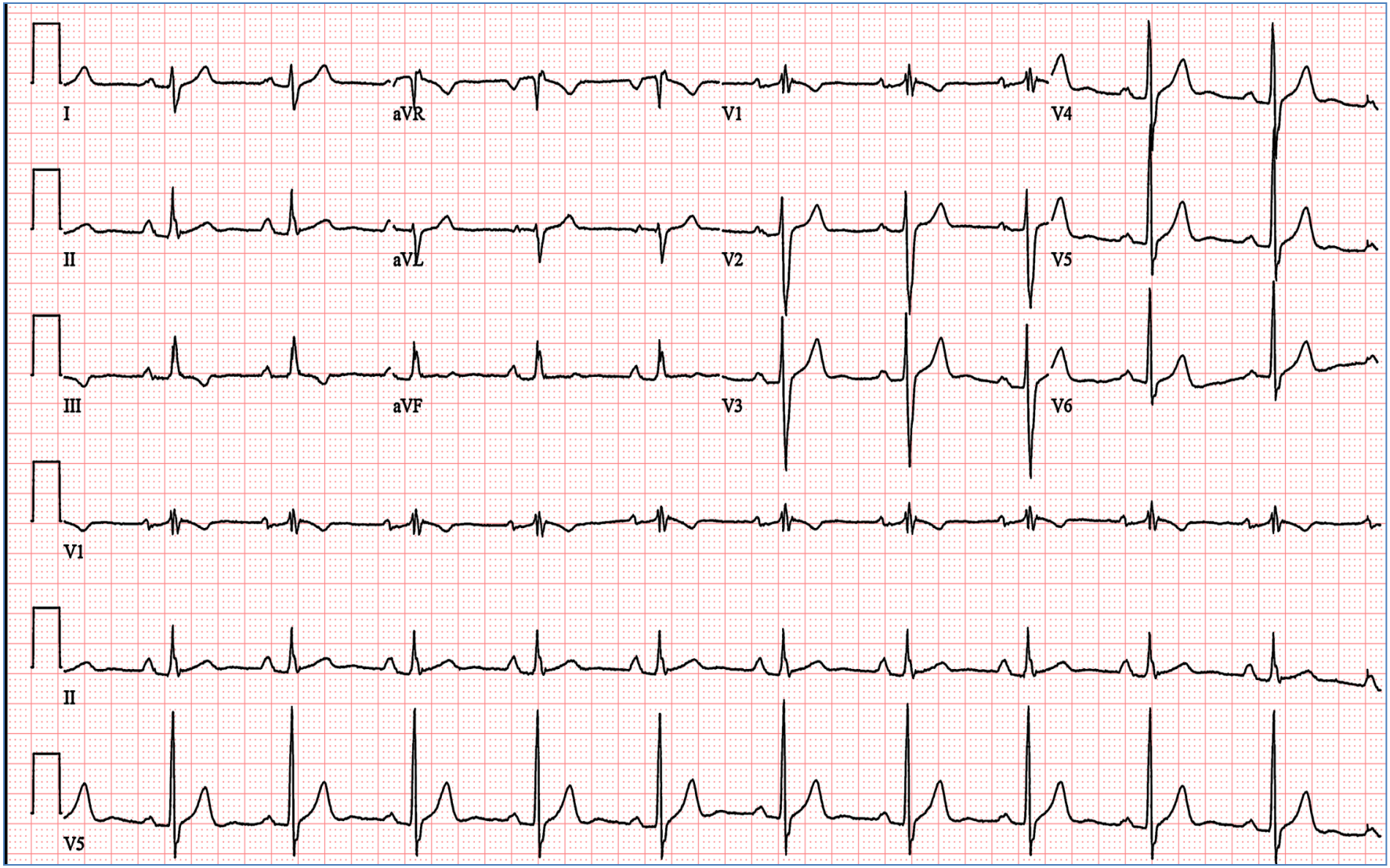
# 2013 춘계 심장학회

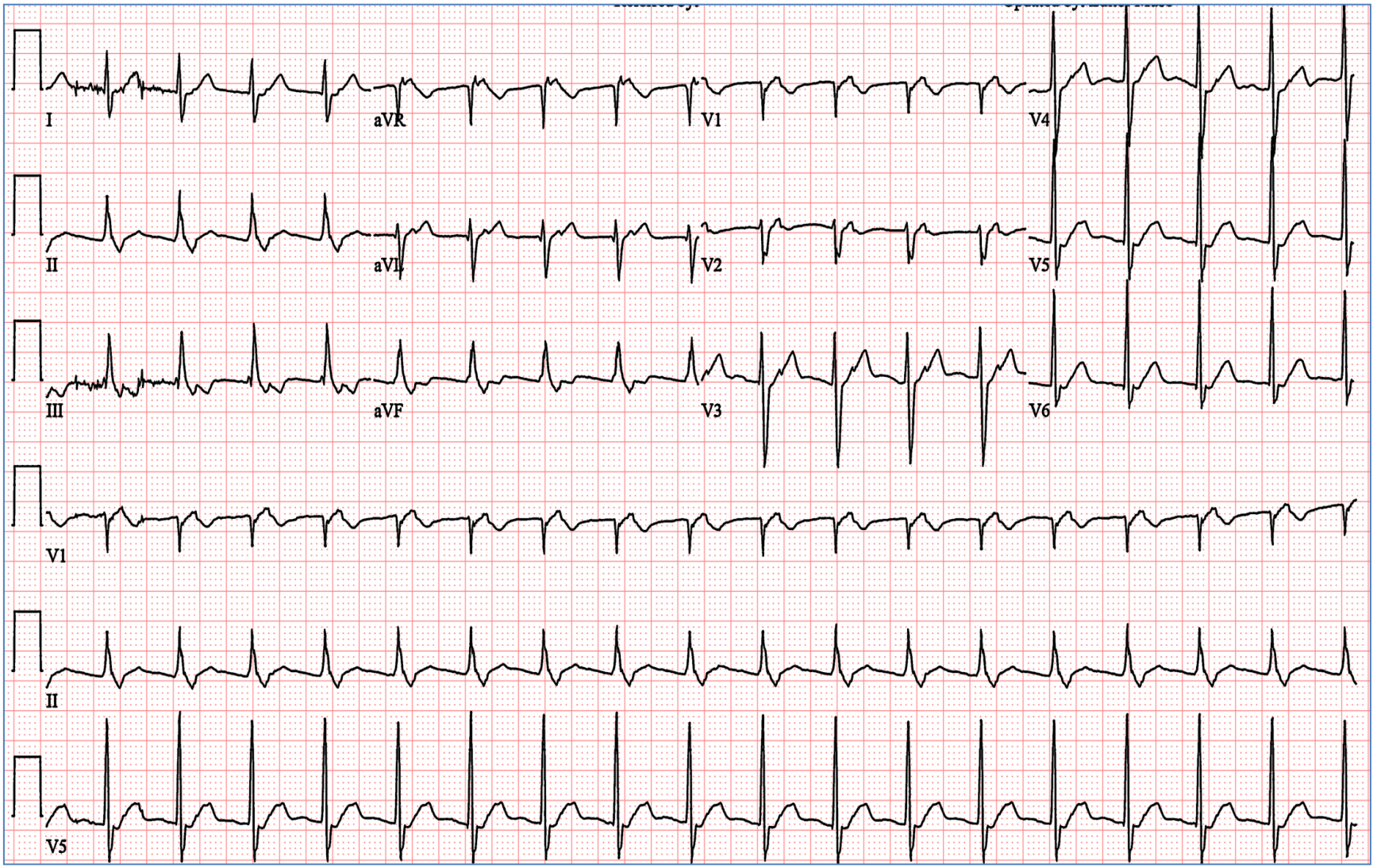
# Interesting ECG

# Case 1.

## 49/M, Palpitation

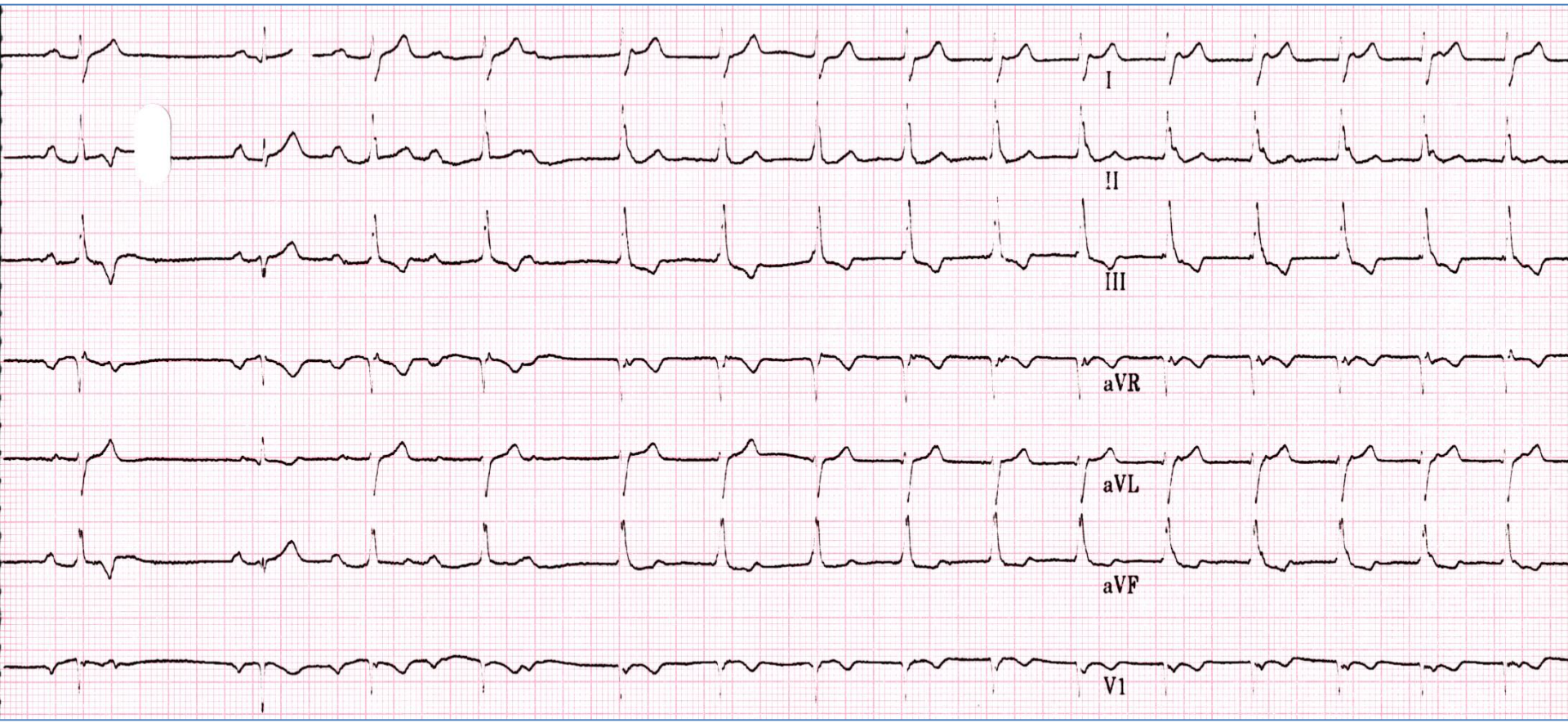


# Tachycardia ECG




2012-07-04

# ECG strip (tachycardia initiation)

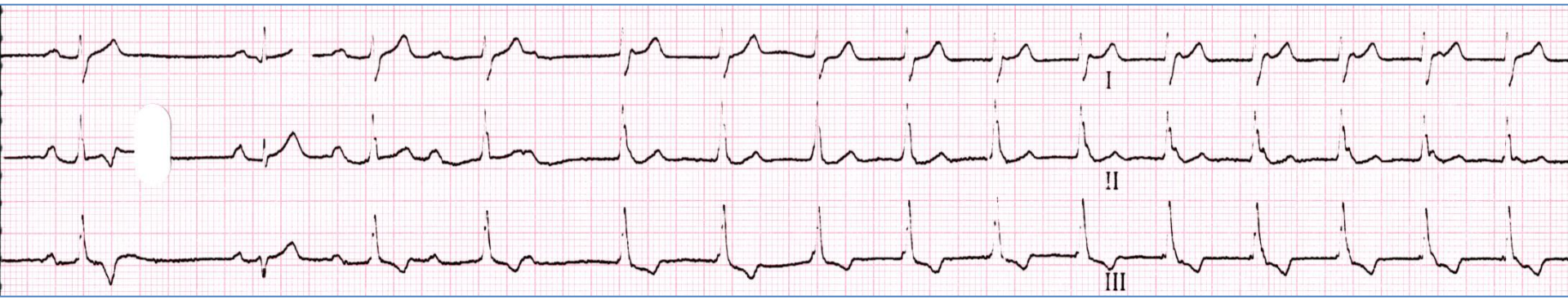


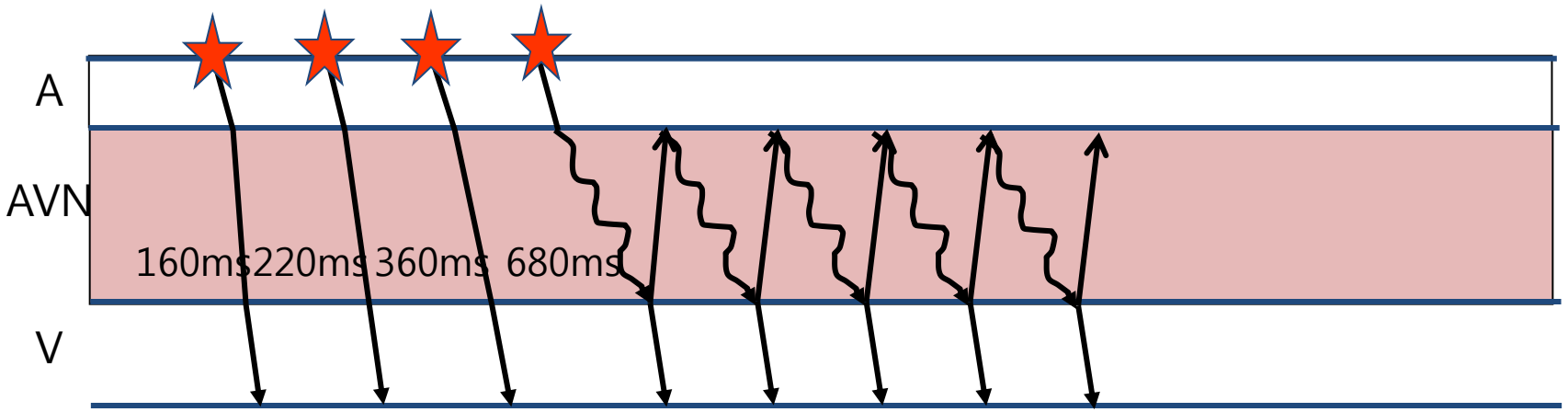

2012-07-04

# What is your diagnosis?

1. Atrial tachycardia
2. Atrial flutter
3. AVNRT
4. AVRT
