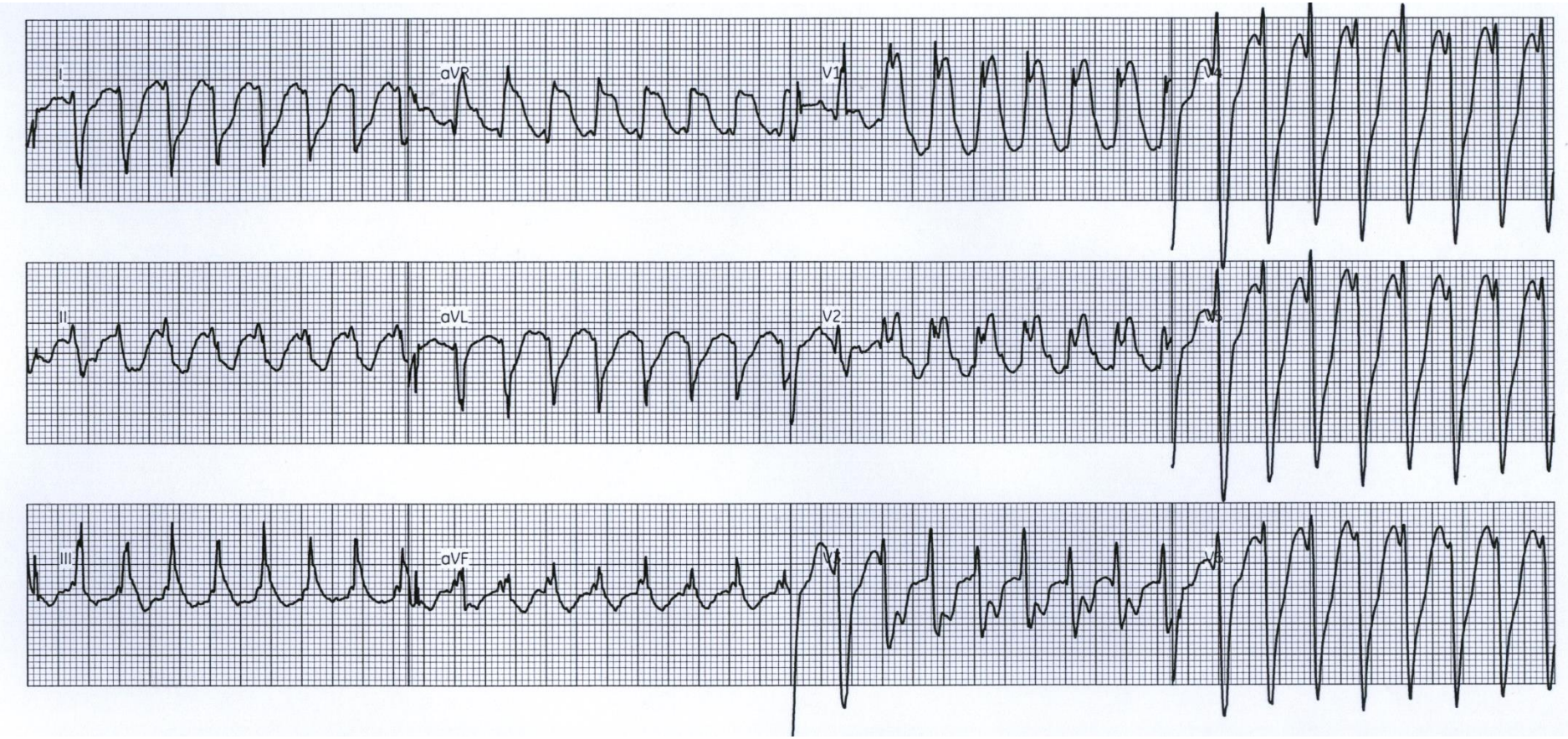
Simulated Tachycardia

Atrial overdrive pacing (@310 ms) with isoproterenol



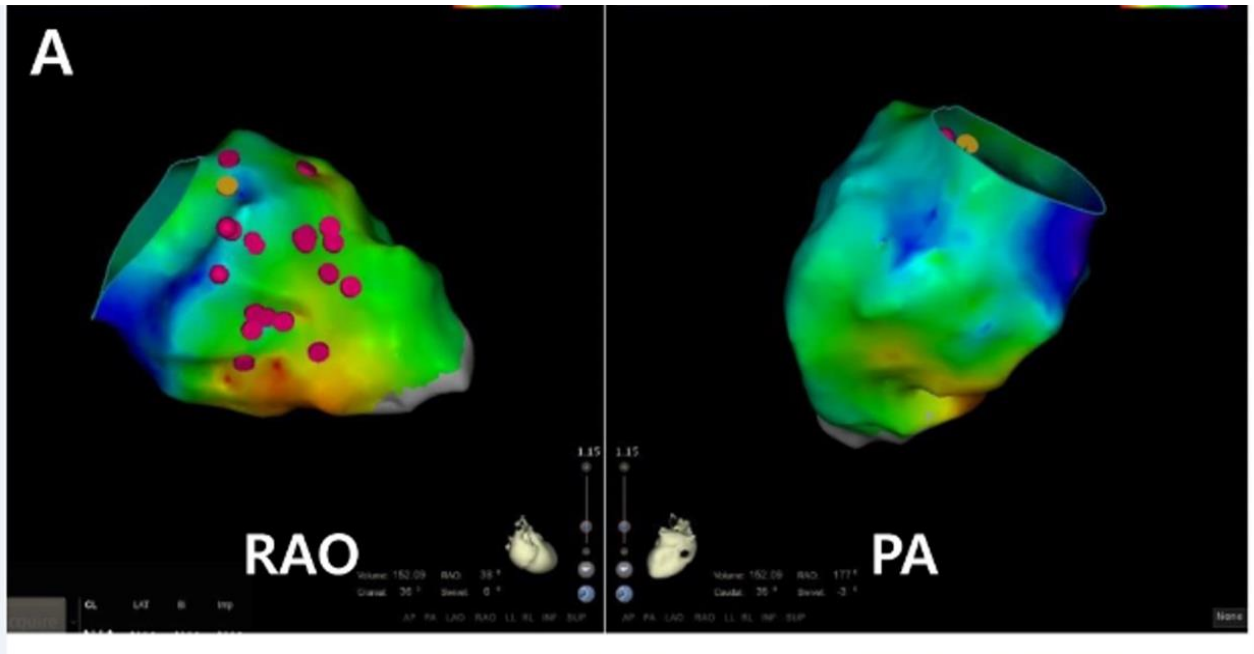
Simulated Tachycardia

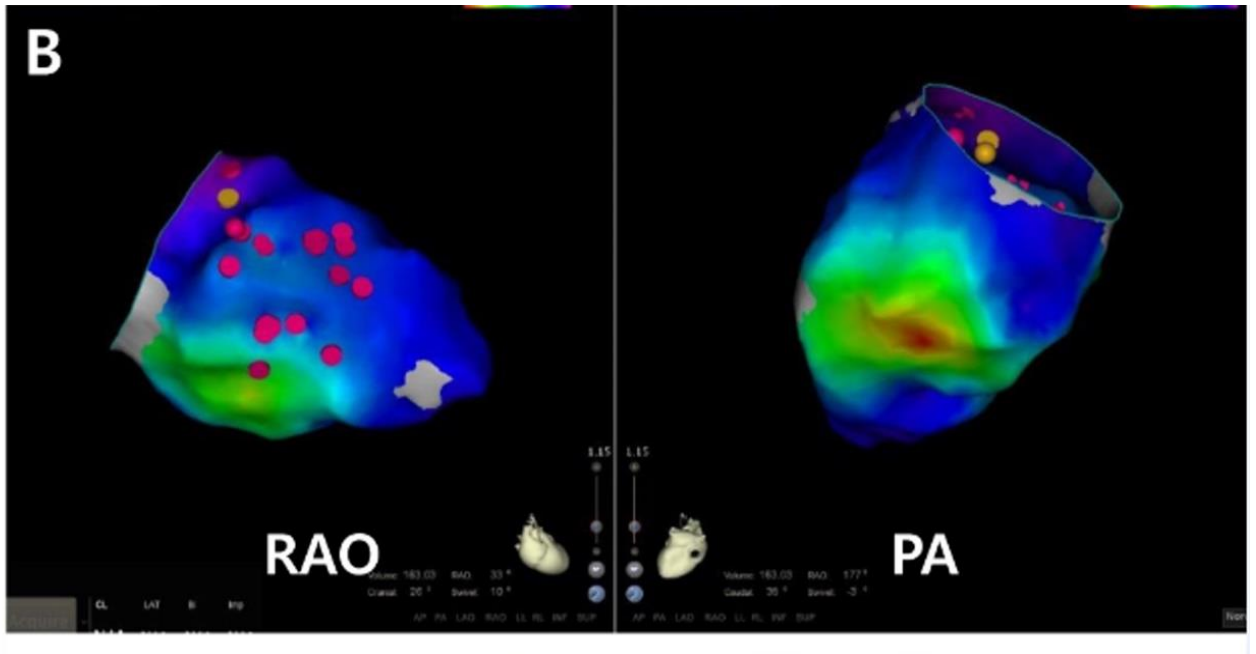
Atrial overdrive pacing with isoproterenol + flecainide