5. Ventricular tachycardia

# ECG ladder gram

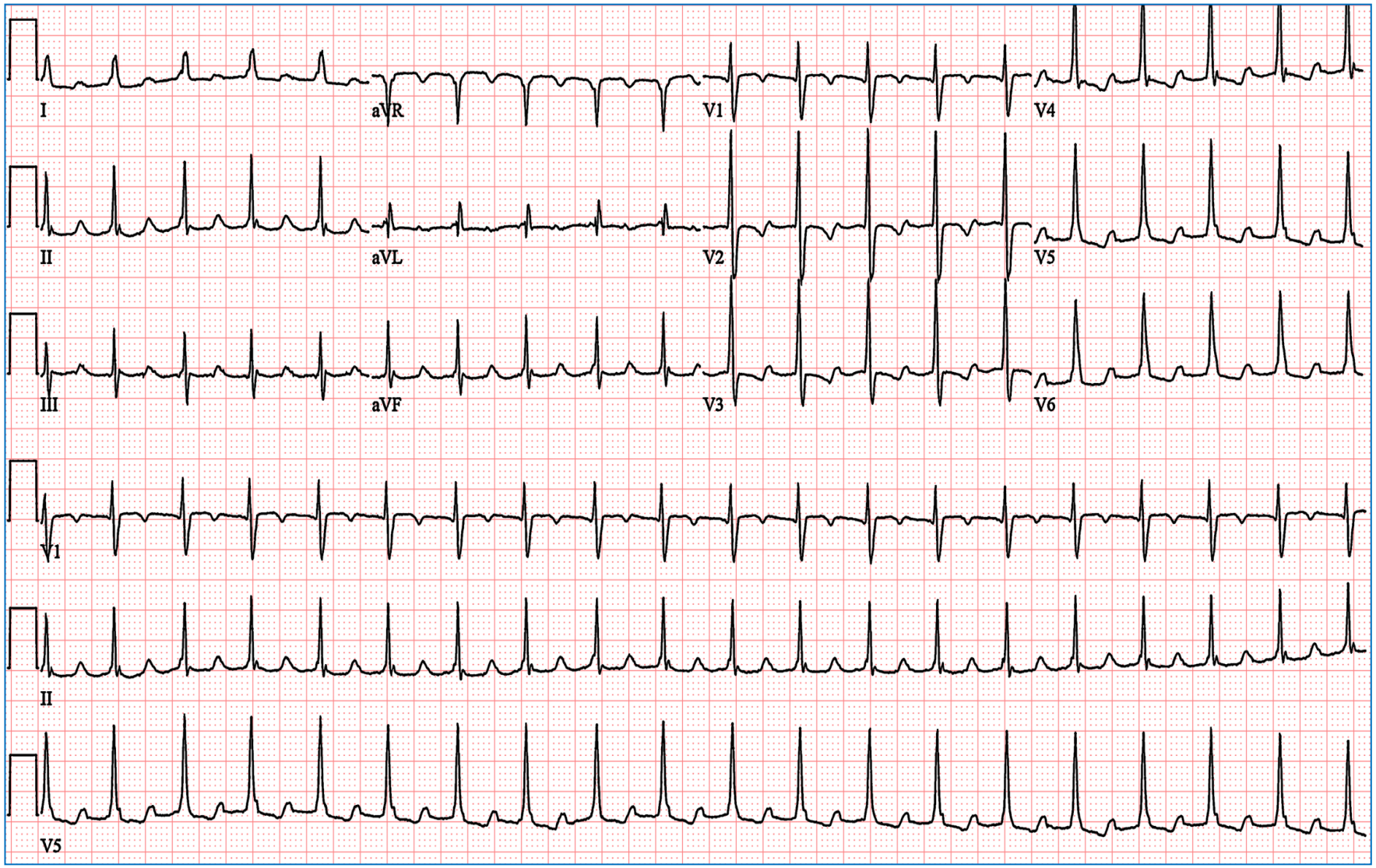


# Case 2.

## 48/F ASD TGV Op 90'

### Palpitation

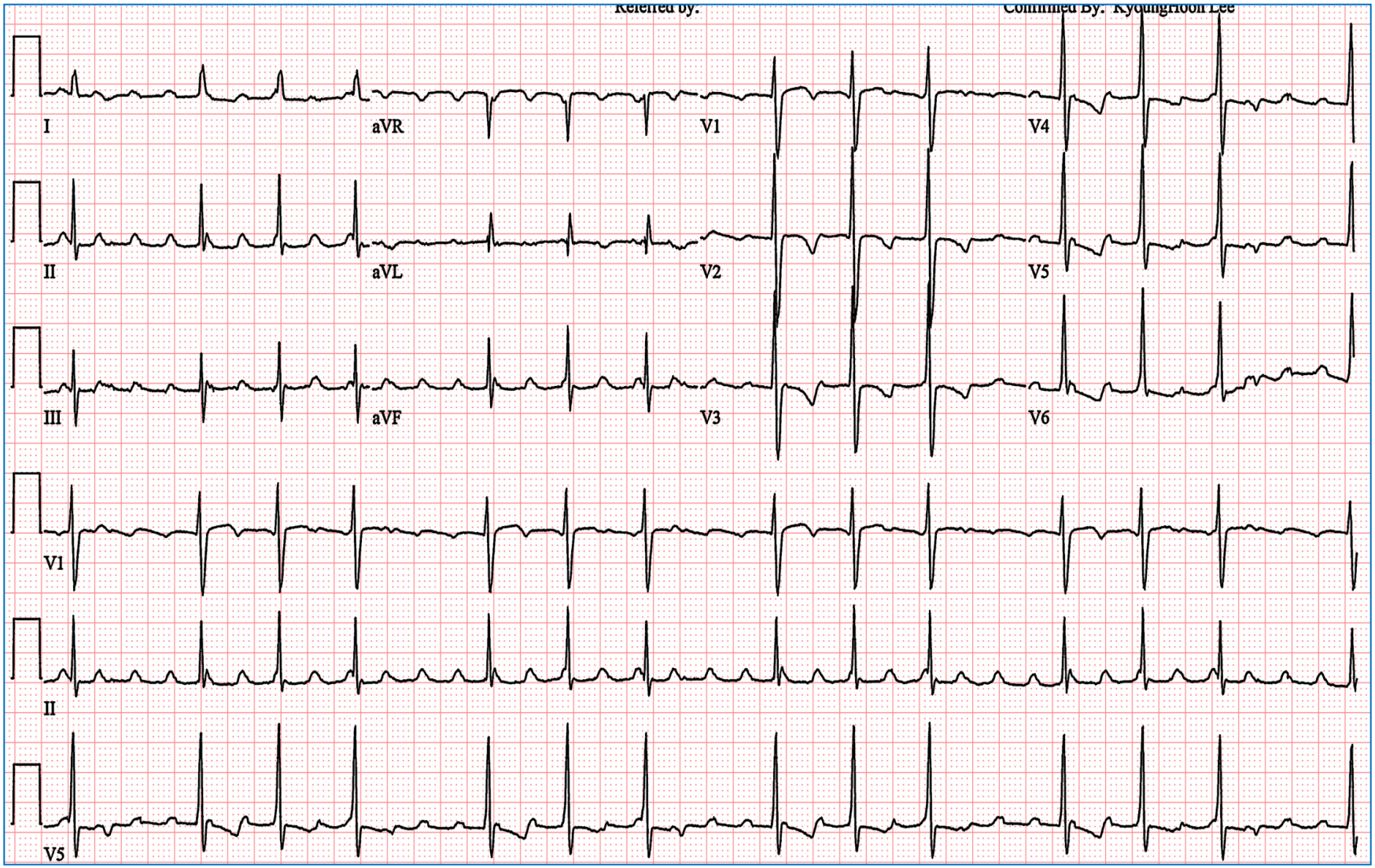



2008-02-01

# What is your diagnosis?

1. AVRT
2. AVNRT
3. AT 1:1 conduction
4. AT 2:1 conduction
5. Sinus tachycardia

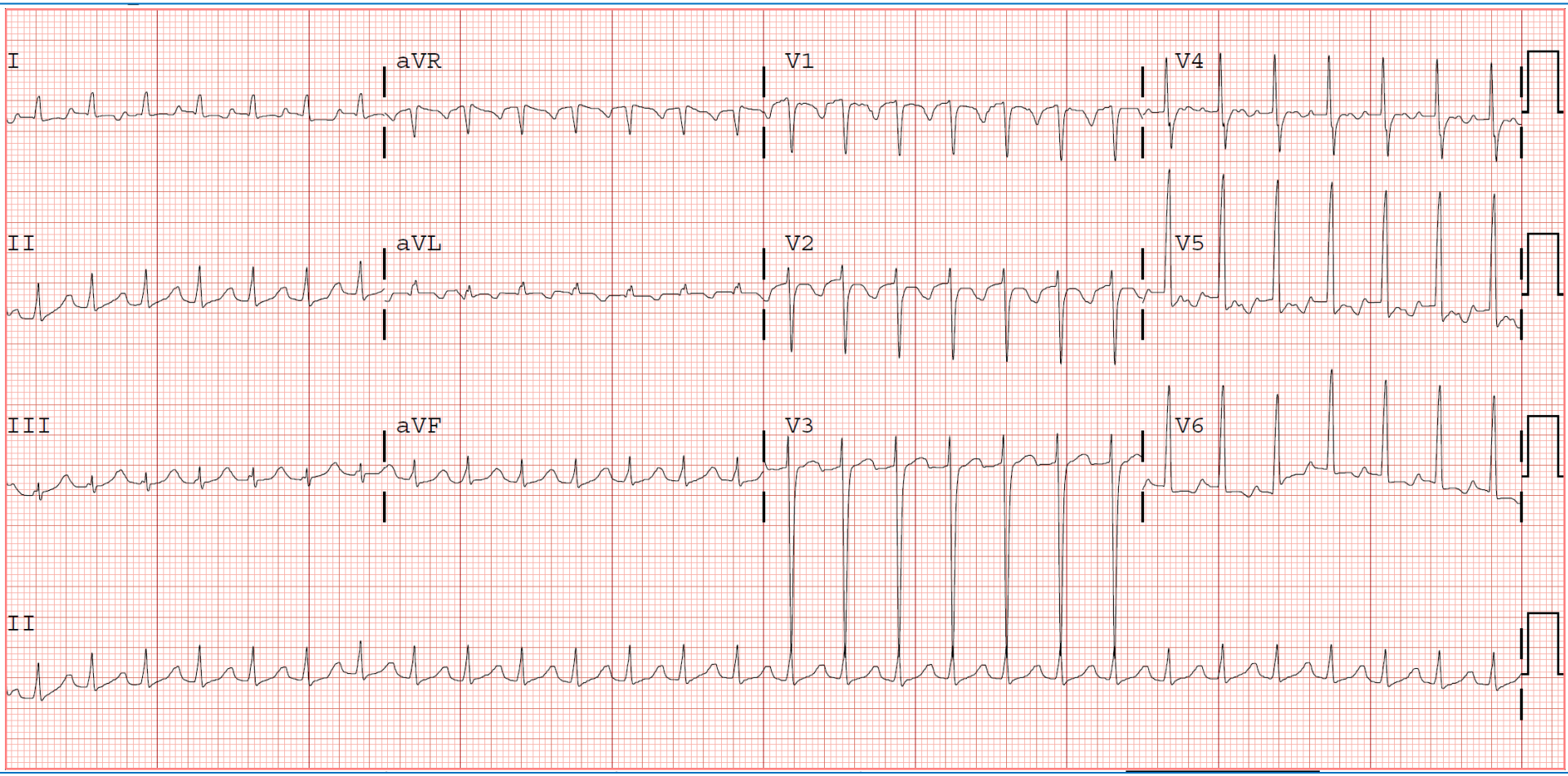
Digoxin 0.125mg, Dilatrend 6.25mg Lasix, Aldactone



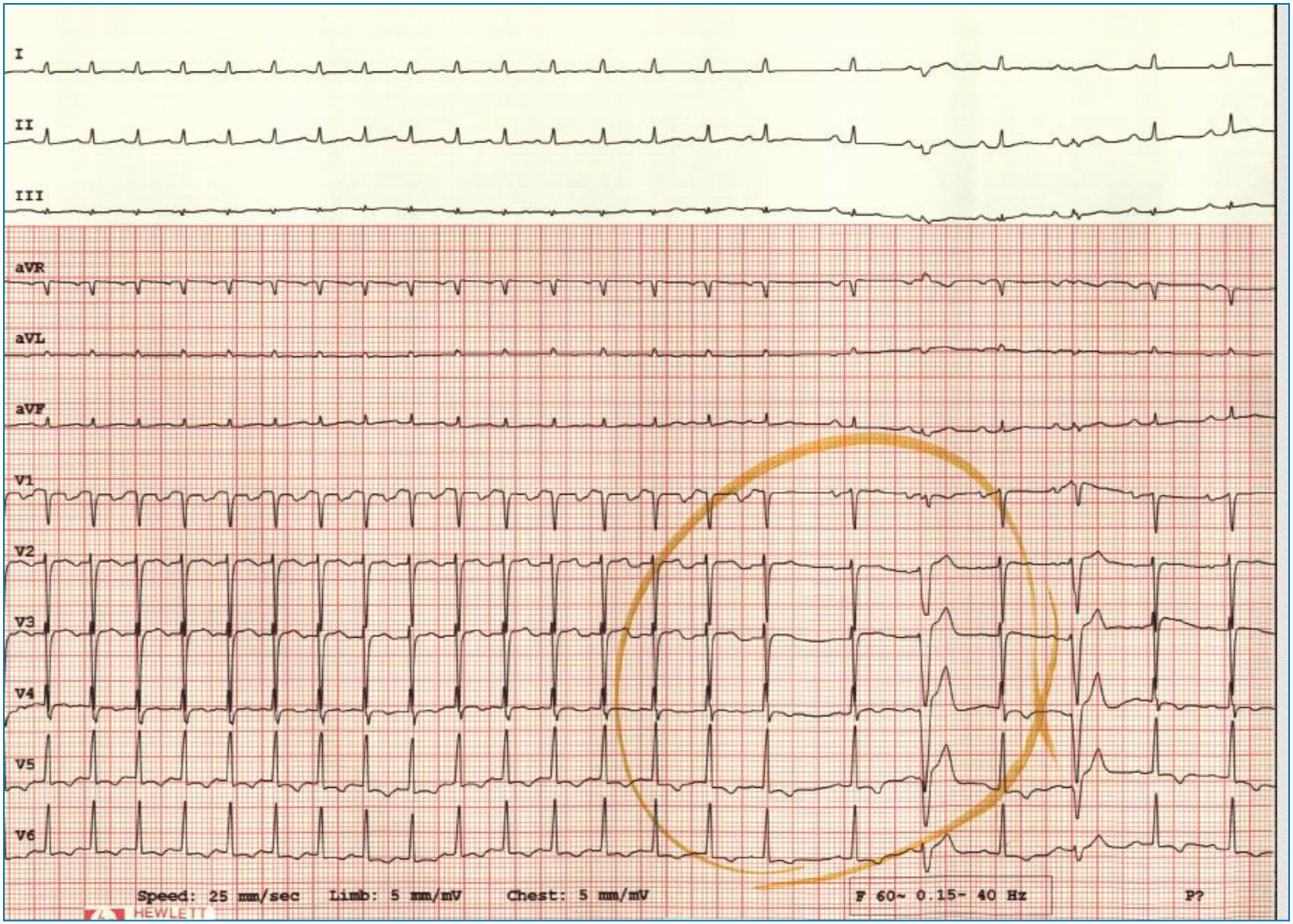
# Case 3.

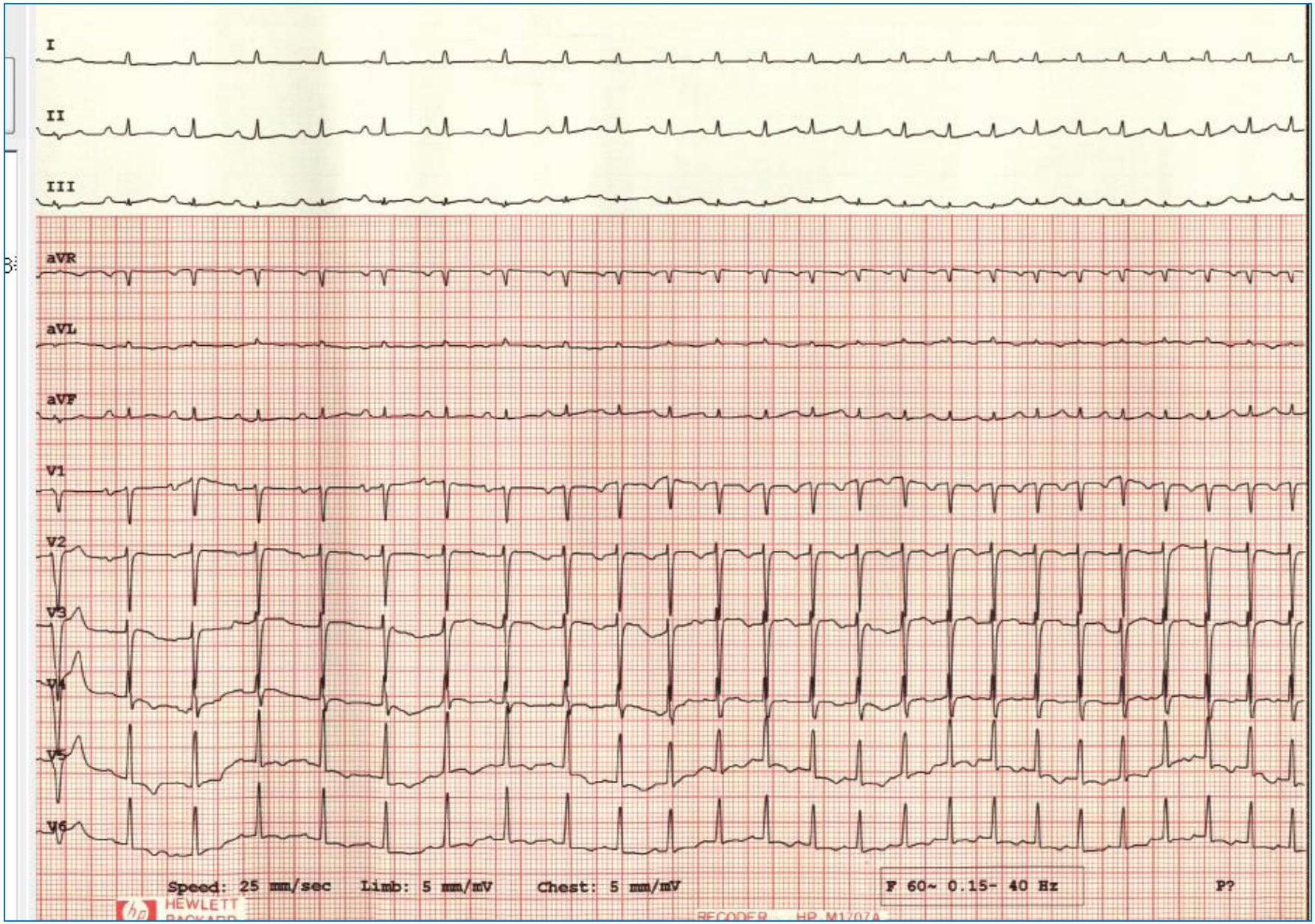
## 50/M

## C/C: palpitation, dyspnea (NYHA III)



# IV adenosine 투여 후

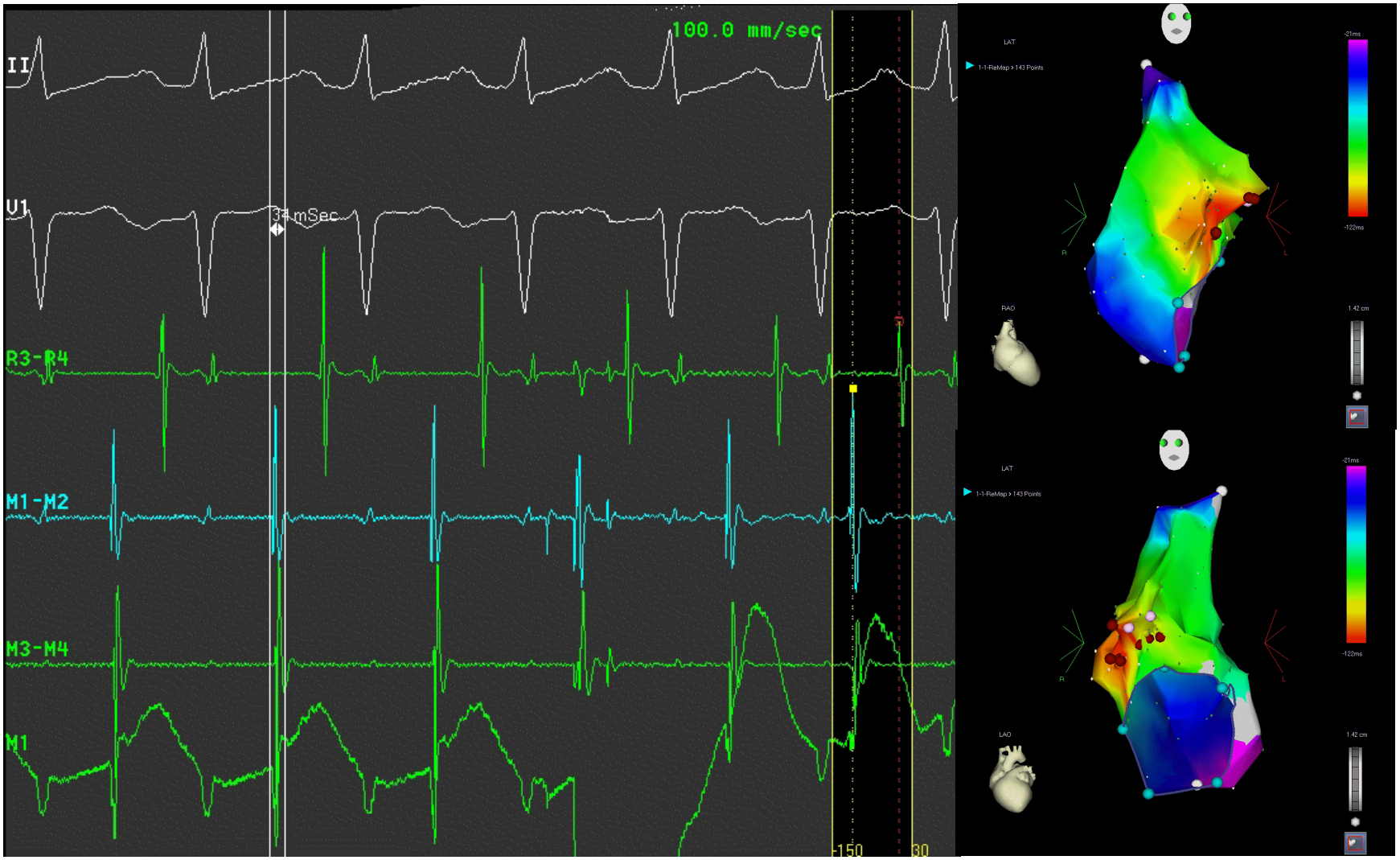



I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
Speed: 25 mm/sec
Limb: 5 mm/mV
Chest: 5 mm/mV
F 60~ 0.15- 40 Hz
P?
HEWLETT
RECORDER HP M1707A

# What is your diagnosis?

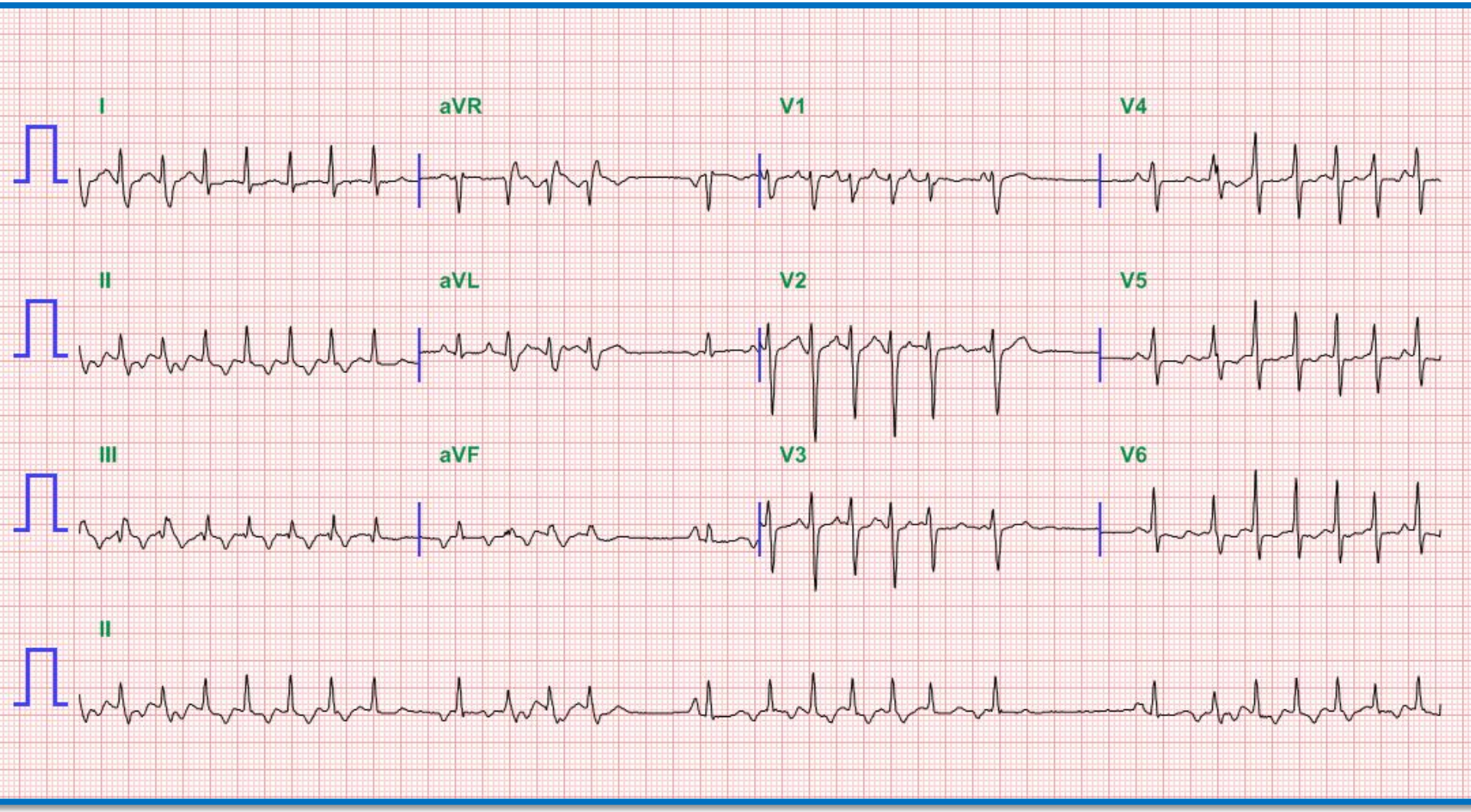
1. Sinus tachycardia
2. Atrial tachycardia
3. Atrial flutter
4. AV re-entrant tachycardia
5. Atrial fibrillation

# RFCA


100.0 mm/sec
II
V1
34 mSec
R3-R4
M1-M2
M3-M4
M1
LAT
1-1-ReMap > 143 Points
RAO
LAO

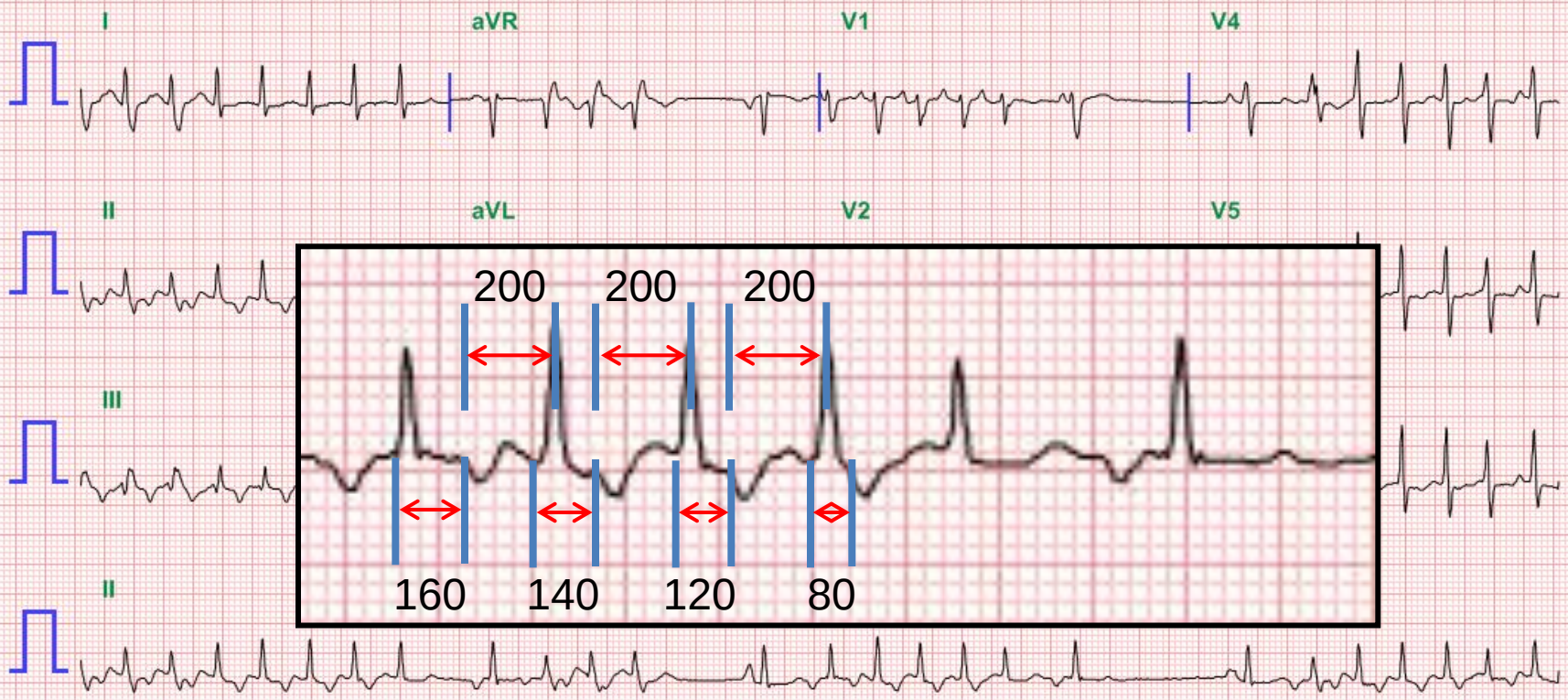
# Case 4.