Earliest activation at inferolateral LV

Activation mapping with Carto® system





Sinus rhythm
; earliest at midseptal wall of LV

Simulated tachycardia
; earliest at posterolateral wall of LV

경청해 주셔서 감사합니다

Presentation Title

박환철

한양대학교 구리병원, South Korea

Korean Heart Rhythm Society

COI Disclosure

Name of First Author:

The authors have no financial conflicts of interest to disclose concerning the presentation

Disclosure

Relationships with commercial interests: None

- Grants/Research Support: None
- Speakers Bureau/Honoraria: None
- Consulting Fees: None
- Other: None

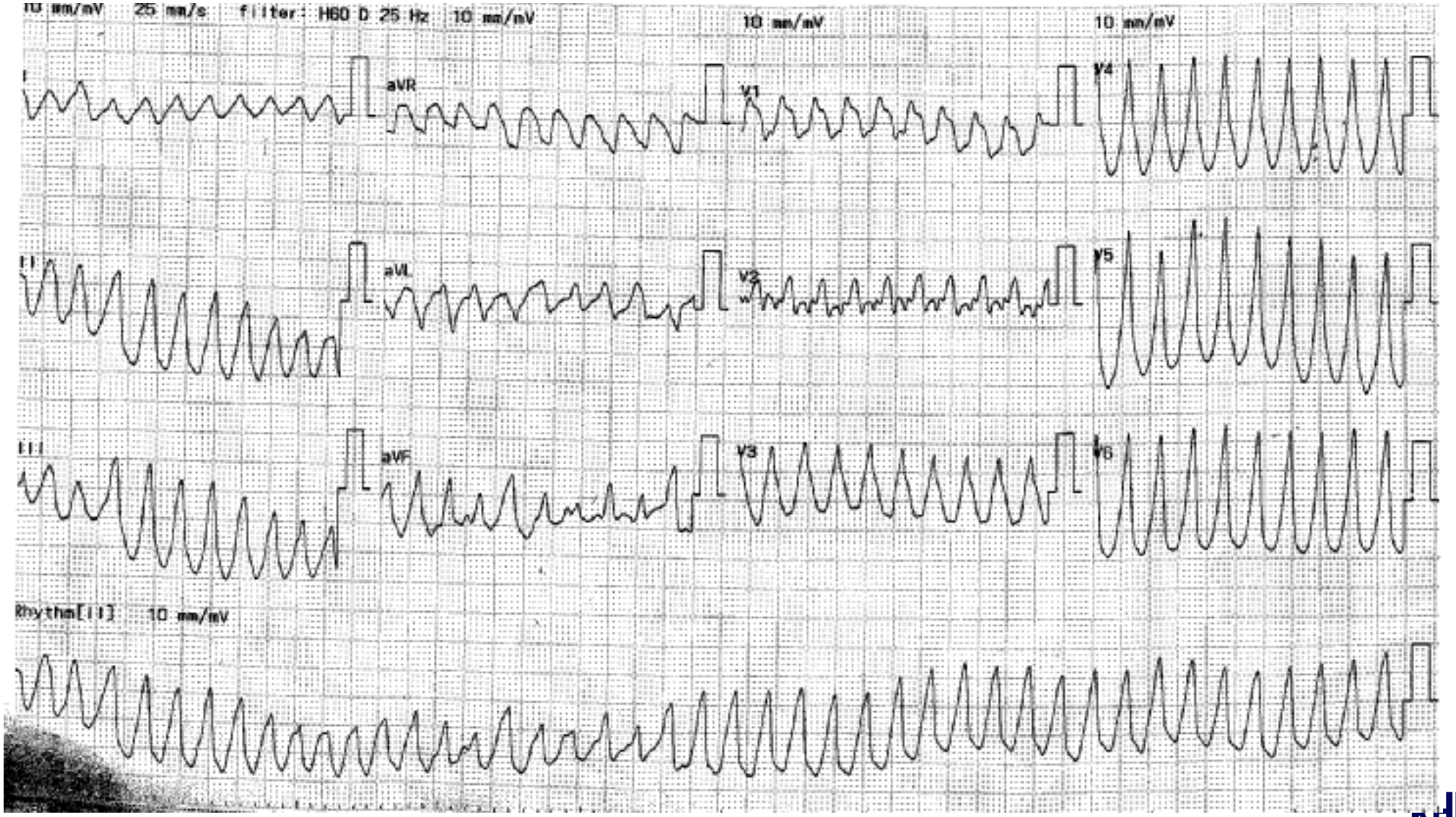
Torsades de Pointes in long QTs

F/42

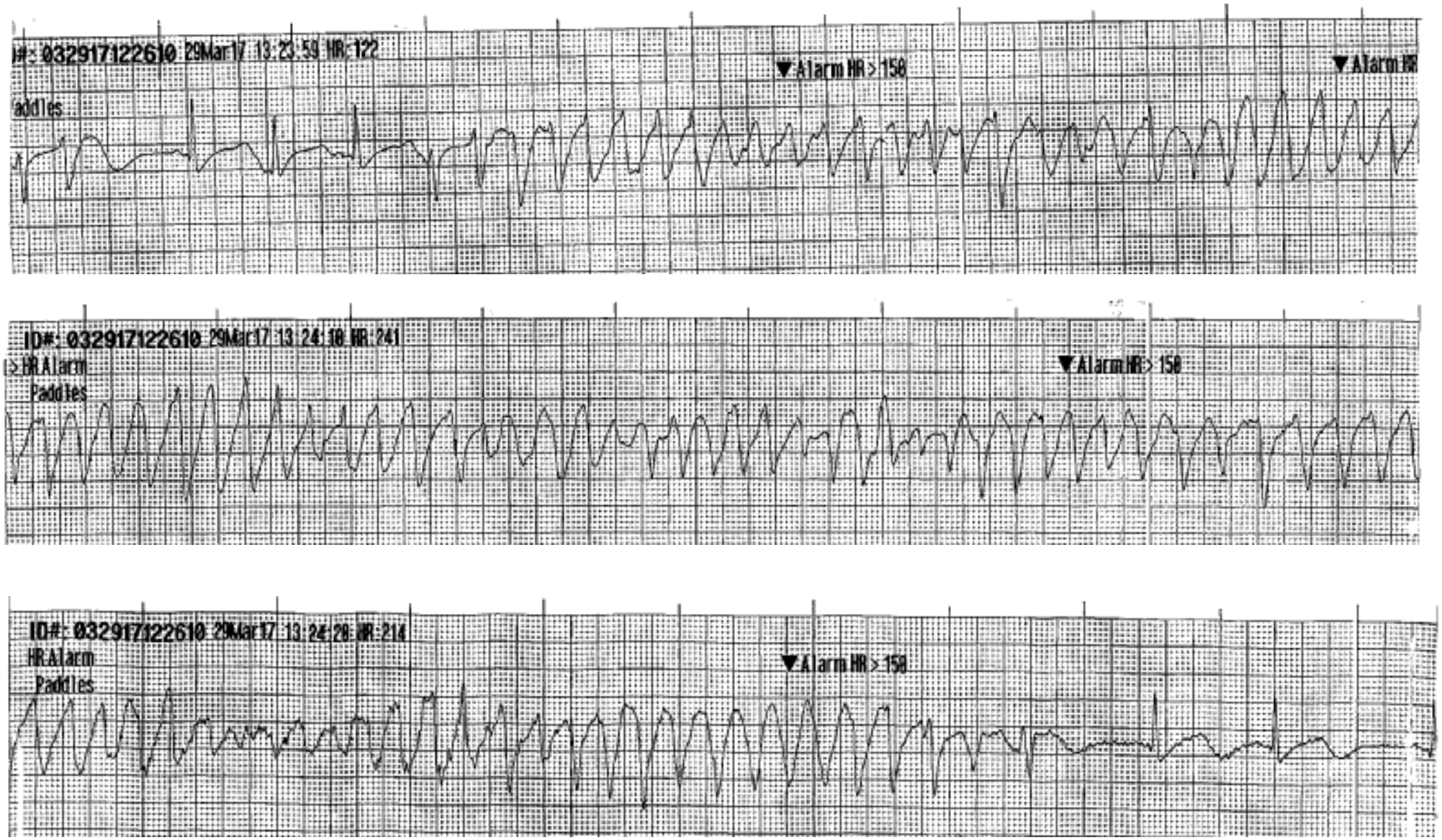
Heavy alcoholics, 기저질환 없이 지내던 자

집에 누워 있다가 경련하는 모습 2차례 보여 local 응급실 내원해서 Brain CT 검사 후 추가 검사 위해 본원 응급실로 내원. 내원 당시 VT 소견 보였고, Cardioversion 준비하면서 VT 발생 → Defib. 시행하고 ROSC

응급실 대기 중 발생한 VT



Long QT 이후 Torsades de pointes



모니터링 중


II x1/2
25 mm/s Zoom: x1 HR: 198 VPC/min: 25
II x1/2
25 mm/s Zoom: x1 HR: 282 VPC/min: 28
II x1/2
25 mm/s Zoom: x1 HR: 223 VPC/min: 0
Clear
Delete