## 44/F, palpitation

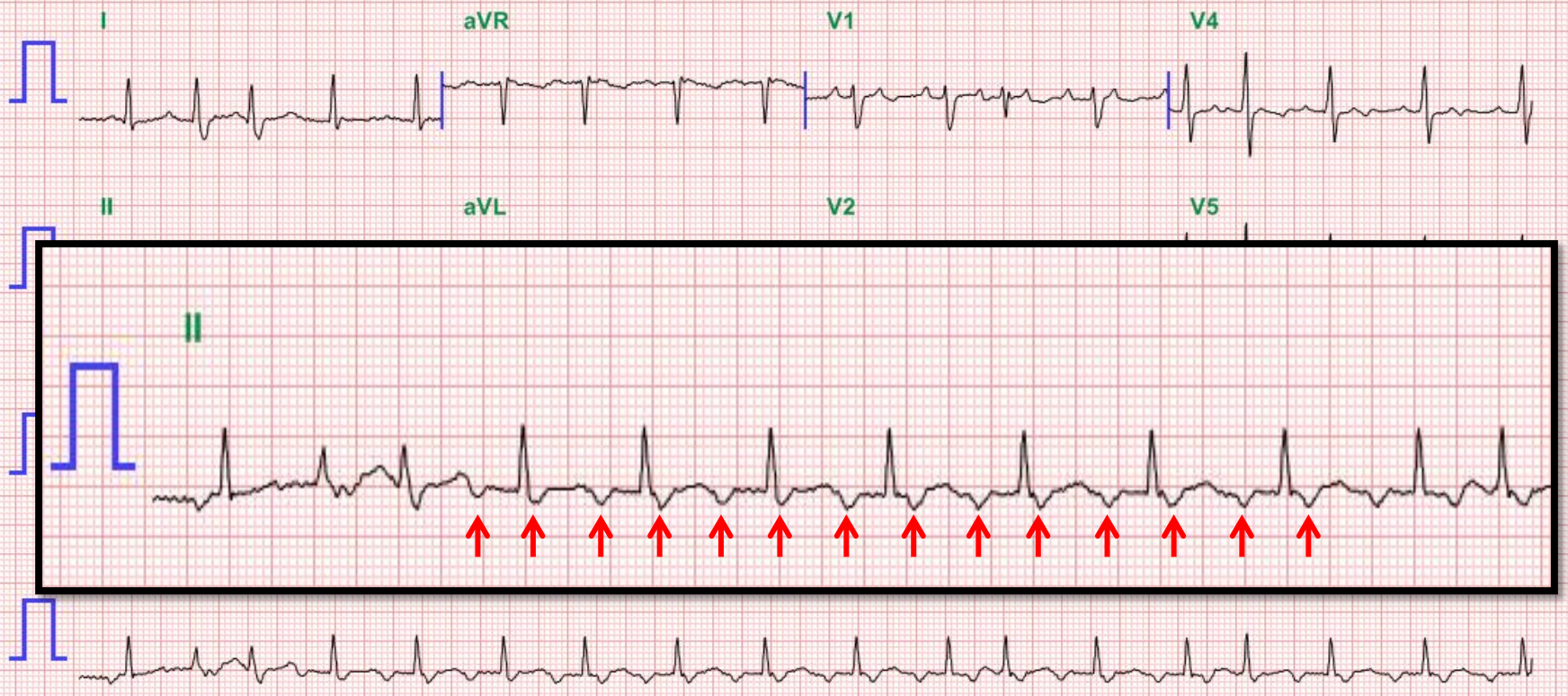


# What is your diagnosis?

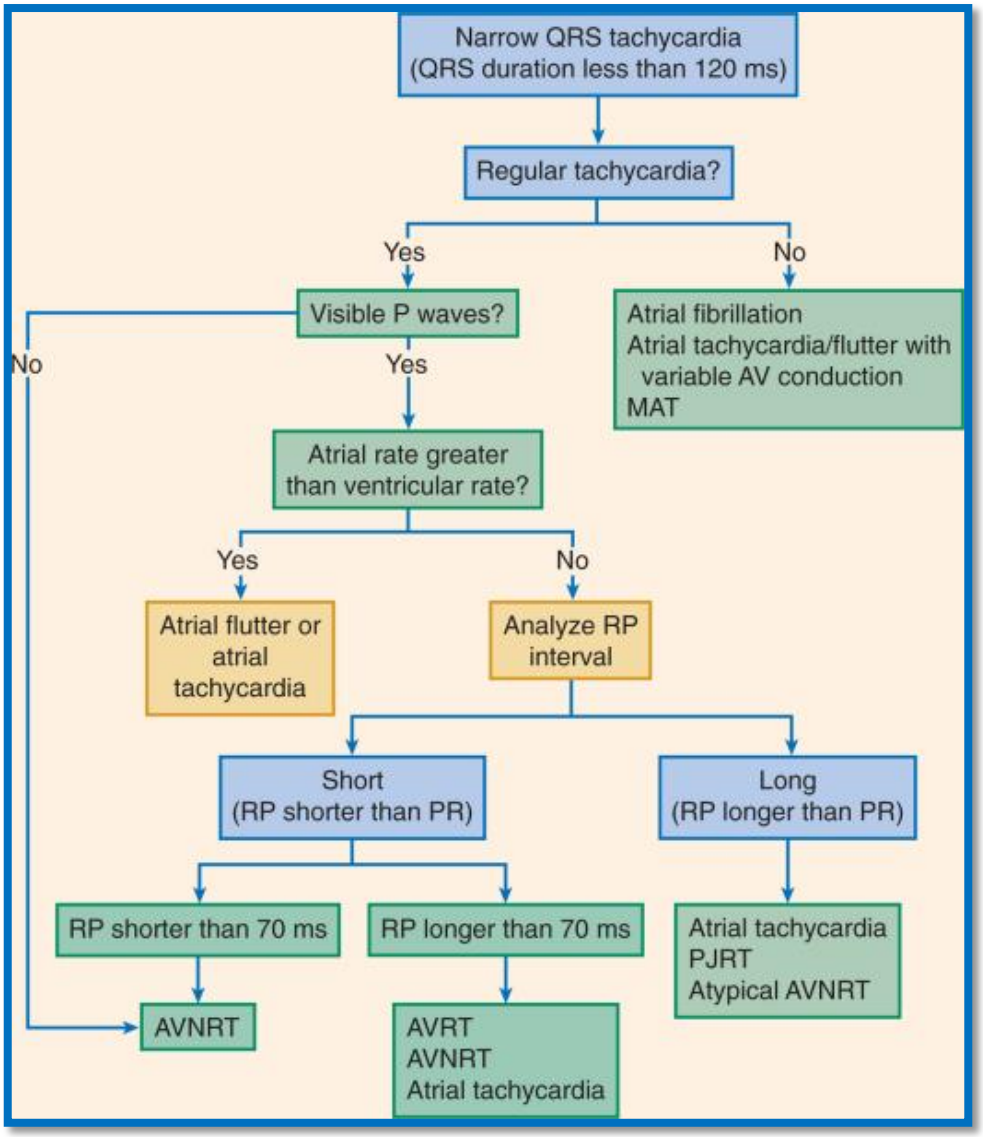
1. Atrioventricular nodal reentrant tachycardia
2. Atrioventricular reentrant tachycardia
3. Sinus arrhythmia
4. Atrial fibrillation
5. Atrial tachycardia


I
aVR
V1
V4
II
aVL
V2
V5
III
II
200
200
200
160
140
120
80

# 증상 지속 시 심전도

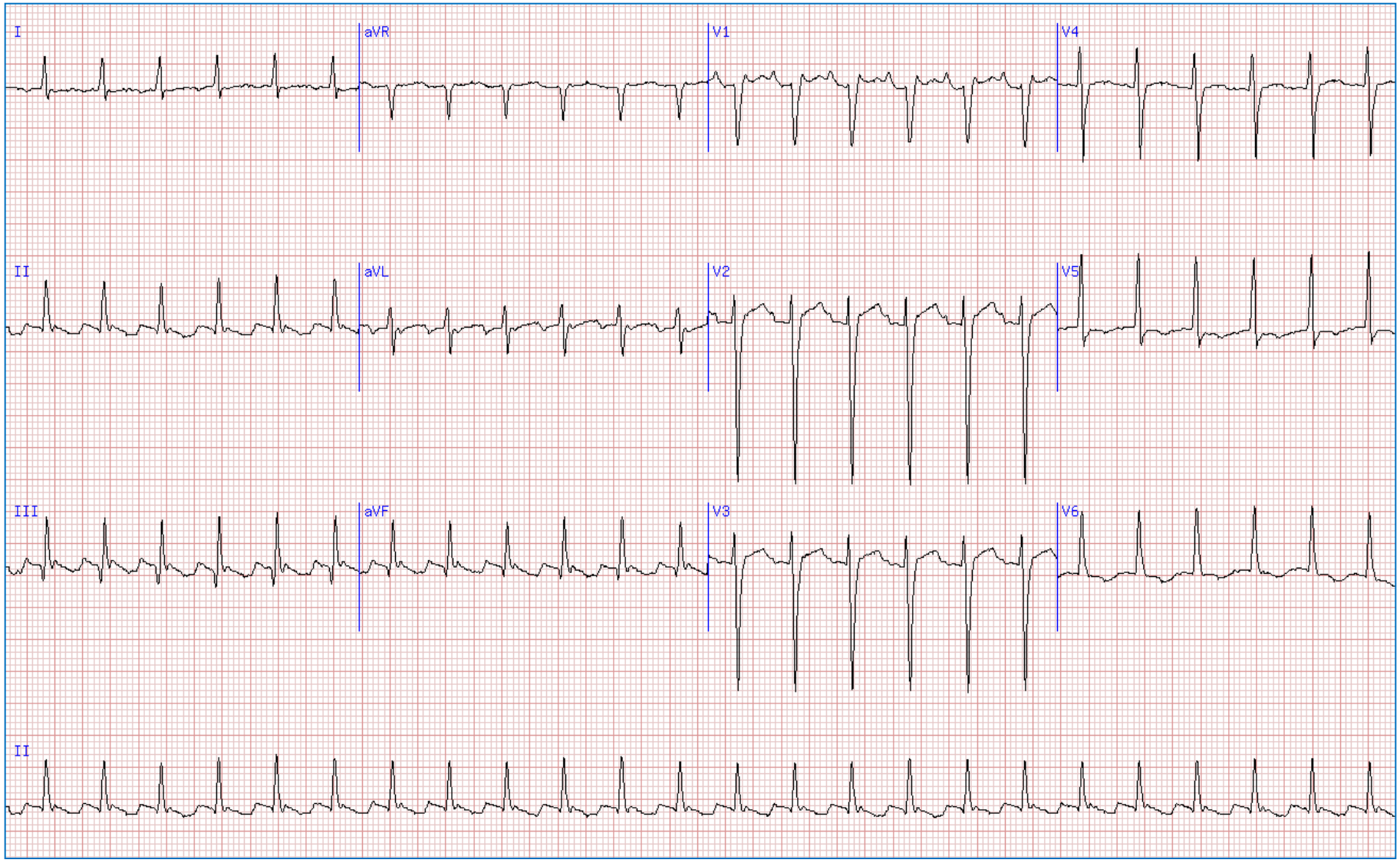


# Differential diagnosis of narrow QRS tachycardia



# Case 5.

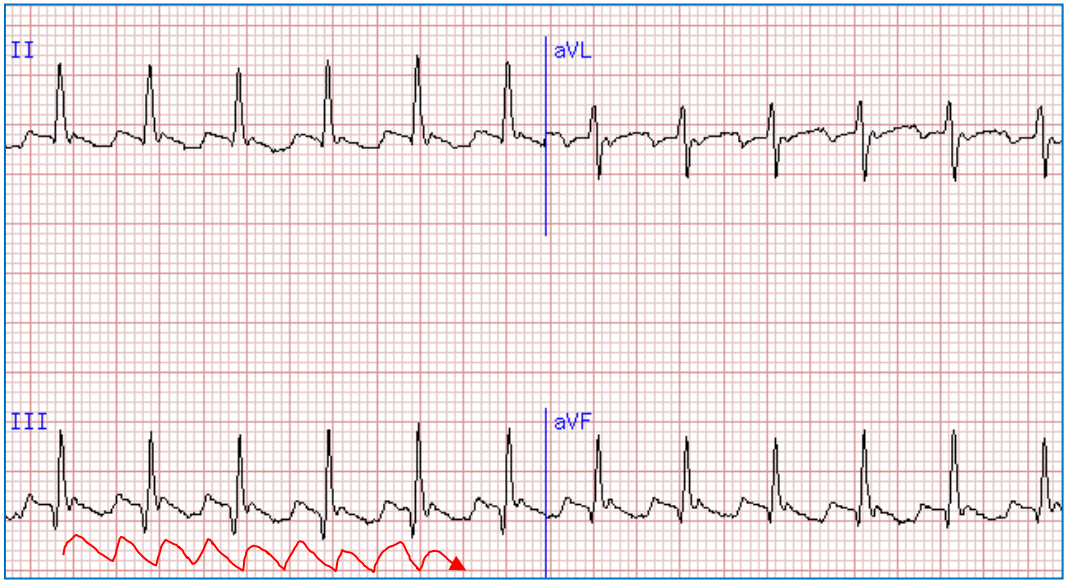
## 43/F, palpitation LVEF 20%

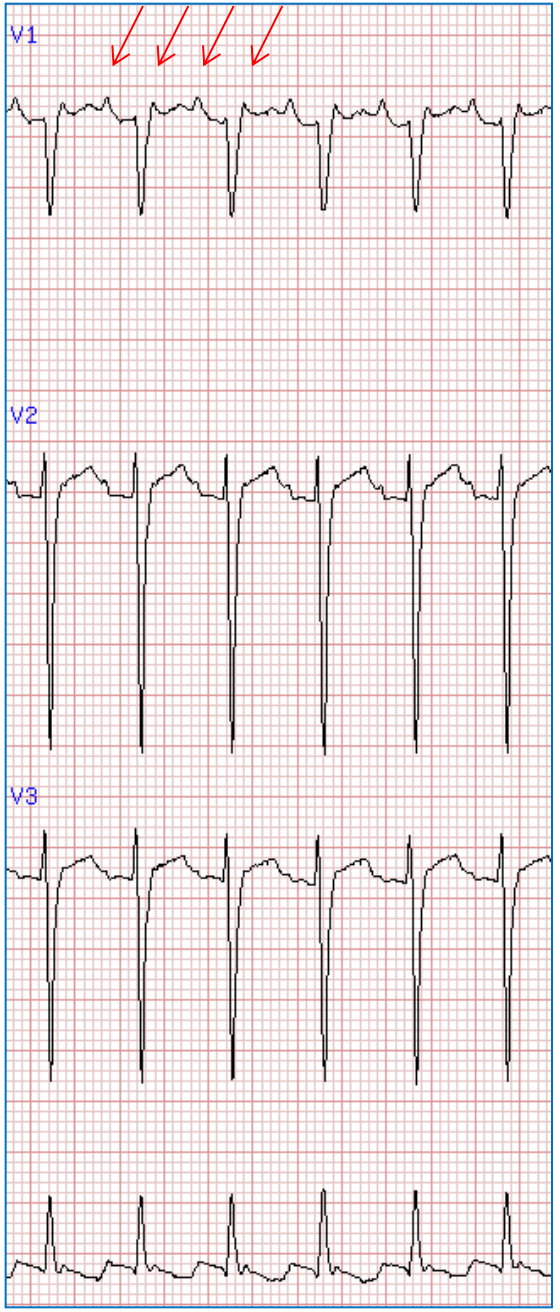


# 심전도에 대한 다음 설명 중 <u>틀린 것은</u>?.

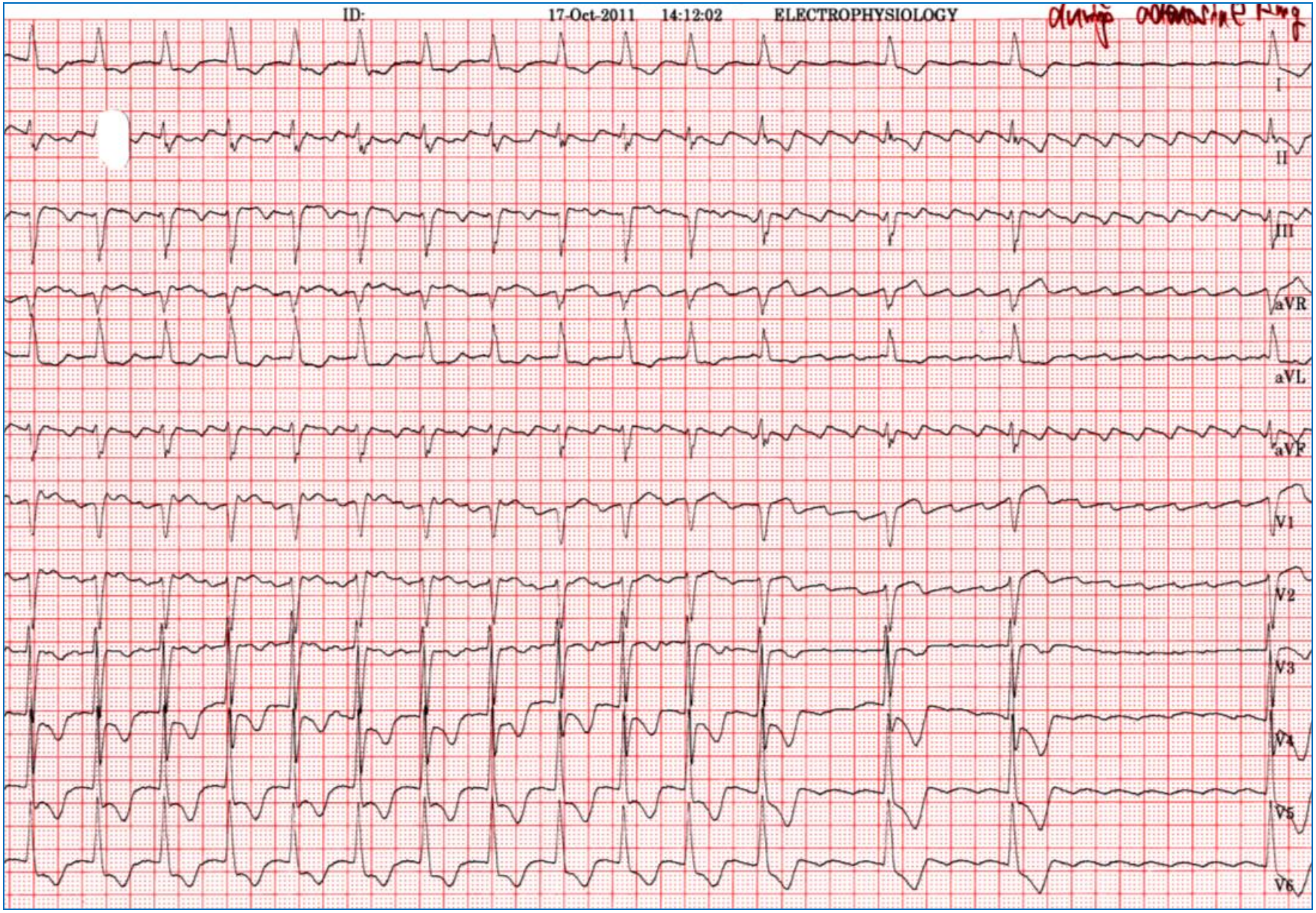

1. Narrow QRS tachycardia 이다.
2. PSVT, atrial flutter, atrial tachycardia 등의 가능성이 있다.
3. P wave 와 QRS wave 가 1:1 관계에 있다.
4. 정확한 P wave 모양을 보기위해 adenosine 이 도움이 된다.