Torsades de Pointes

- Twisting of the QRS complexes around the ECG baseline in patients and preceded by an extended QT interval
- 주로 전해질 이상 (저칼륨혈증과 저마그네슘혈증)과 여러 항부정맥 약제 사용 (주로 quinidine, phenothiazine, TCA계열 약제), Intracranial event, 서맥에서 나타난다.
- Polymorphic VT를 선행하는 marked QT prolongation (대개 600ms 이상)이 특징

Incessant VT storm

F/74

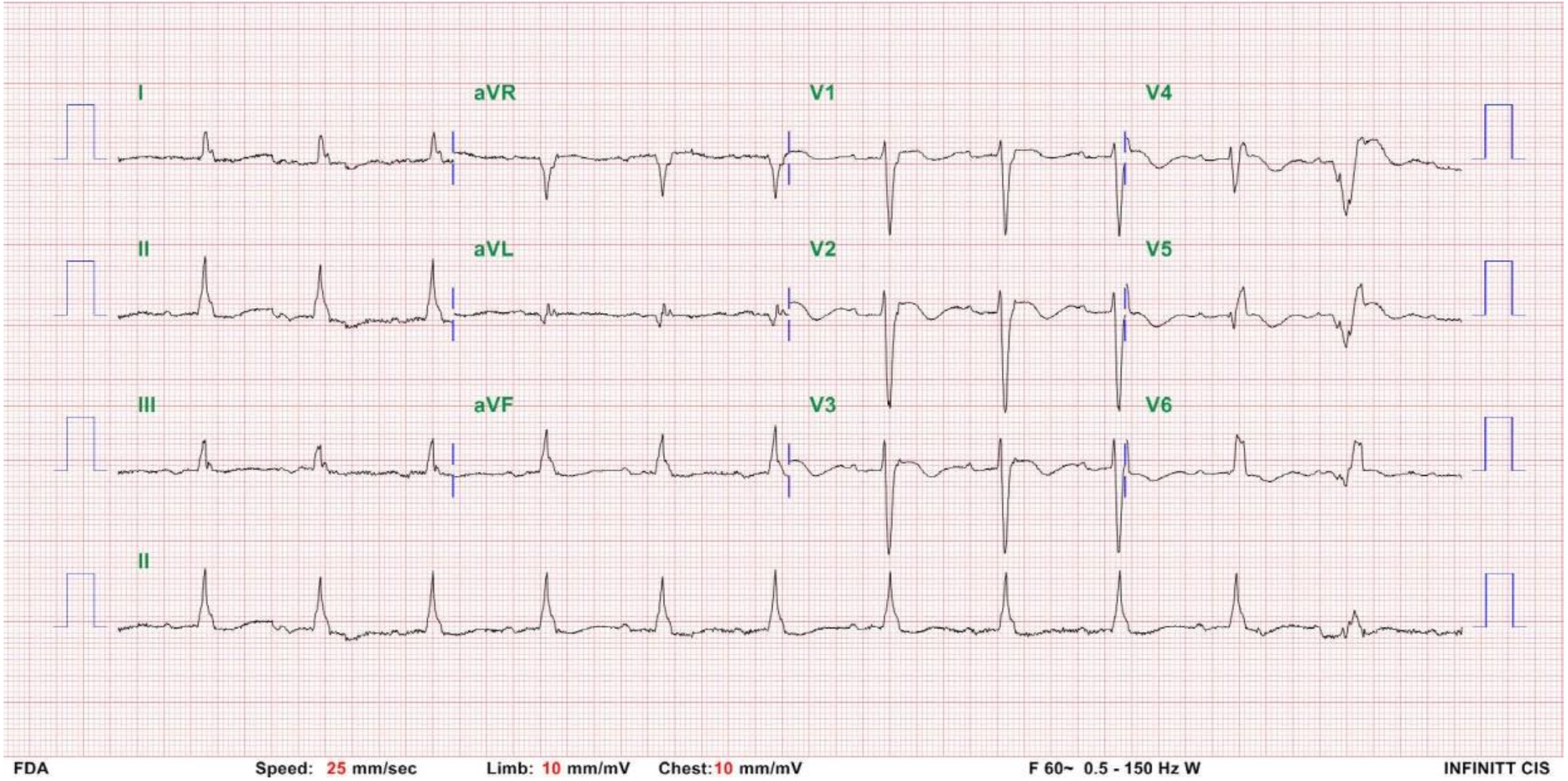
C/C) Syncope with chest pain

1995년 Unstable angina로 LAD에 PCI 시행하고 1996년 CABG 병력.

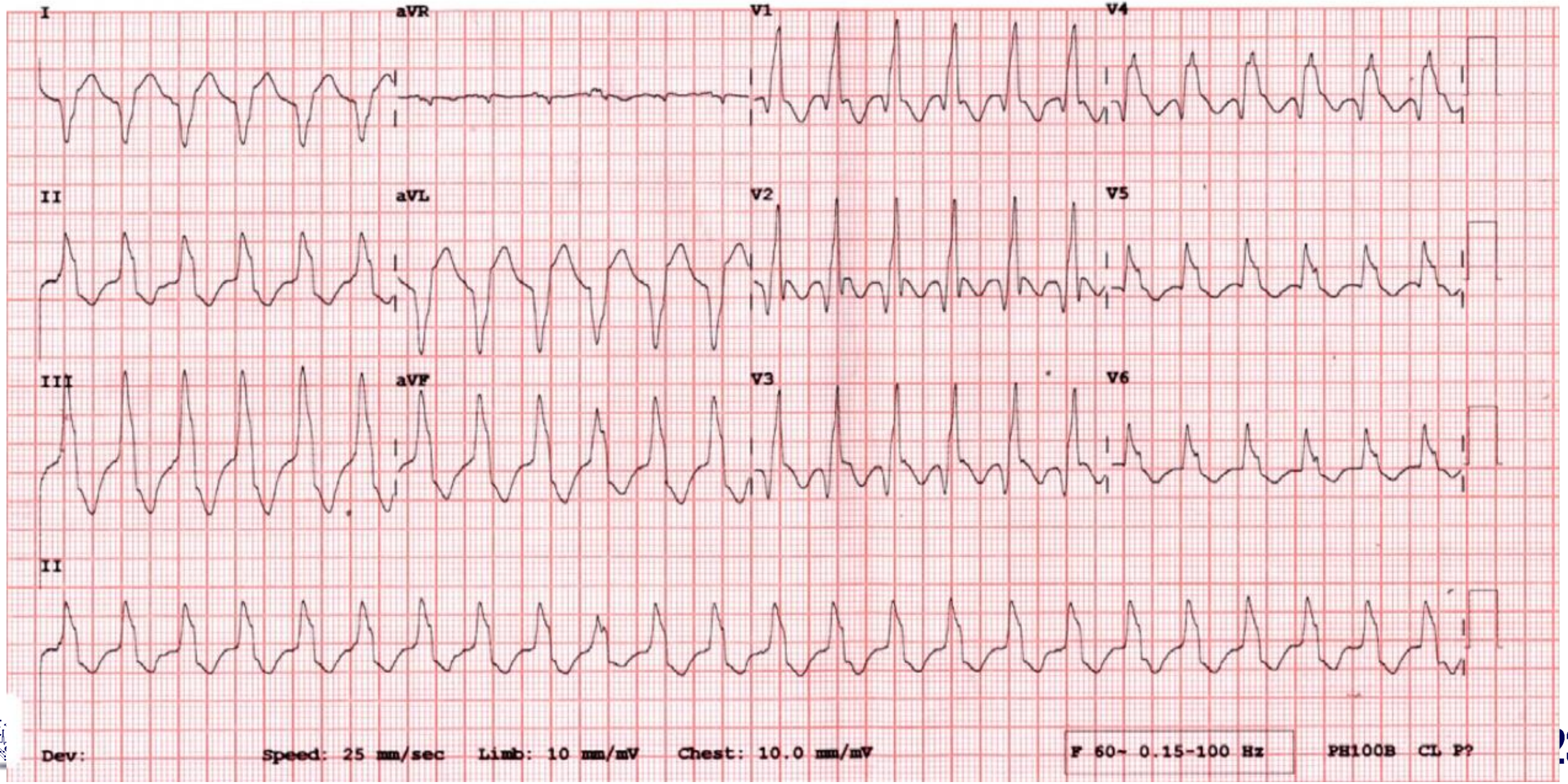
2009년 aborted SCD로 내원, AMI 진단하고 LAD에 PCI 재시행

고혈압, 당뇨 20여년 전 진단, 약복용 중

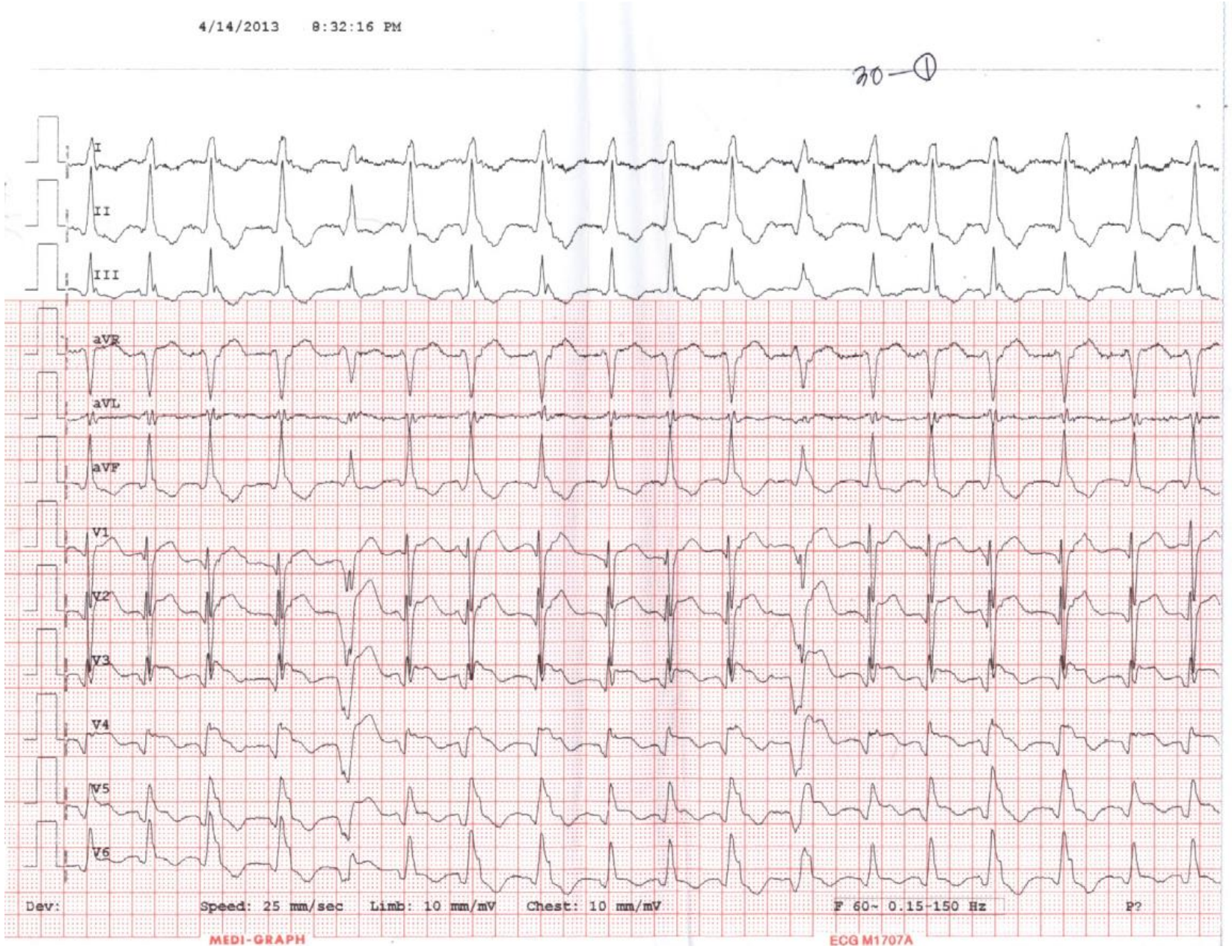
Surface ECG (OPD FU 중)



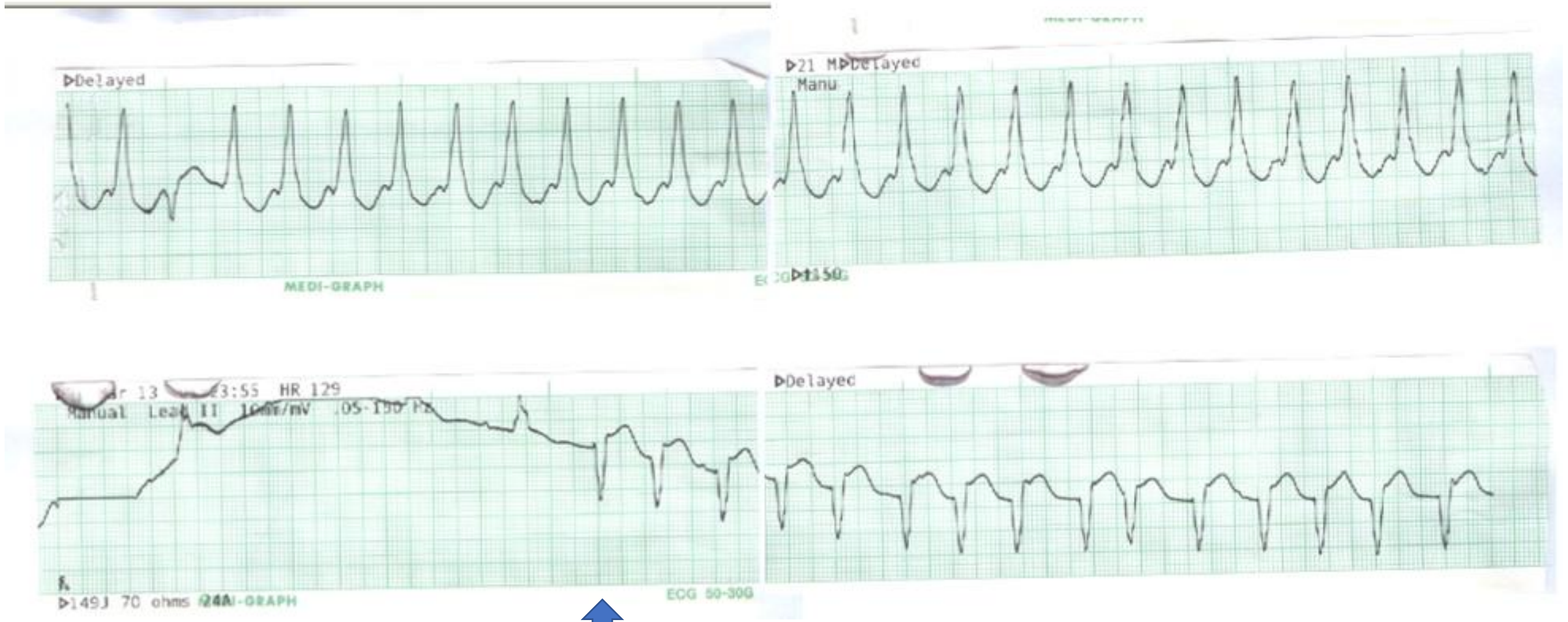
Surface ECG at ER



Surface ECG at ICU



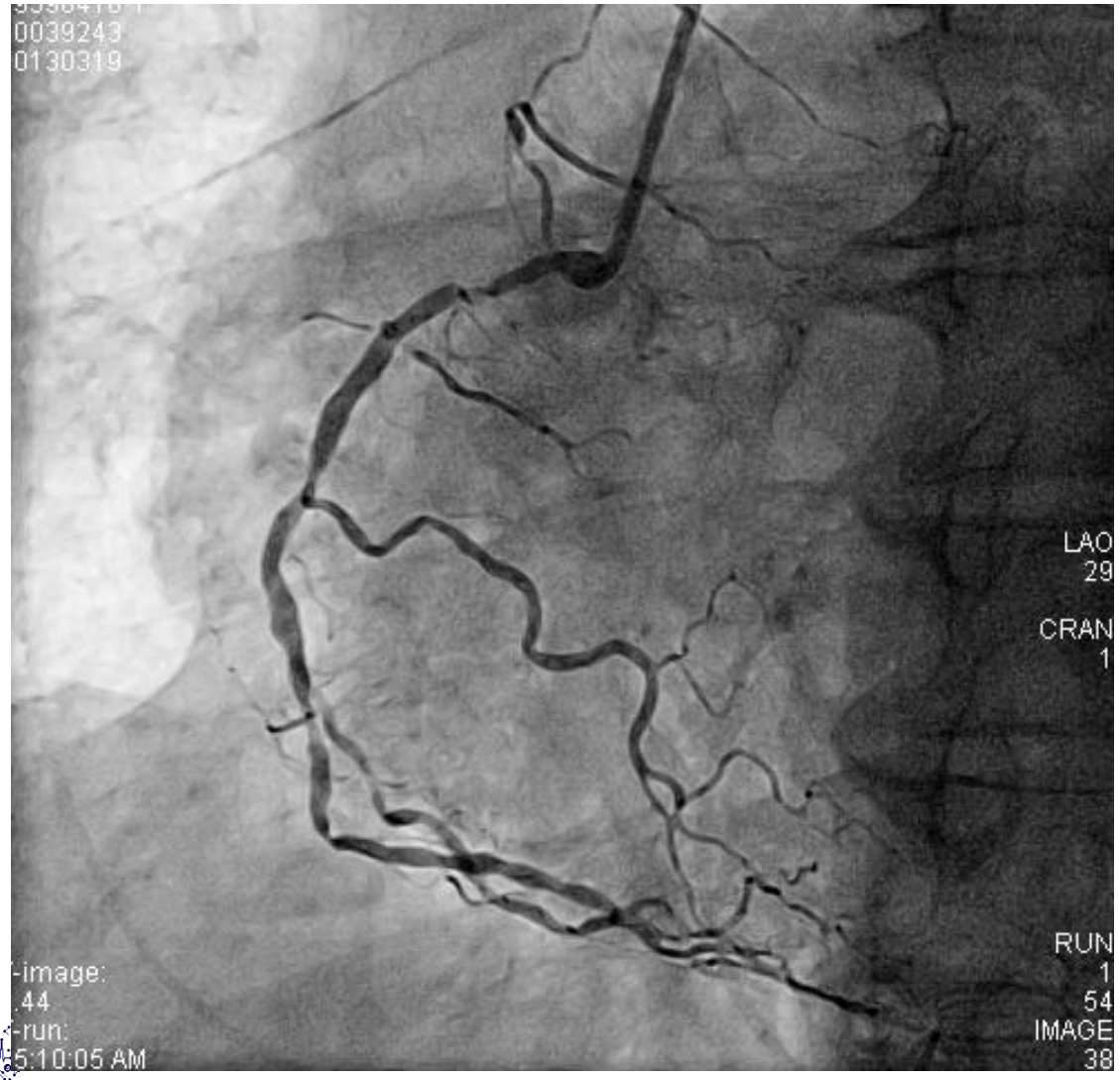
Cardioversion 150 J



Immediate recurrence of VT

KHRS 2023

Coronary angiography



VT/VF storm

- Occurrence of three or more episode of VT/VF within 24hr
- Risk should be stratified according to hemodynamic tolerance and co-morbidity.
- If patients have devices, devices reprogramming (to reduce inappropriate shock/self-terminating VT, favor ATP therapies) needed
- Correct underlying problems (Ischemia, E’ disturbances, pro-arrhythmic drugs)
- B-blockers, AADs (Amiodarone IV first, lidocaine in selected patients)