I

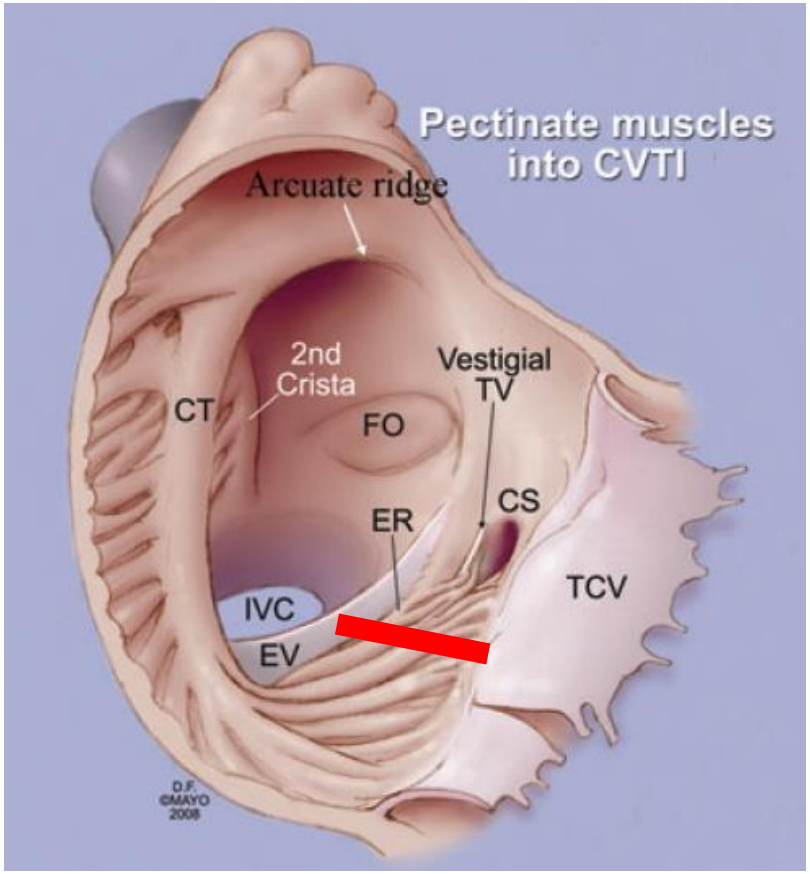

II
aVL
III
aVF

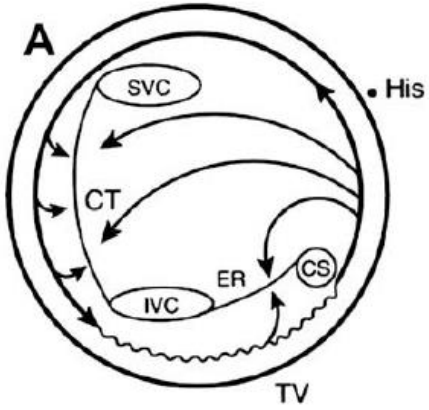

V1
V2
V3

# Adenosine 의 유용성 (다른 case)

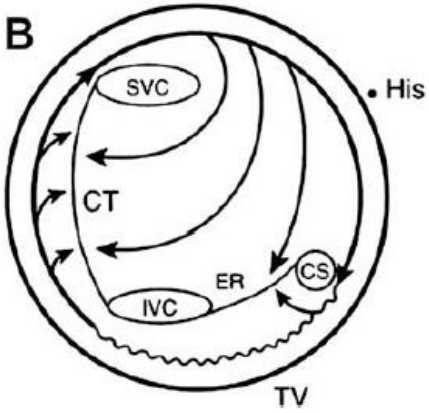


# **Cavotricuspid isthmus (CTI)** dependent AFL



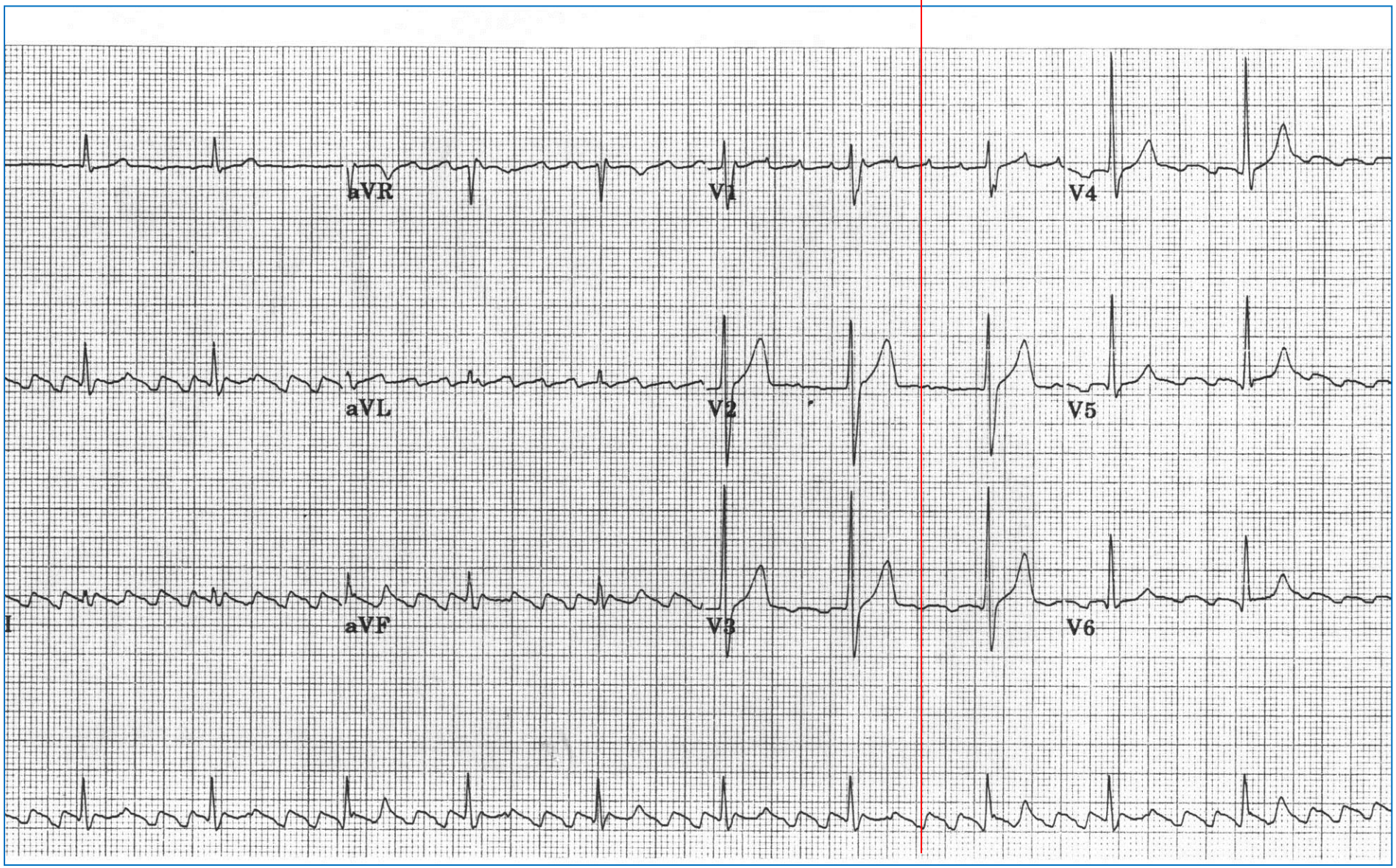




Typical AFL
= CTI dependent AFL
= Isthmus dependent AFL
= Counterclockwise AFL
= Type 1 AFL

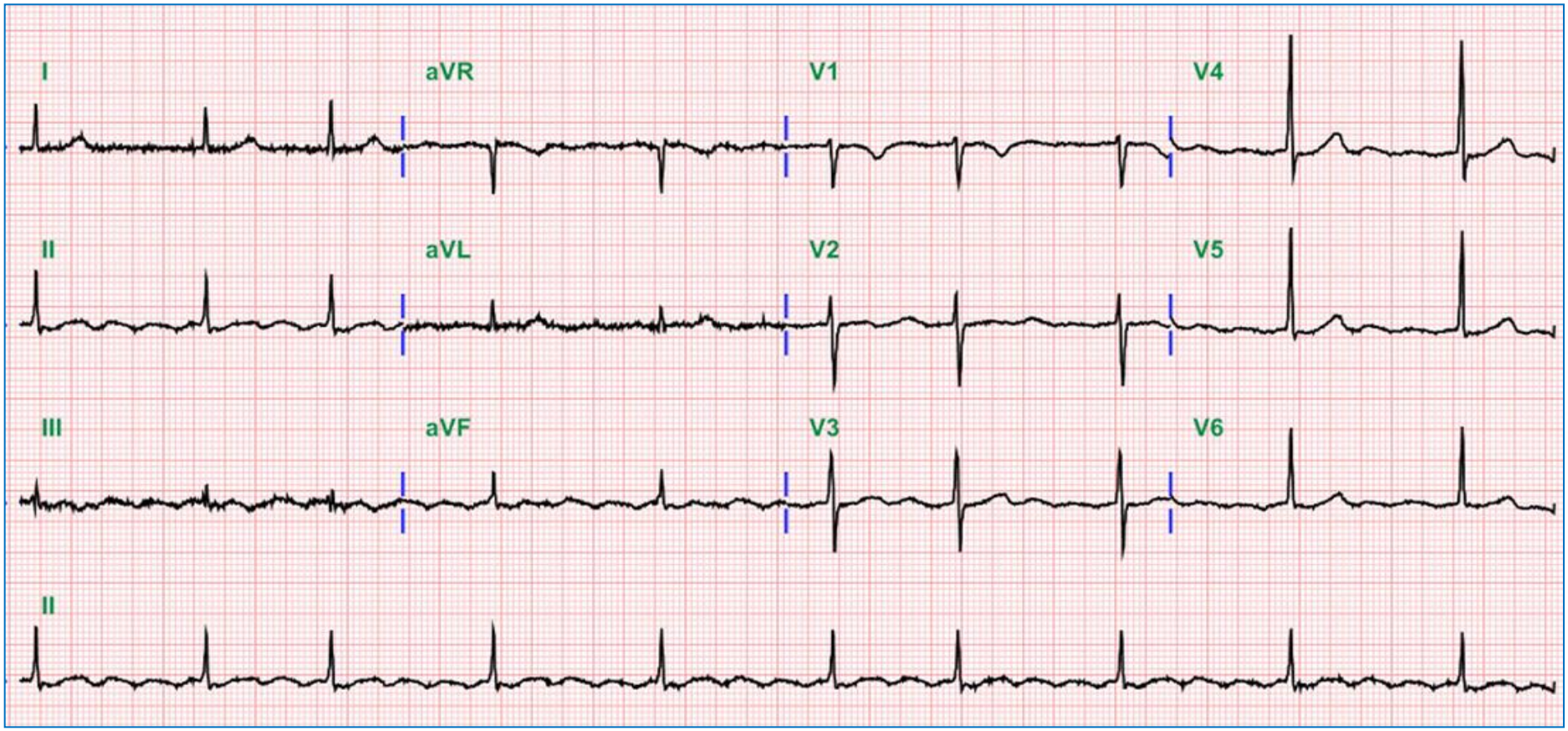



Reverse typical AFL
= CTI dependent AFL
= Clockwise AFL

# Typical atrial flutter (counterclockwise)



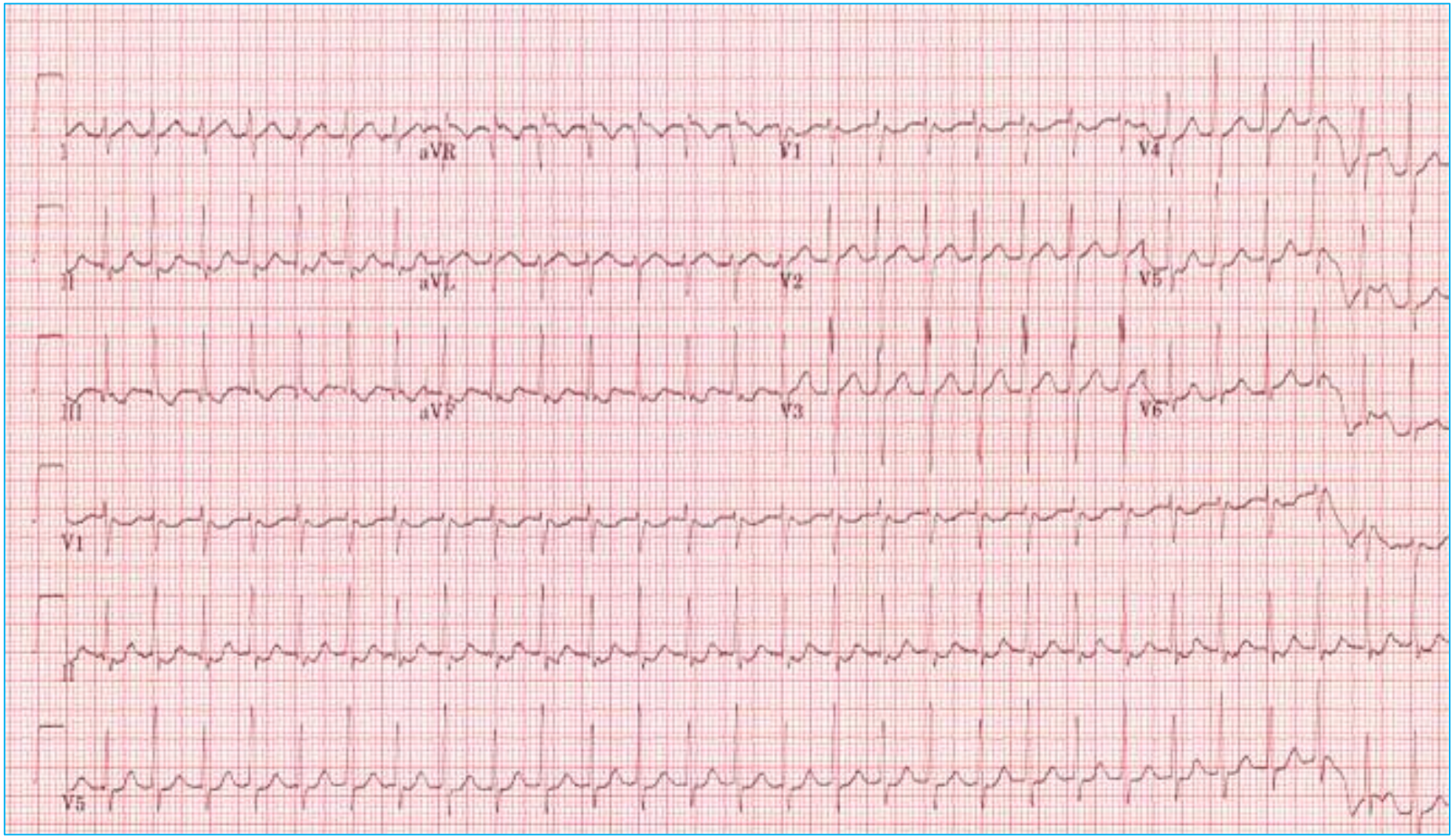
# Atypical atrial flutter



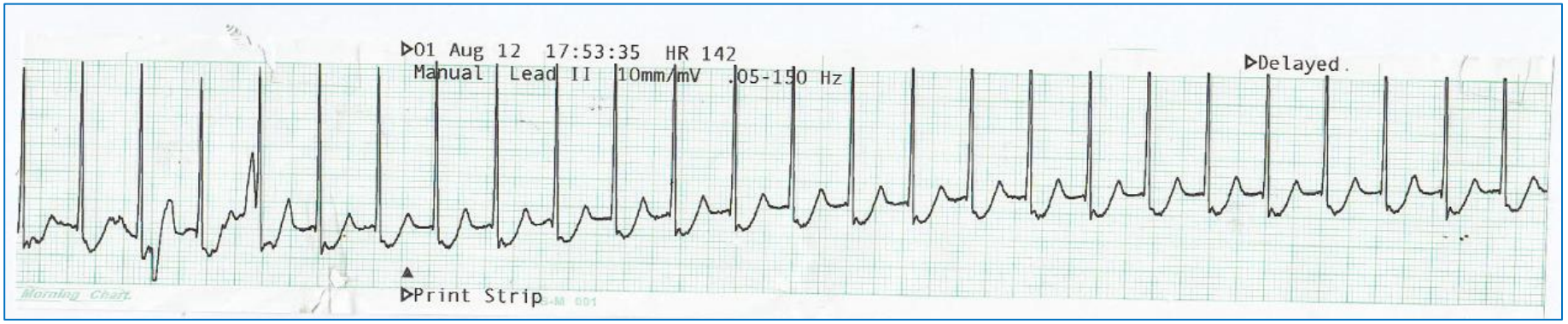
# Case 6.