VT/VF storm

- Sedation, if needed intubation with deep sedation
- Mechanical hemodynamic support (IABP, ECMO, LVAD etc.)
- Neuroaxial modulation (thoracic epidural anesthesia, cardiac sympathetic denervation)
- Catheter ablation, cardiac transplantation

Polymorphic VT in acute ischemia

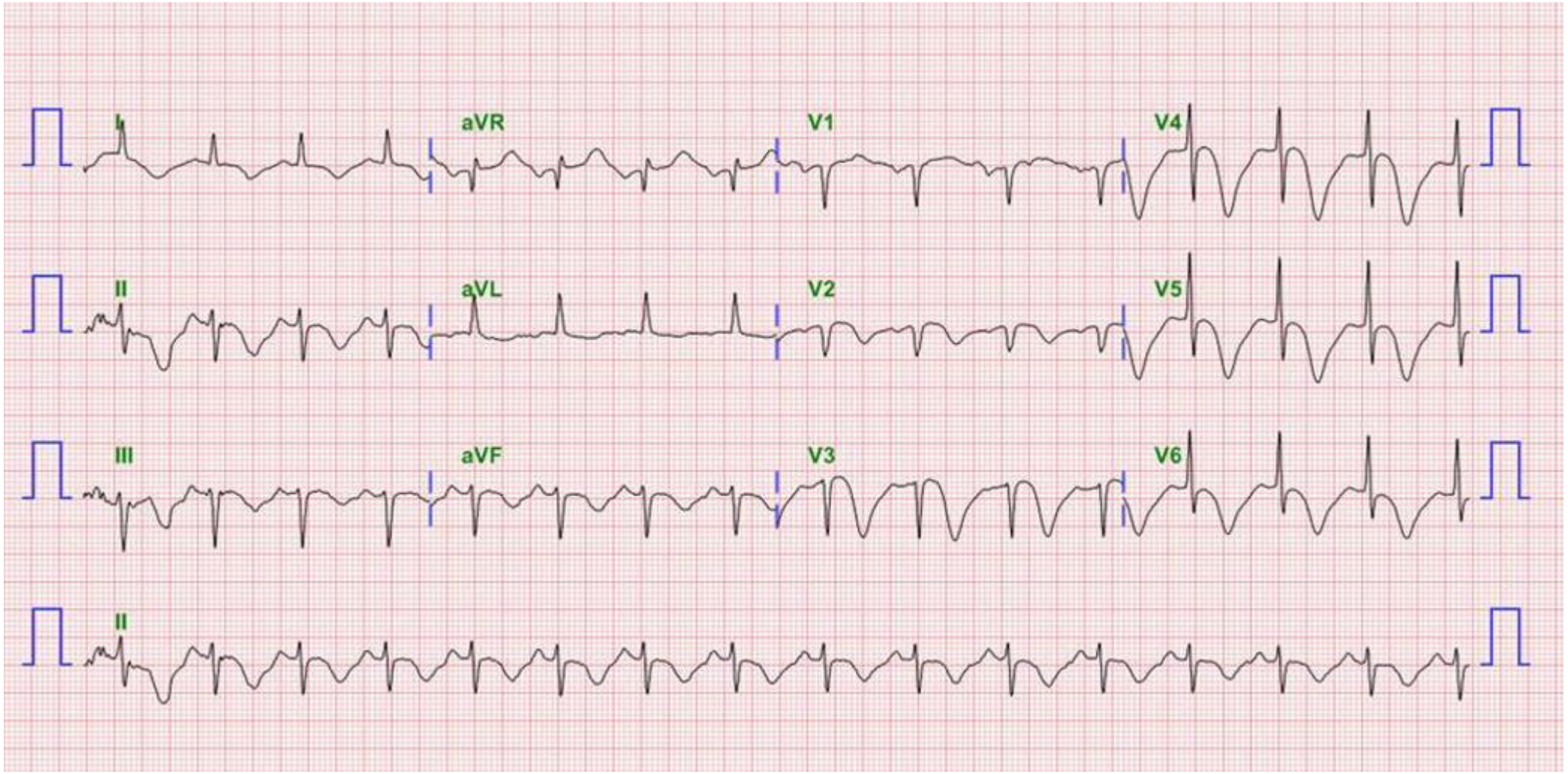
M/42

Heavy smoker, 2년 전 흉통으로 타원에서 PCI history. Hypertension (+)

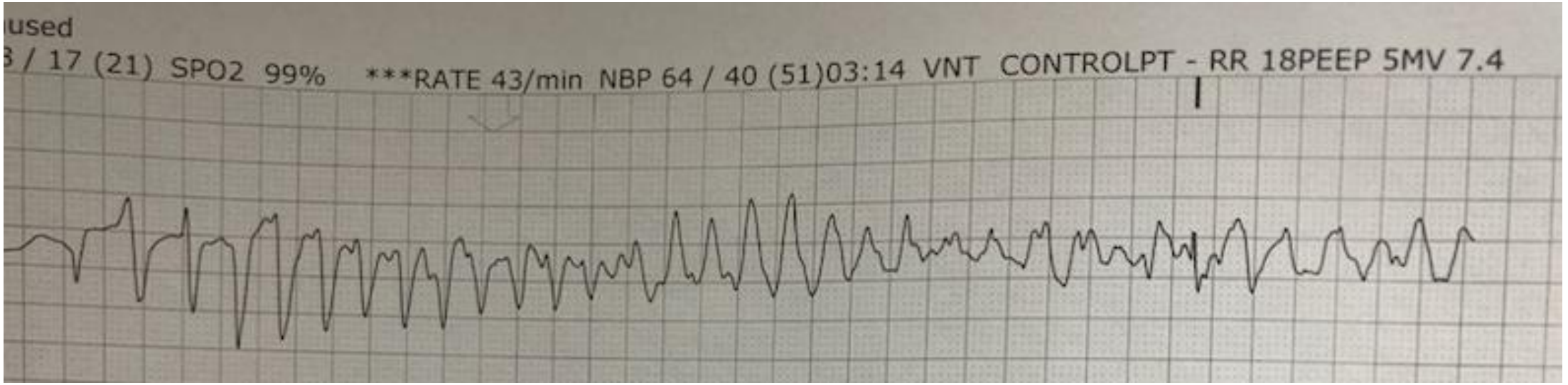
집에서 지인과 다툰 후 흡연하다가 발생한 흉통으로 응급실 내원함

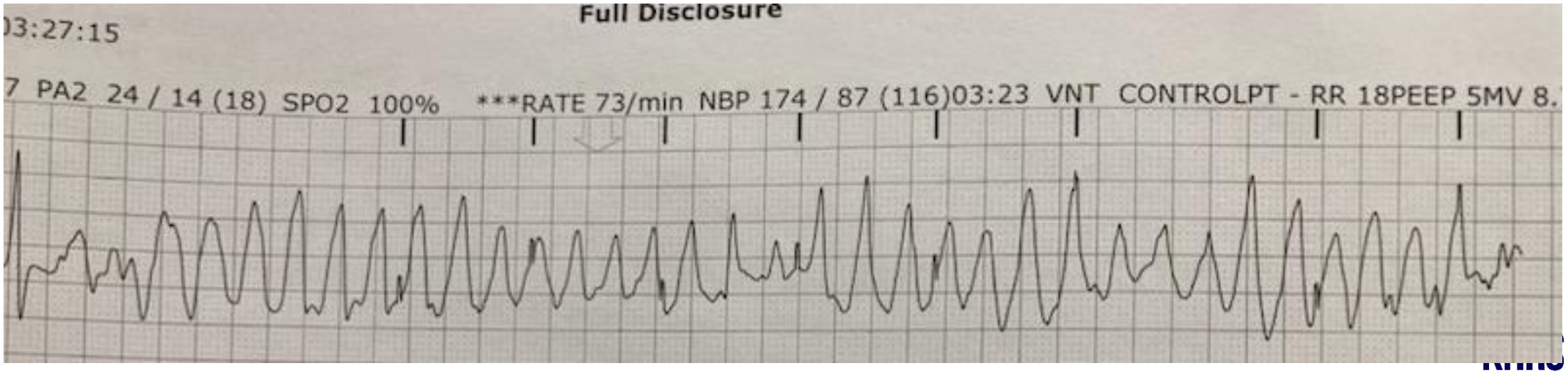
심전도에서 ST elevation은 없고, 내원해서 NTG apply 후 흉통 사라져 CCU에 입원 후 Elective CAG 계획 중

Surface ECG at ER

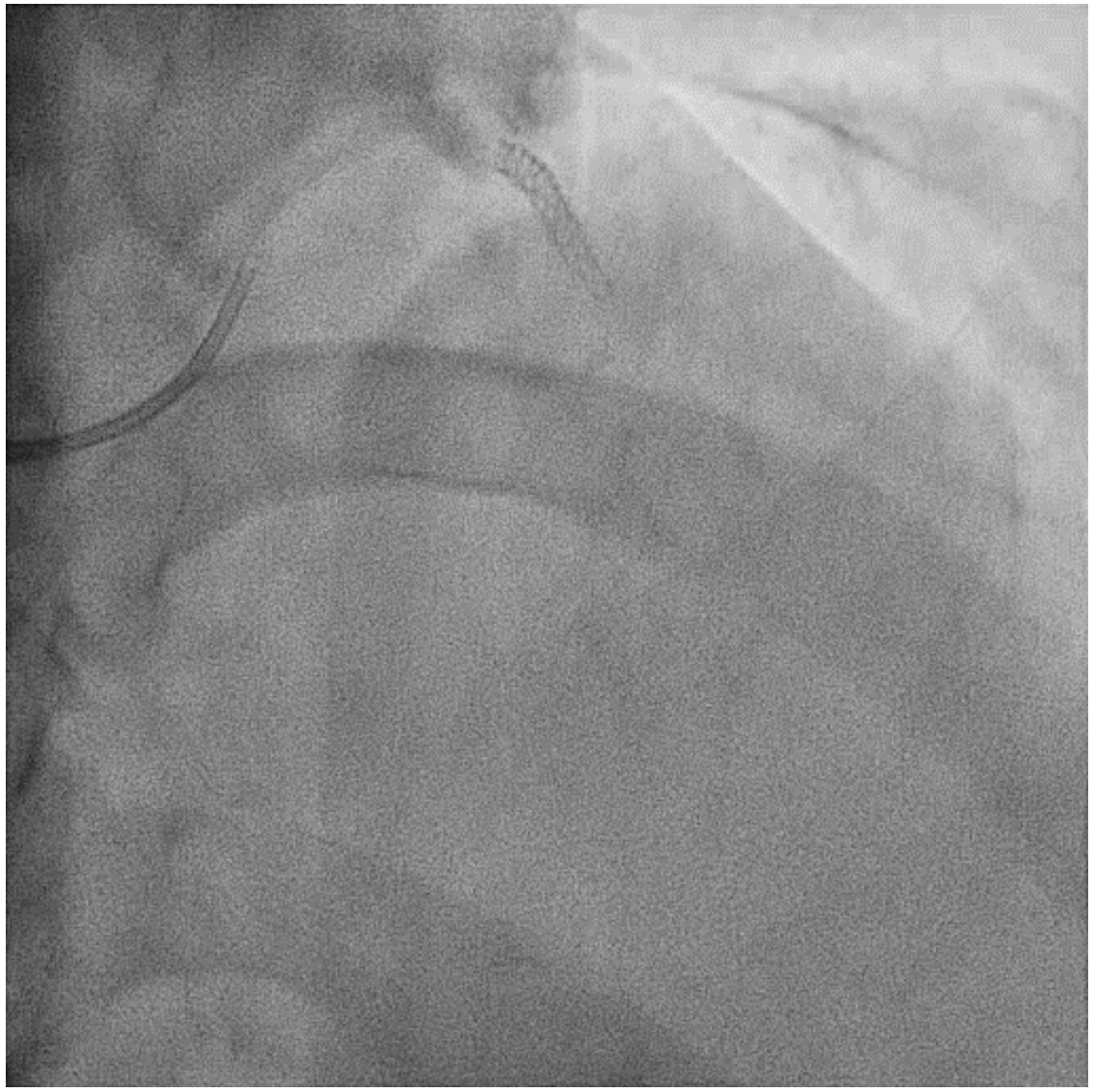


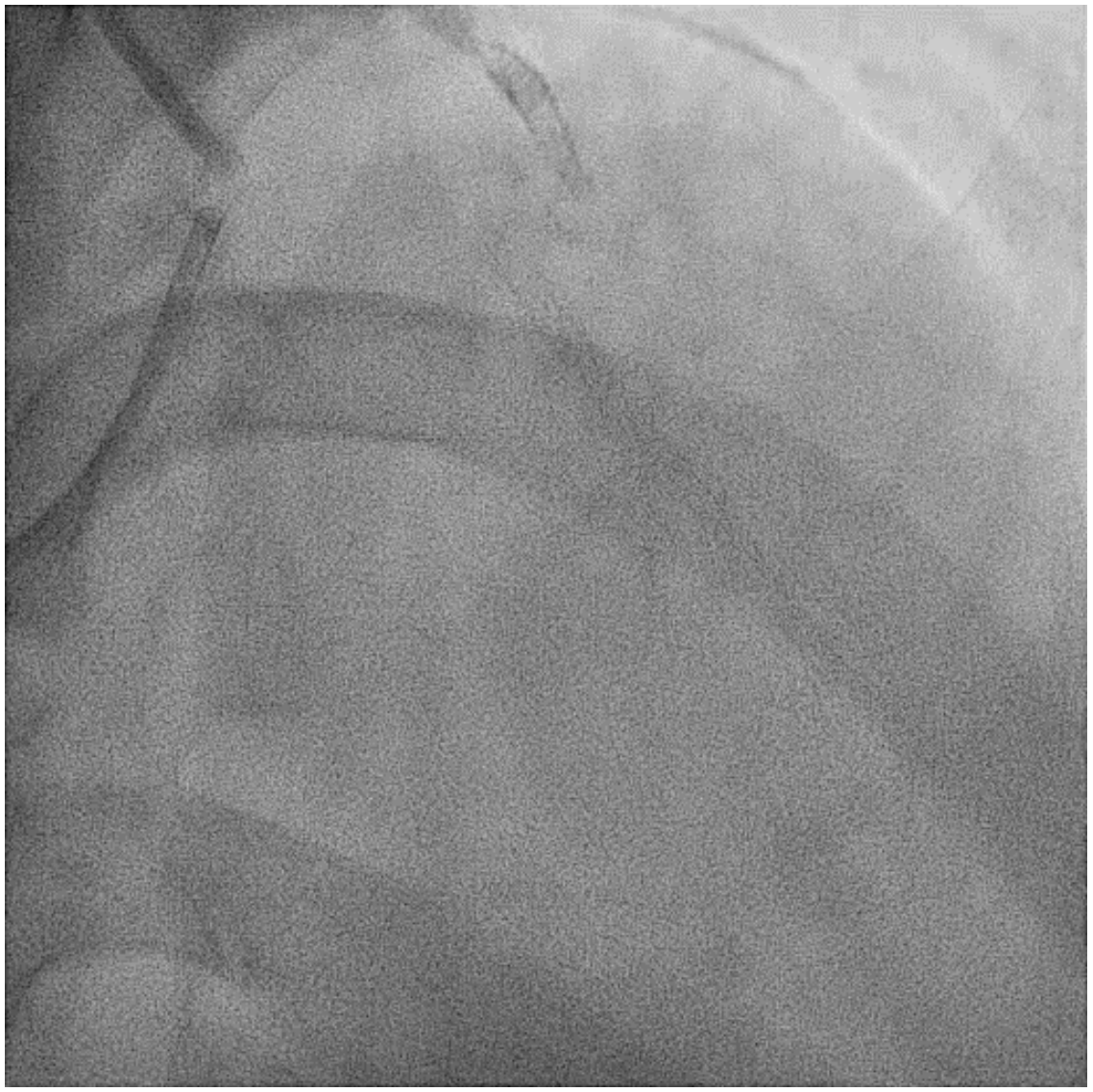
CCU 입원 Monitoring 중





Coronary angiography





Polymorphic VT in acute ischemia

- 주로 심혈관질환 환자에서 정상적인 QT 간격을 가지며 “R-on-T” VPCs에 의해 유발되며 주로 reentry 기전에 의한다.
- TdP과는 기전과 치료가 완전히 다르다.
- Class I or III AADs가 효과적이나 근본적인 치료는 Revascularization