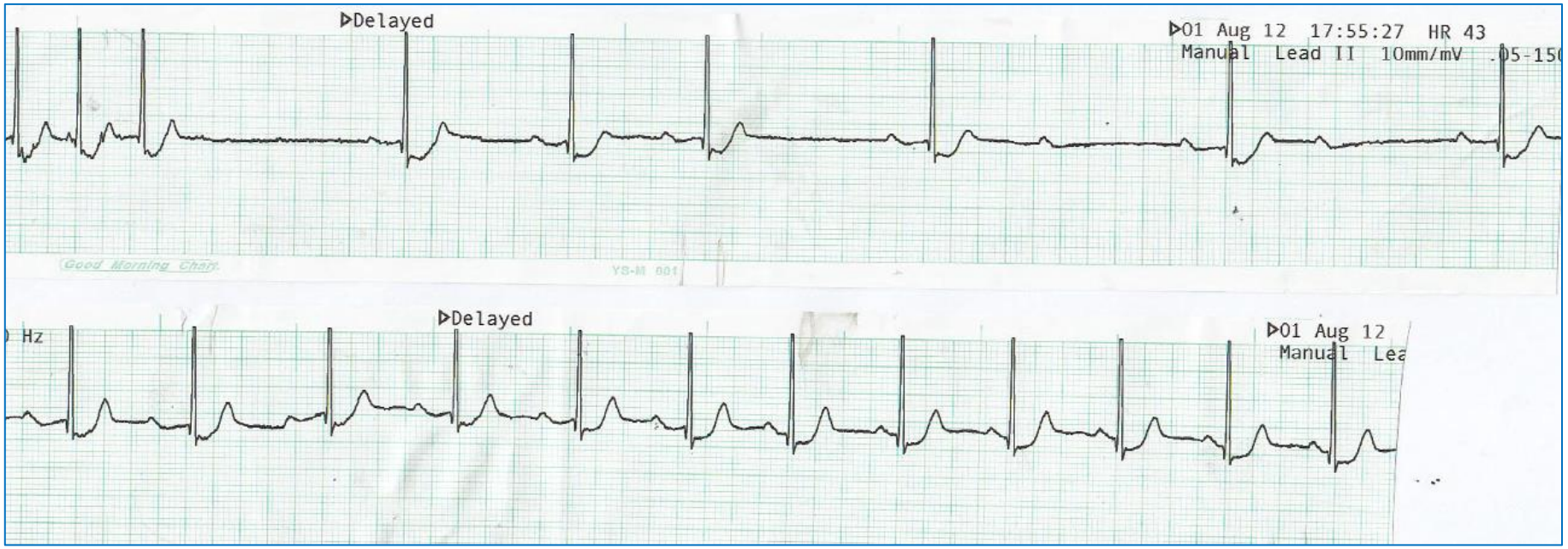
**25/F, palpitation**

Sudden onset, sudden termination

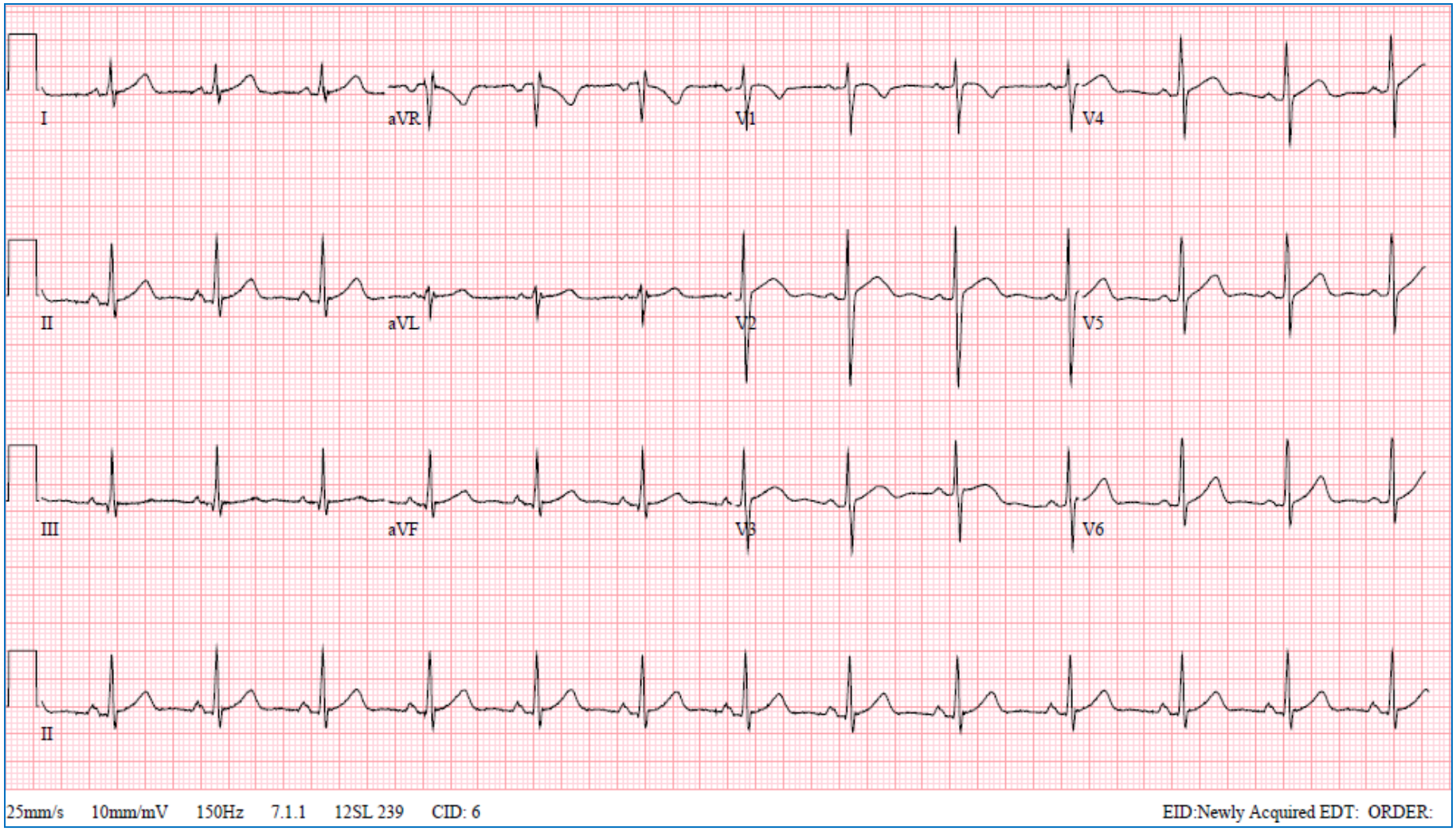


# Adenosine iv



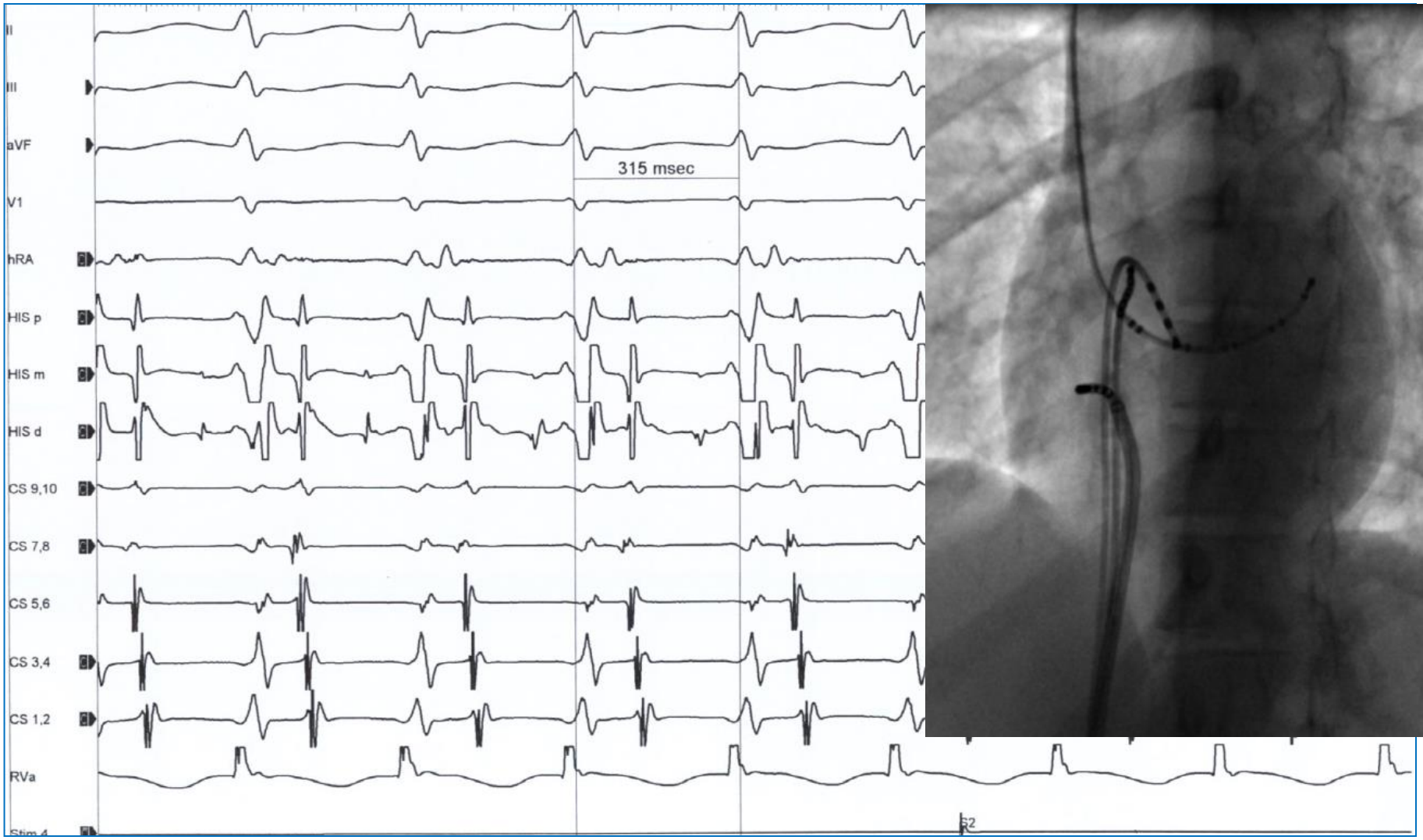
# After NSR conversion



# What is your diagnosis?

1. AVNRT
2. AVRT
3. AT
4. Atrial fibrillation

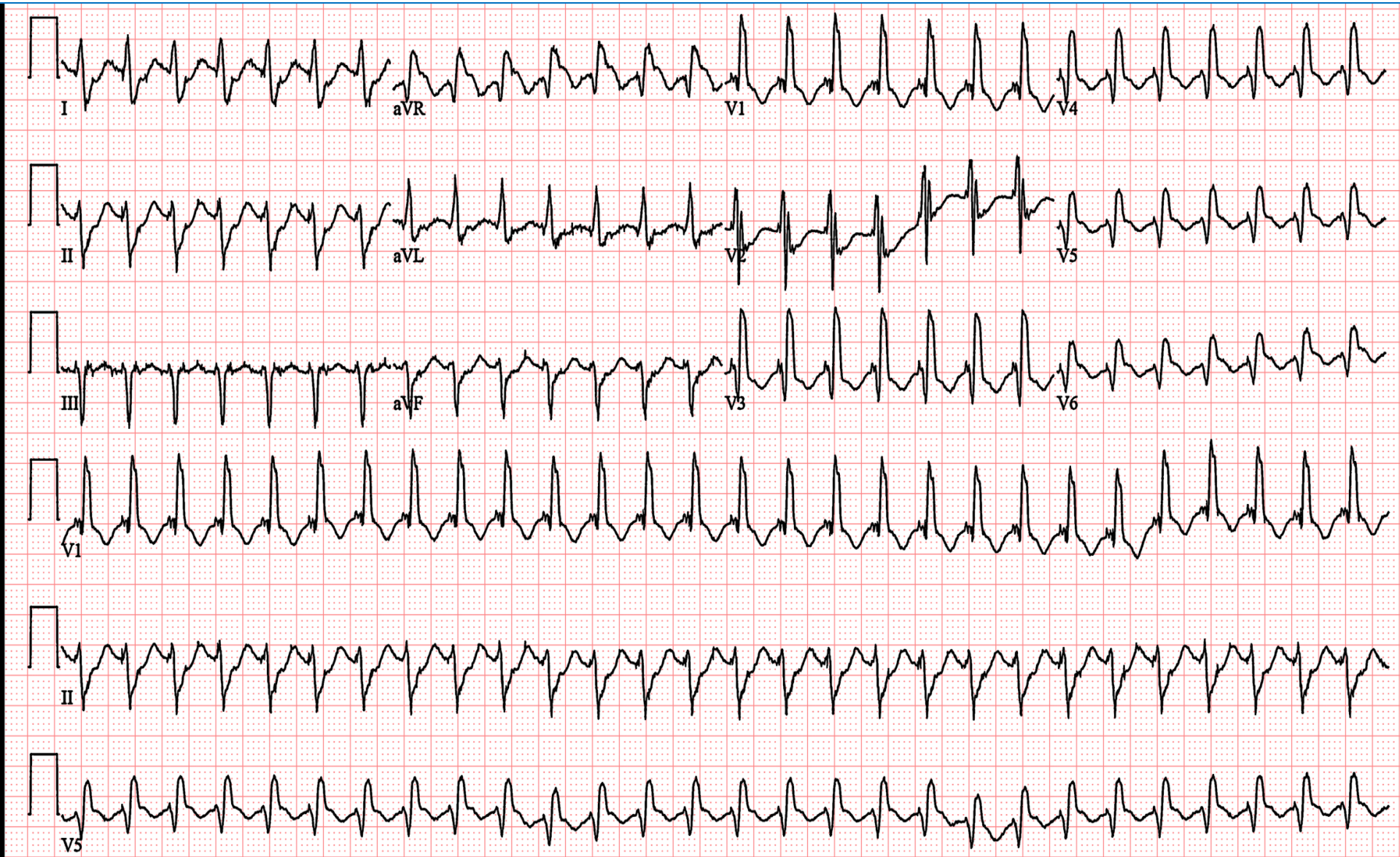
# Induced AVRT using right side bypass tract



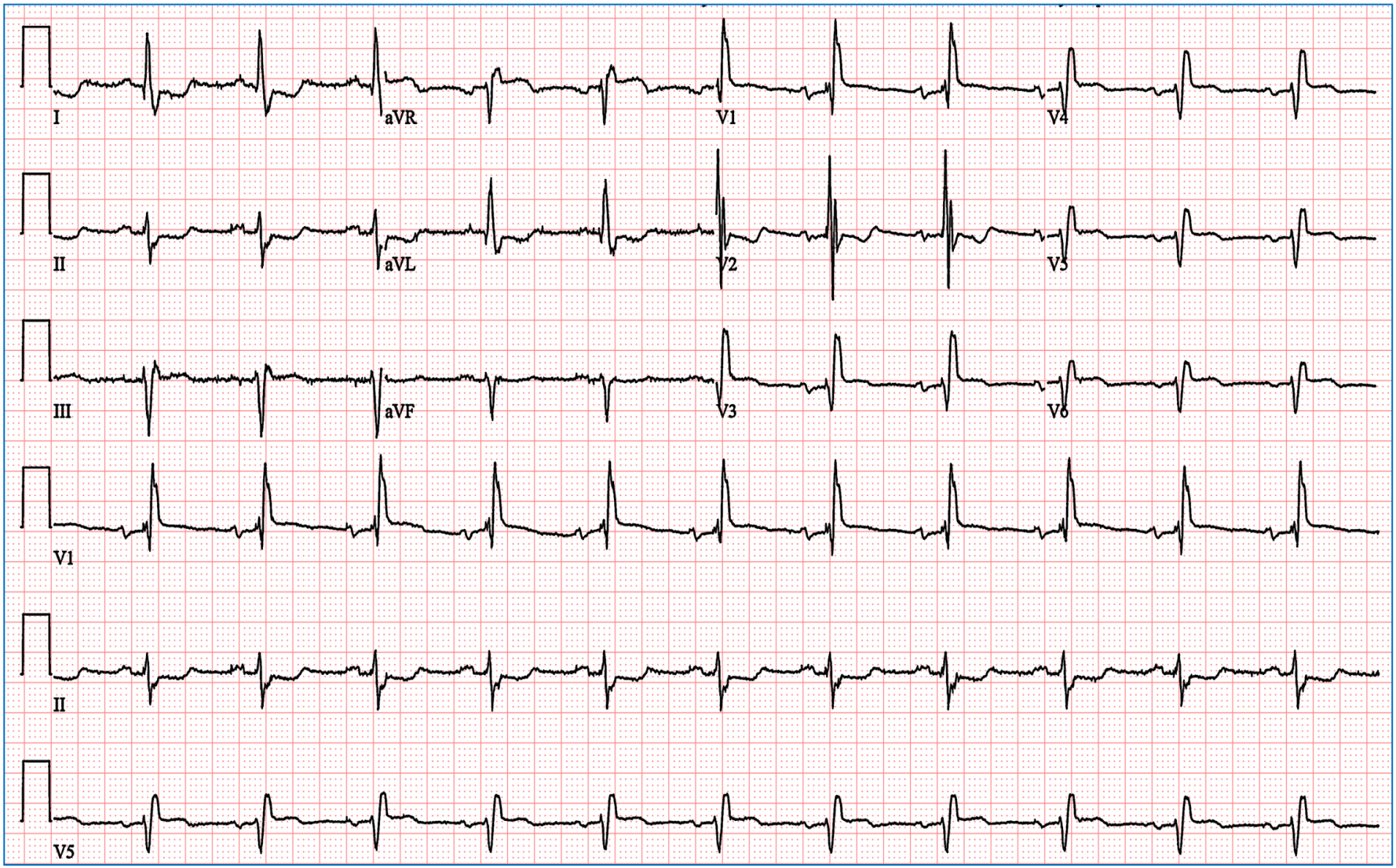
# Case 7.

**75/M CABG 09'**
**Chest discomfort**

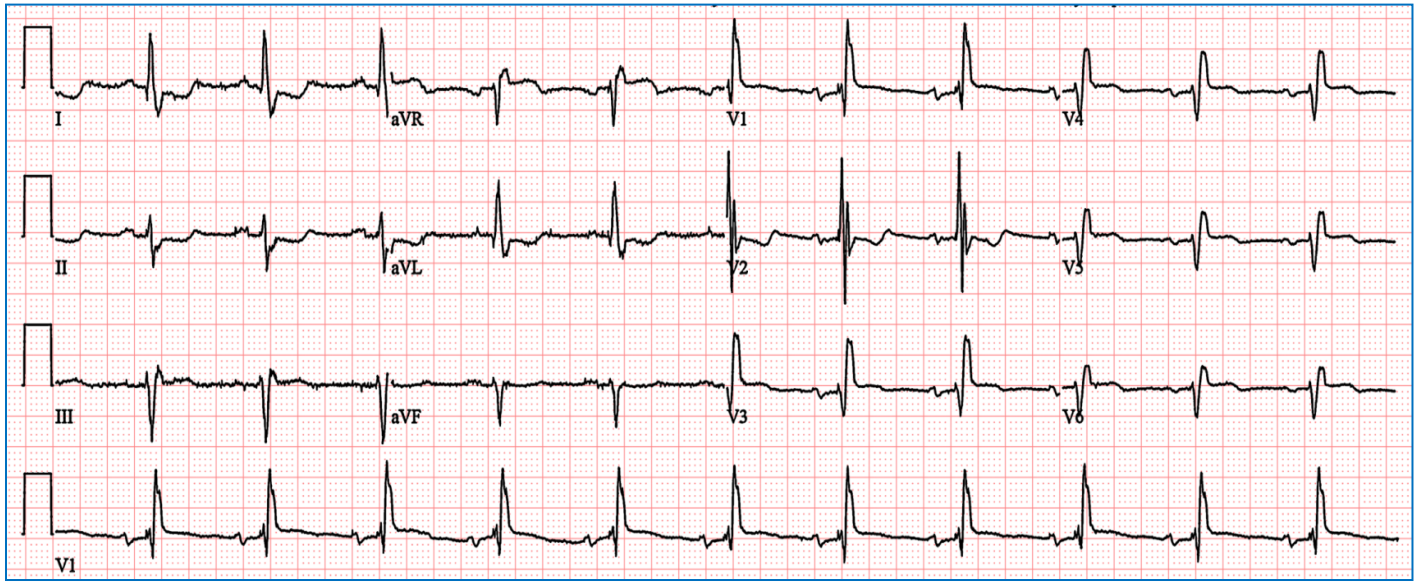
138/88mmHg

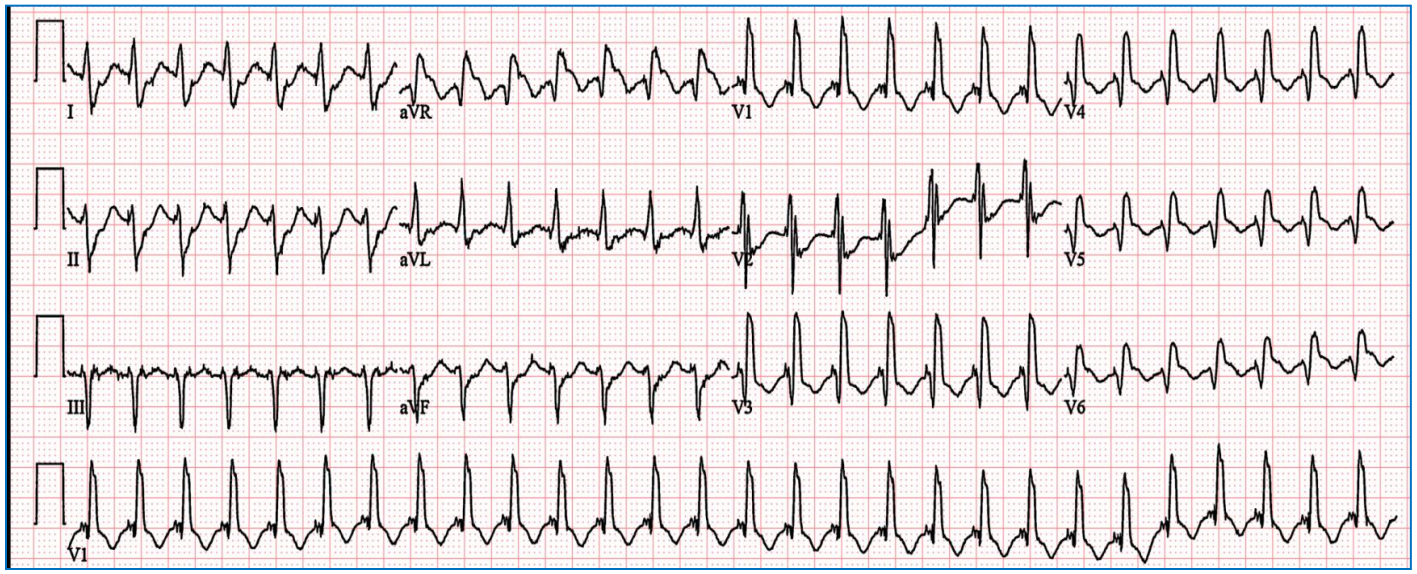


# Previous ECG



# Previous ECG



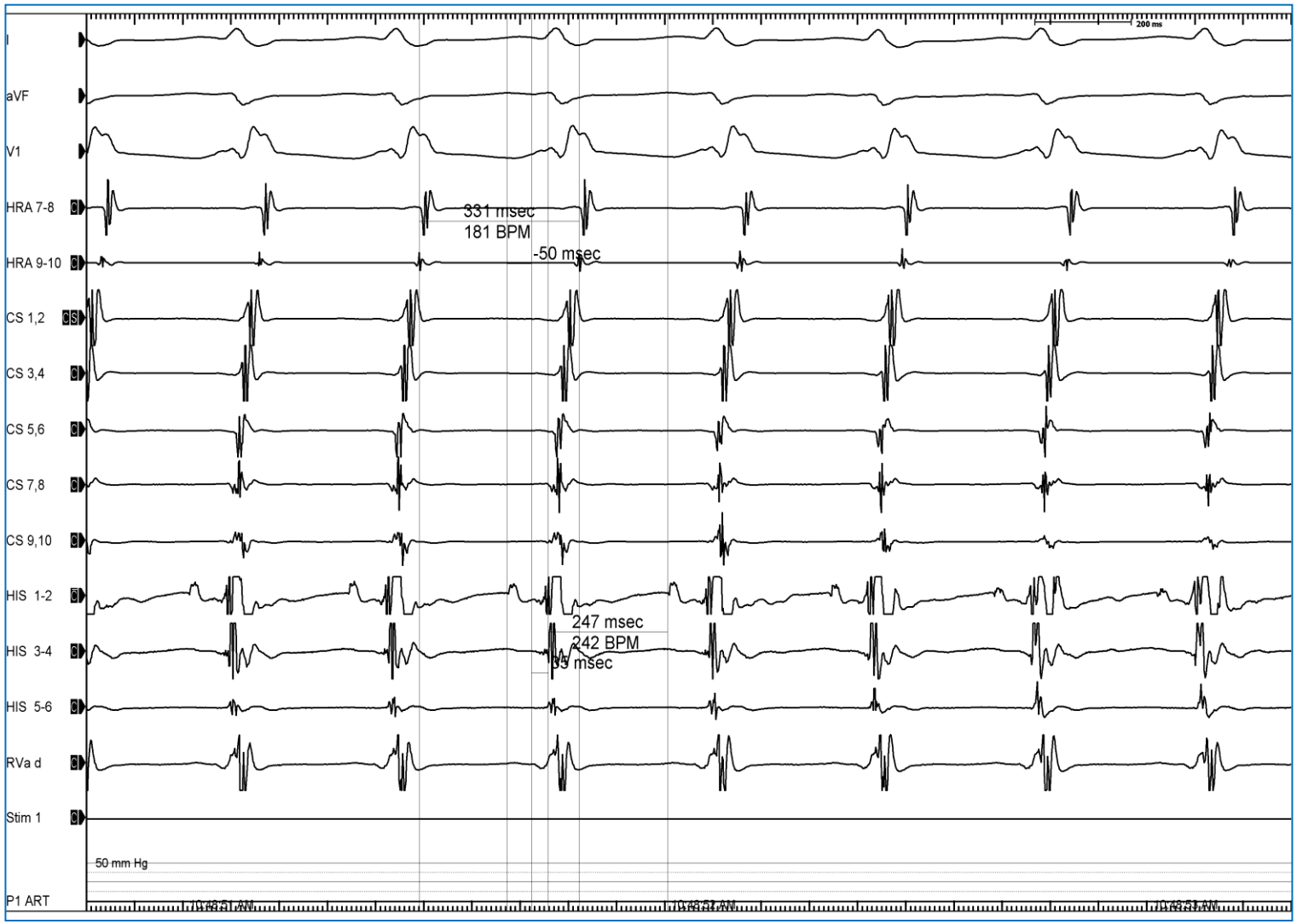
# What is your diagnosis?

1. Ventricular tachycardia
2. WPW syndrome
3. SVT with aberrancy
4. SVT with BBB
5. Other

# DDx of wide QRS tachycardia

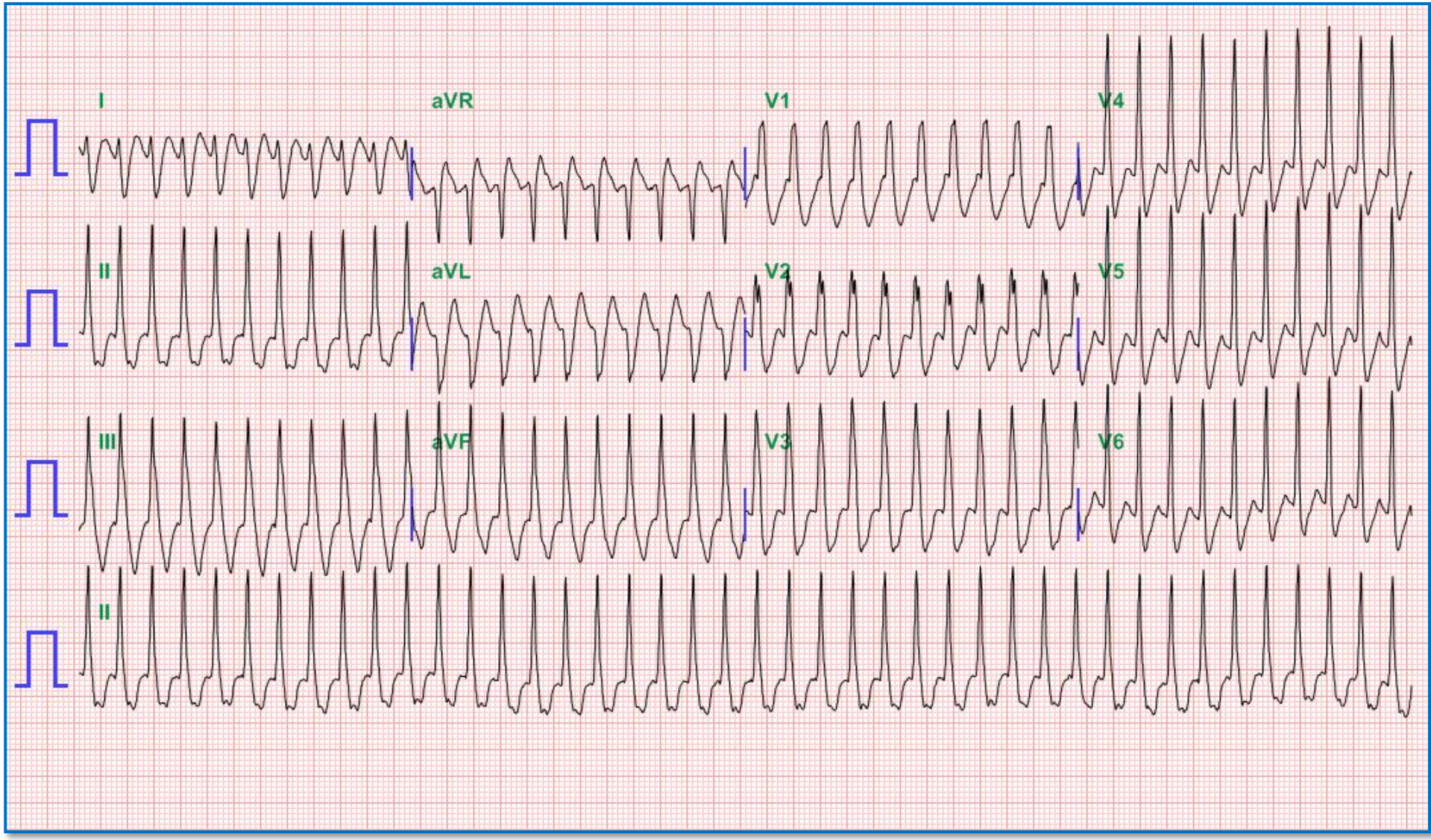
1. Ventricular tachycardia
2. WPW syndrome
   - Atrial fibrillation, atrial flutter, atrial tachycardia with exclusive anterograde AP conduction
   - Preexcited circus movement tachycardia
3. SVT with preexisting BBB
4. SVT with aberration

# EPS


I
aVF
V1
HRA 7-8
HRA 9-10
CS 1,2
CS 3,4
CS 5,6
CS 7,8
CS 9,10
HIS 1-2
HIS 3-4
HIS 5-6
RVa d
Stim 1
P1 ART
200 ms
331 msec
181 BPM
-50 msec
247 msec
242 BPM
39 msec
50 mm Hg