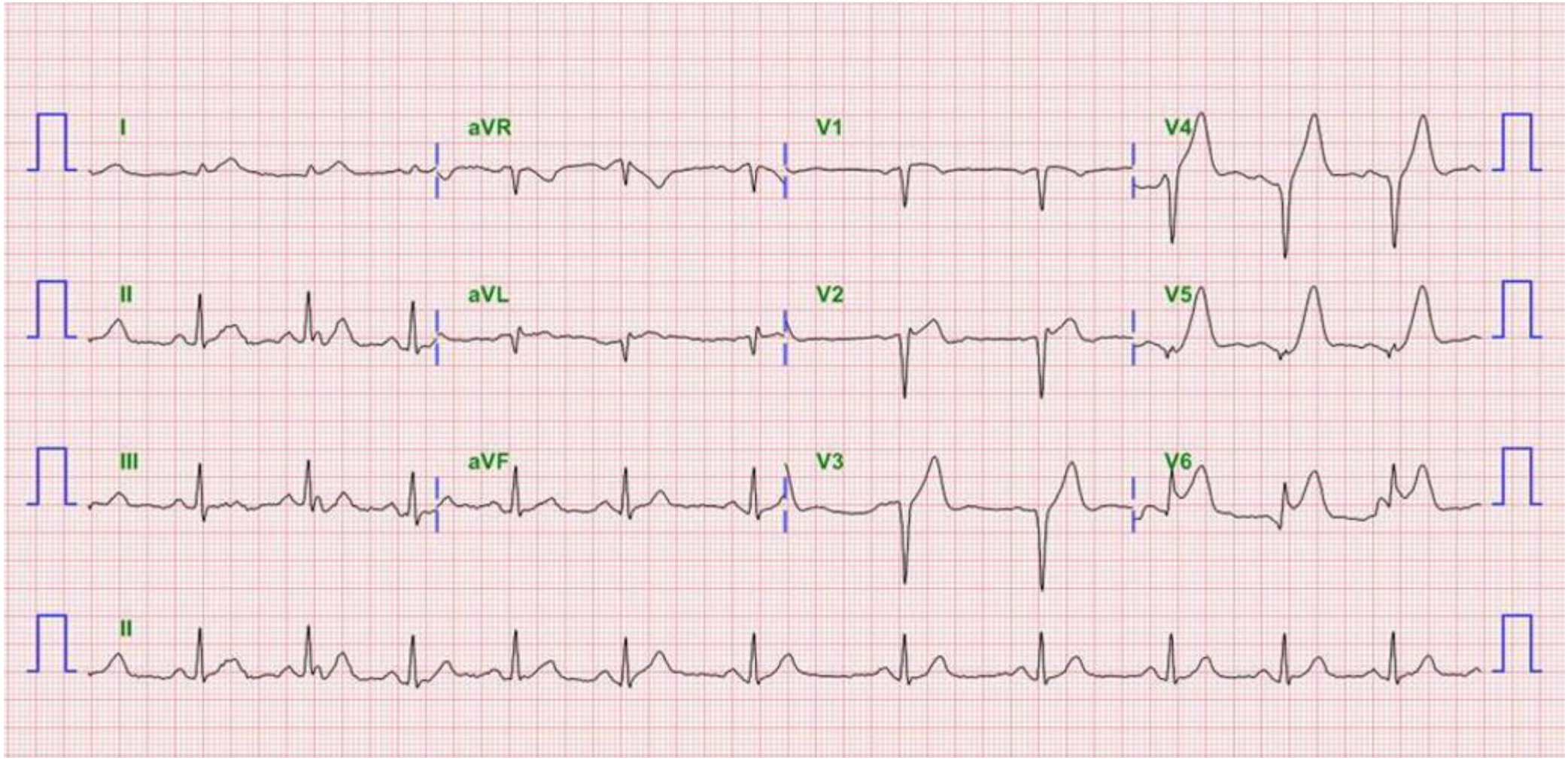
Accelerated IdioVentricualr Rhythm (1)

M/48

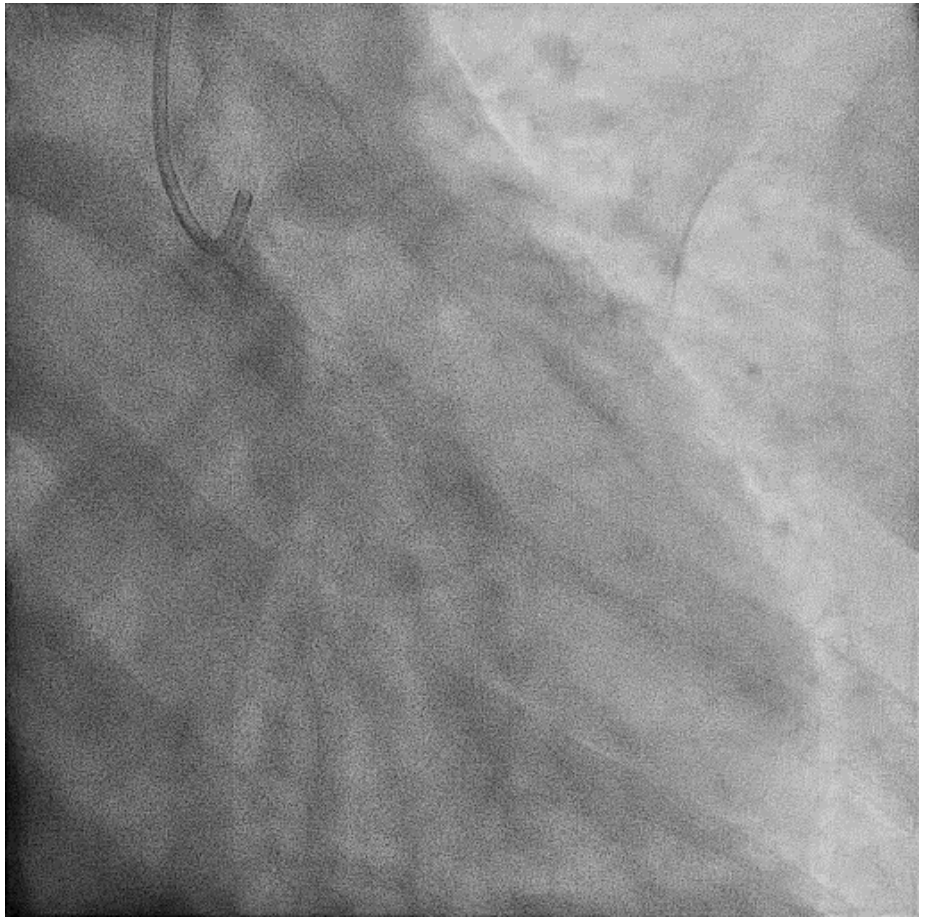
Heavy smoker

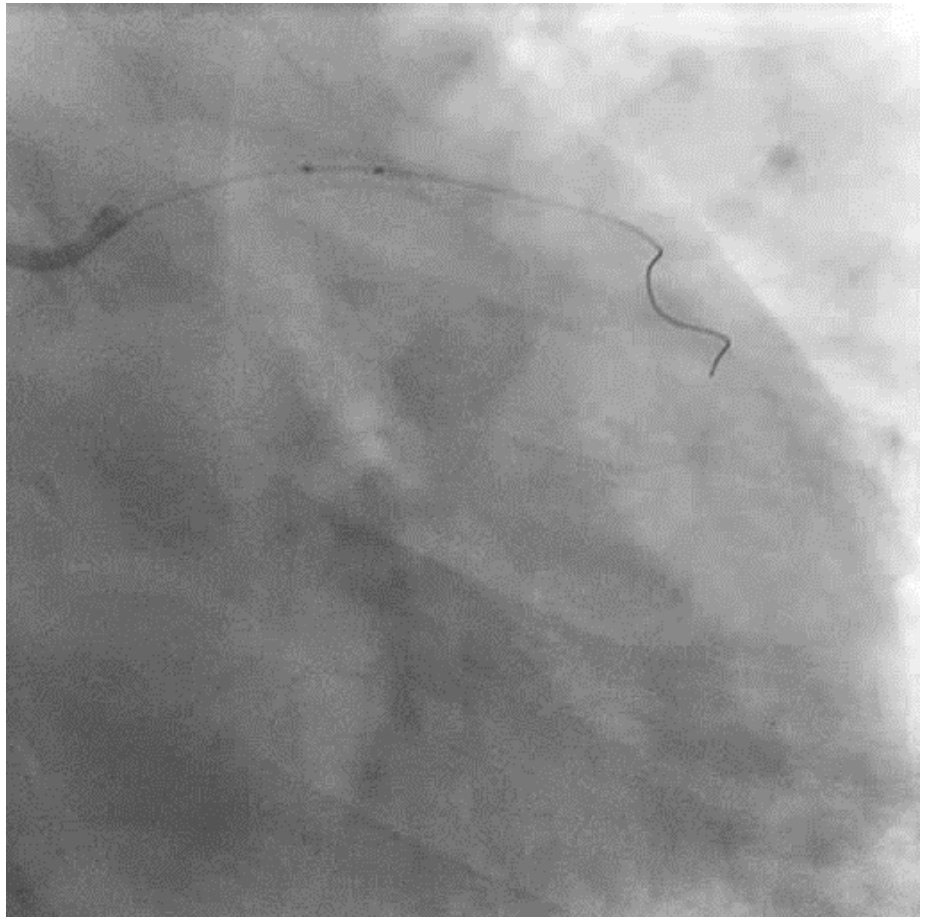
집에서 지인과 다툰 후 흡연하다가 발생한 흉통으로 응급실 내원함

Surface ECG at ER



Coronary angiography





During PCI


7:38:13 AM
7:38:14 AM
7:38:15 AM
7:38:16 AM
7:38:17 AM
7:47:59 AM
7:48:00 AM
7:48:01 AM
7:48:02 AM
7:48:26 AM
7:48:27 AM
7:48:28 AM
7:48:29 AM

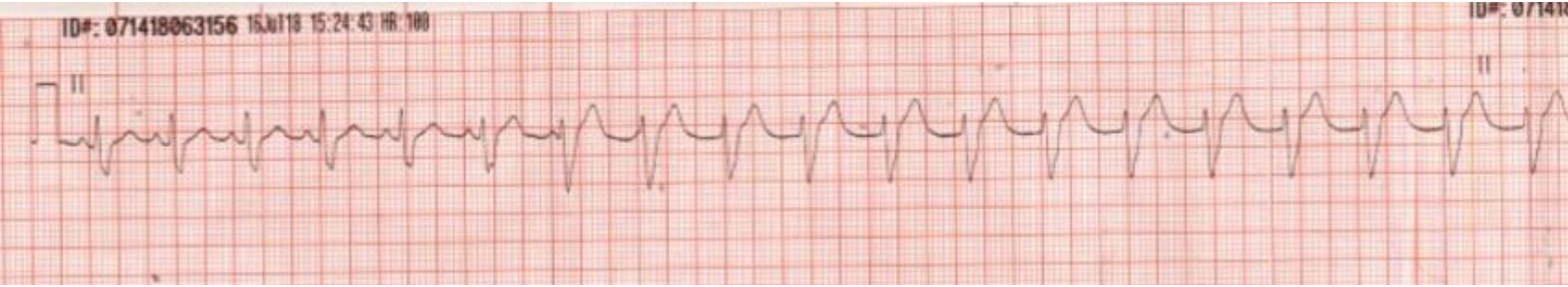
Accelerated IdioVentricualr Rhythm (2)

M/43

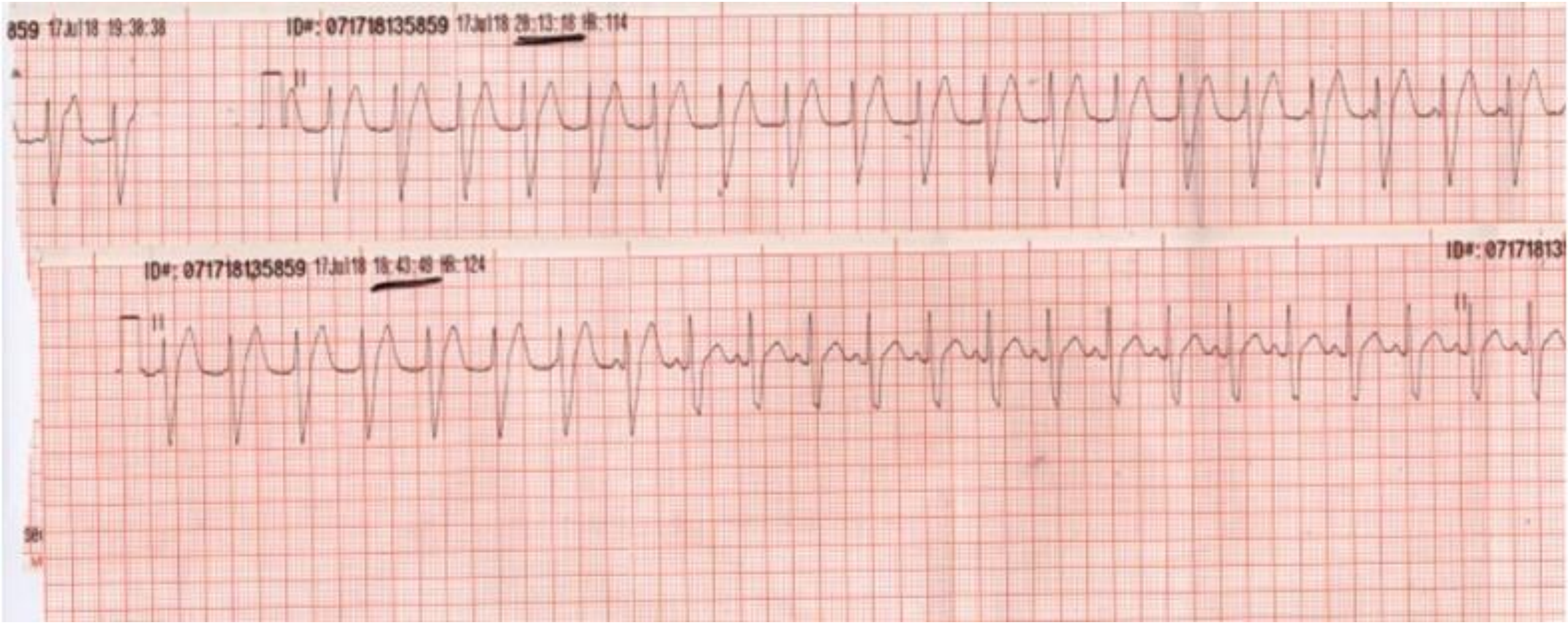
Idiopathic VF로 resuscitatio후 CCU에 입원 중

Monitoring 중 간호사가 이상 소견 확인 후 심전도 시행

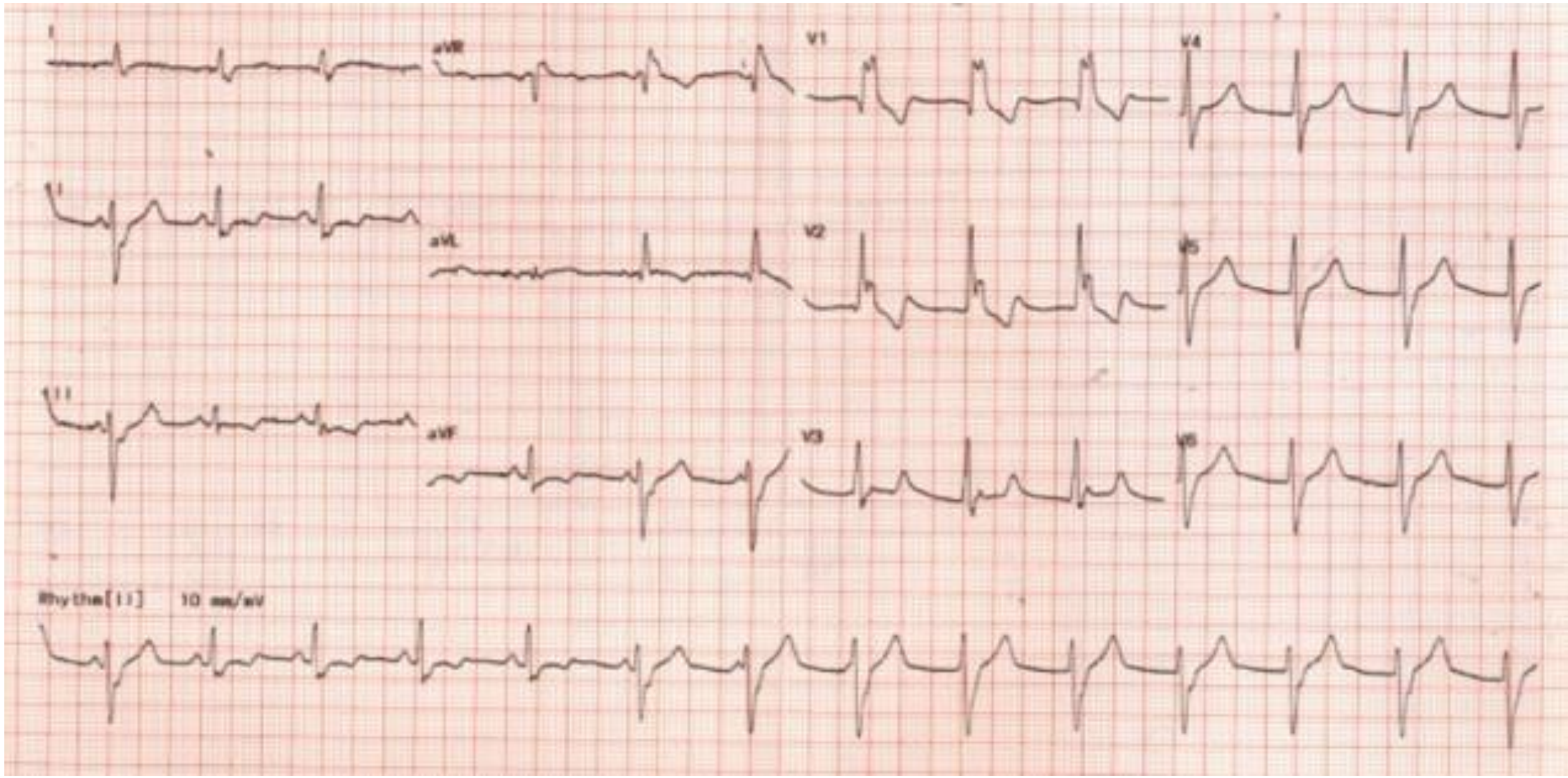
단일채널 심전도



단일채널 심전도



12 leads 심전도



Accelerated IdioVentricualr Rhythm

- Also termed “slow VT” (60 ~ 120 bpm)
- 주로 acute MI의 재관류 중에 자주 나타난다.
- 그 외 심장수술 후, 심근증, 류마티스 열, 디지탈리스 중독증에서 나타날 수 있다.
- 대개 일시적이며 혈역학적으로 안정한 경우가 많다.
- 치료는 대개 필요 없으나 만일 방실해리로 인해 환자가 증상을 호소하면 필요할 수 있다.
- Atropine I.V