# Case 8.

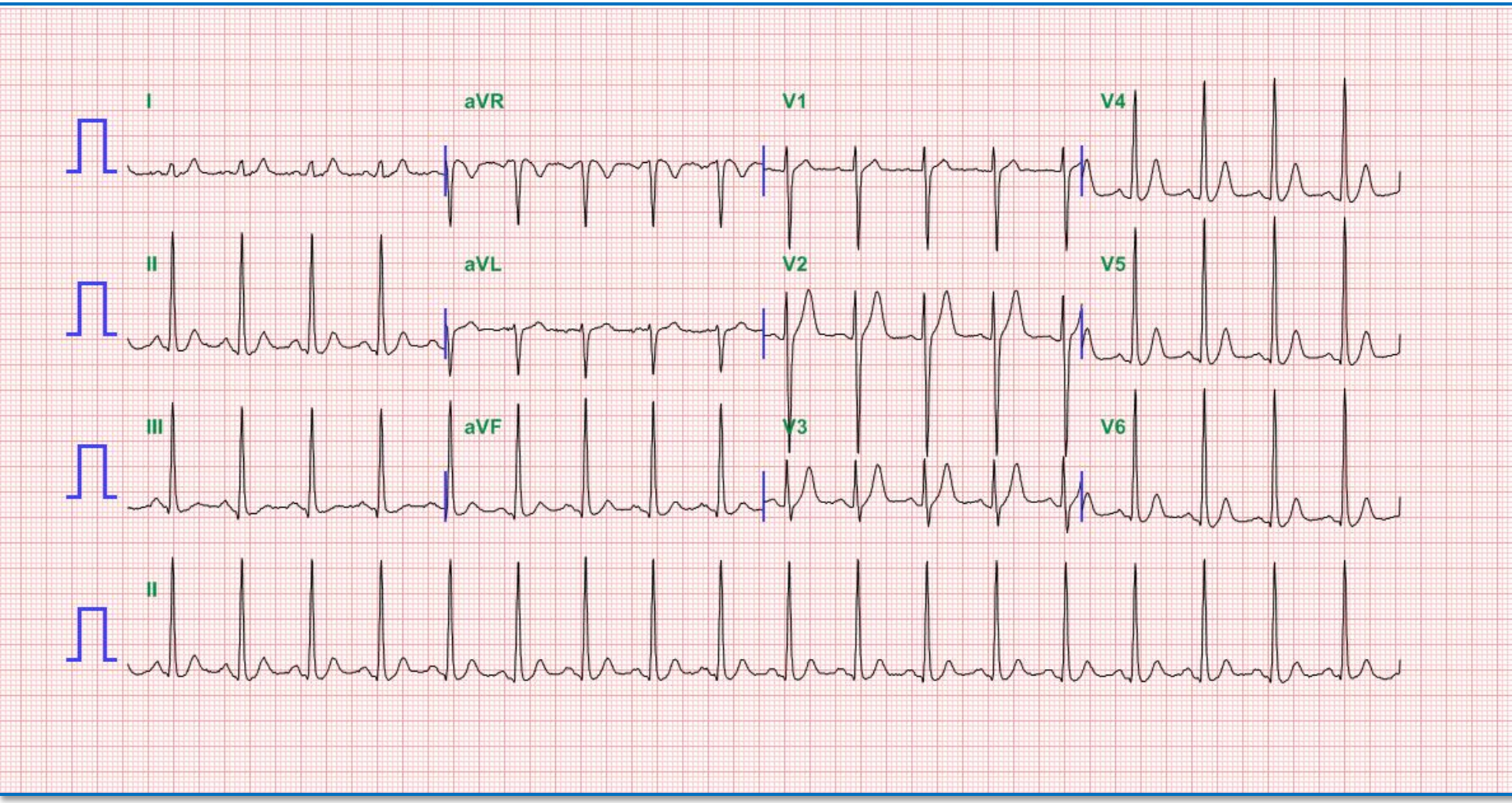
**18/M**
**palpitation**



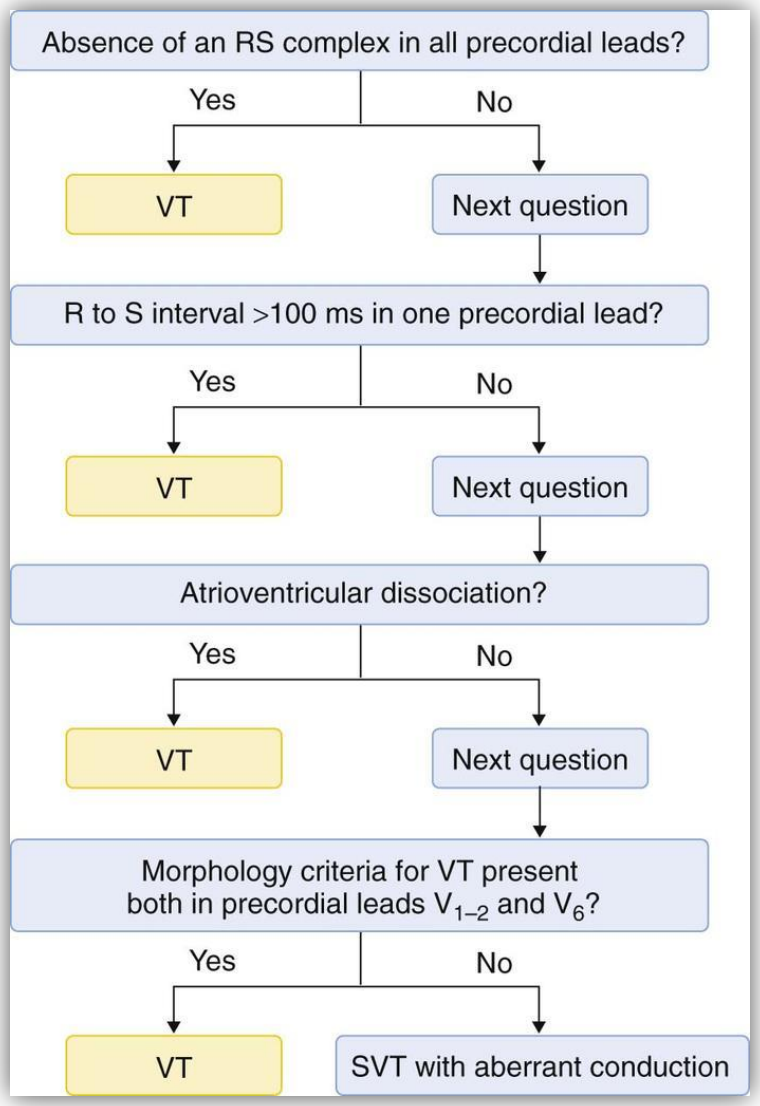
# What is your diagnosis?

1. Ventricular tachycardia
2. SVT with aberrant conduction
3. Antidromic AVRT
4. Atrial fibrillation with preexcitation
5. Nobody knows.

# 동율동 전환 후 심전도

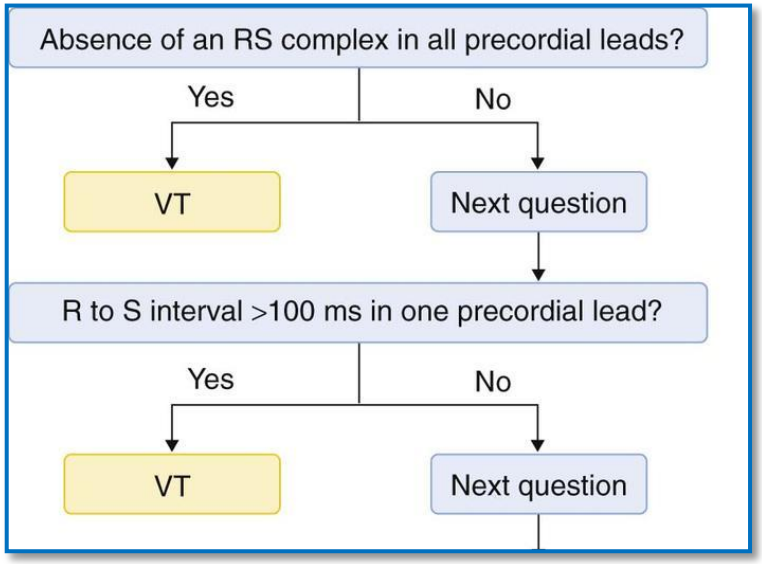


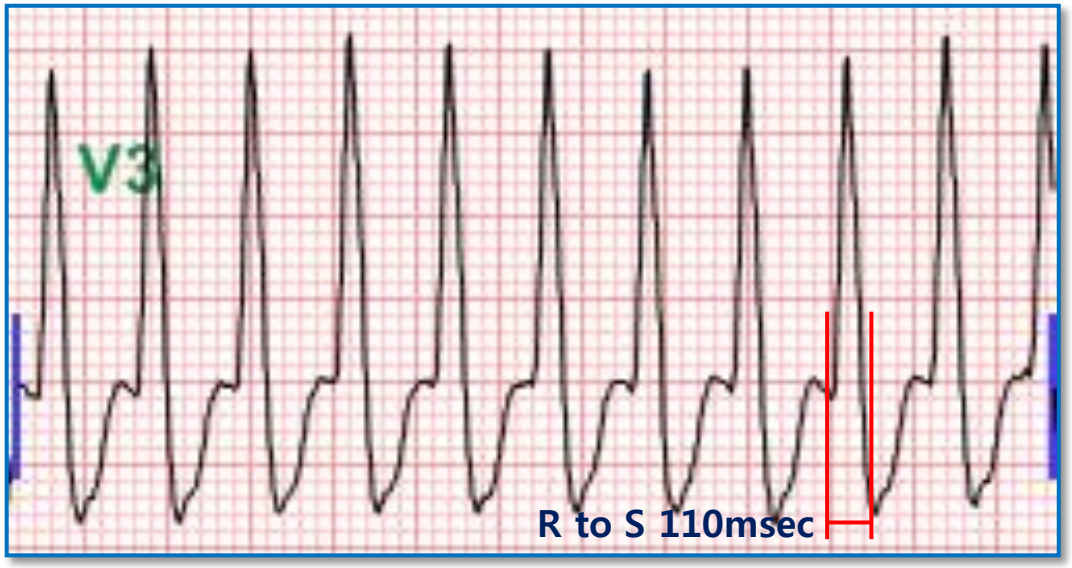
# Algorithm for distinguishing VT




*Brugada P et al., Circulation, 1991*

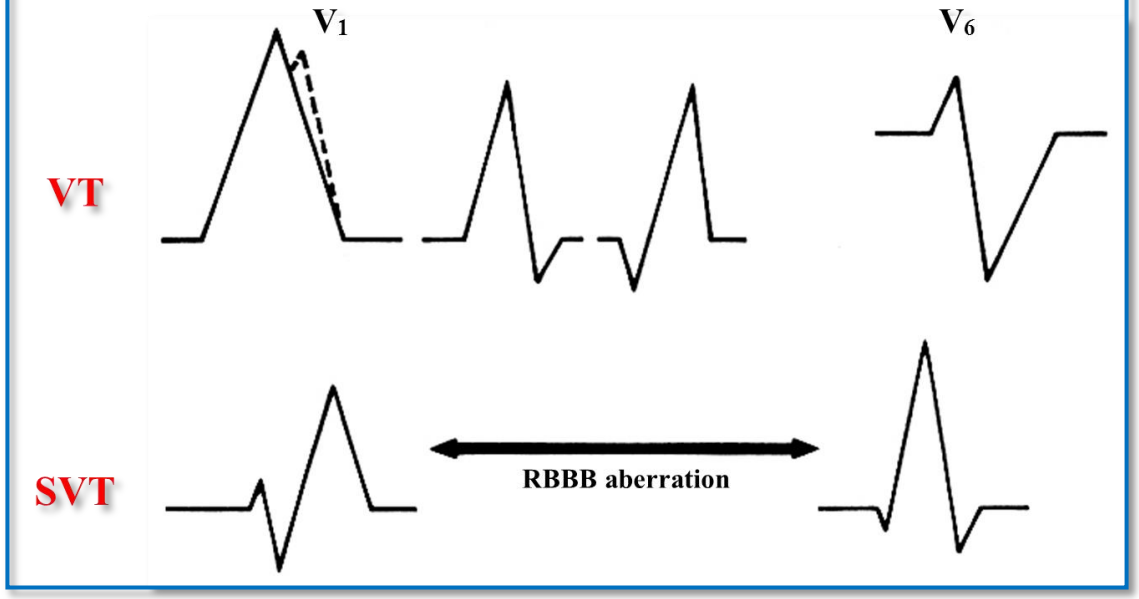
# RS complex in precordial leads

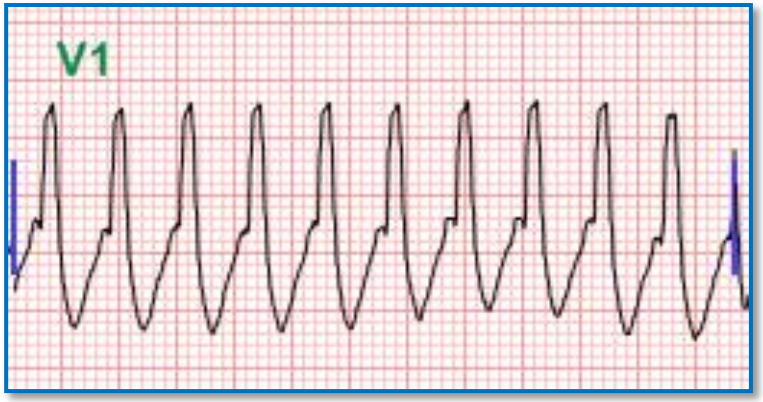


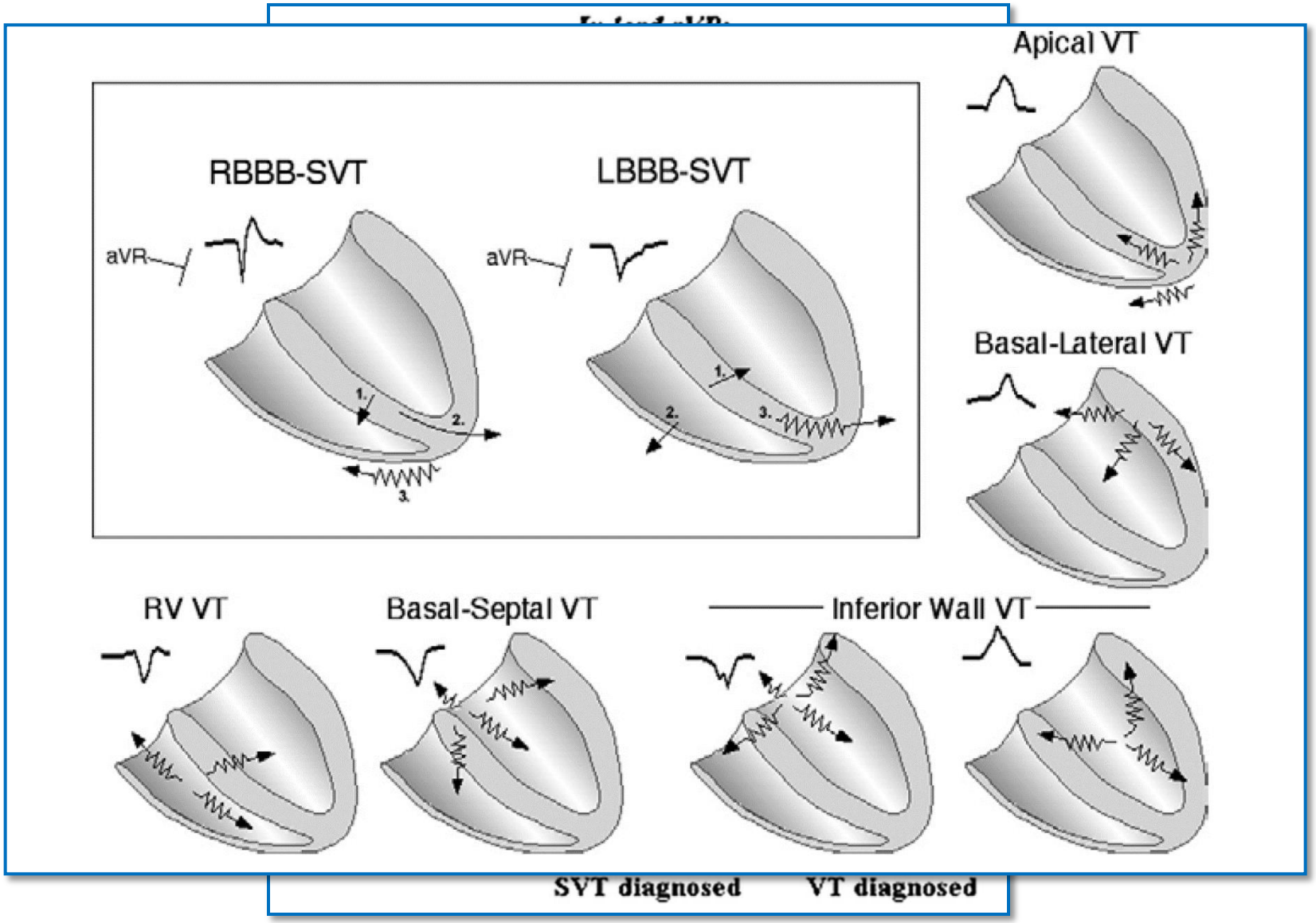
# Morphologic criteria for VT (RBBB)

- $V_1$: mono- or biphasic complex
- $V_6$: RS or QS, R/S ratio<1



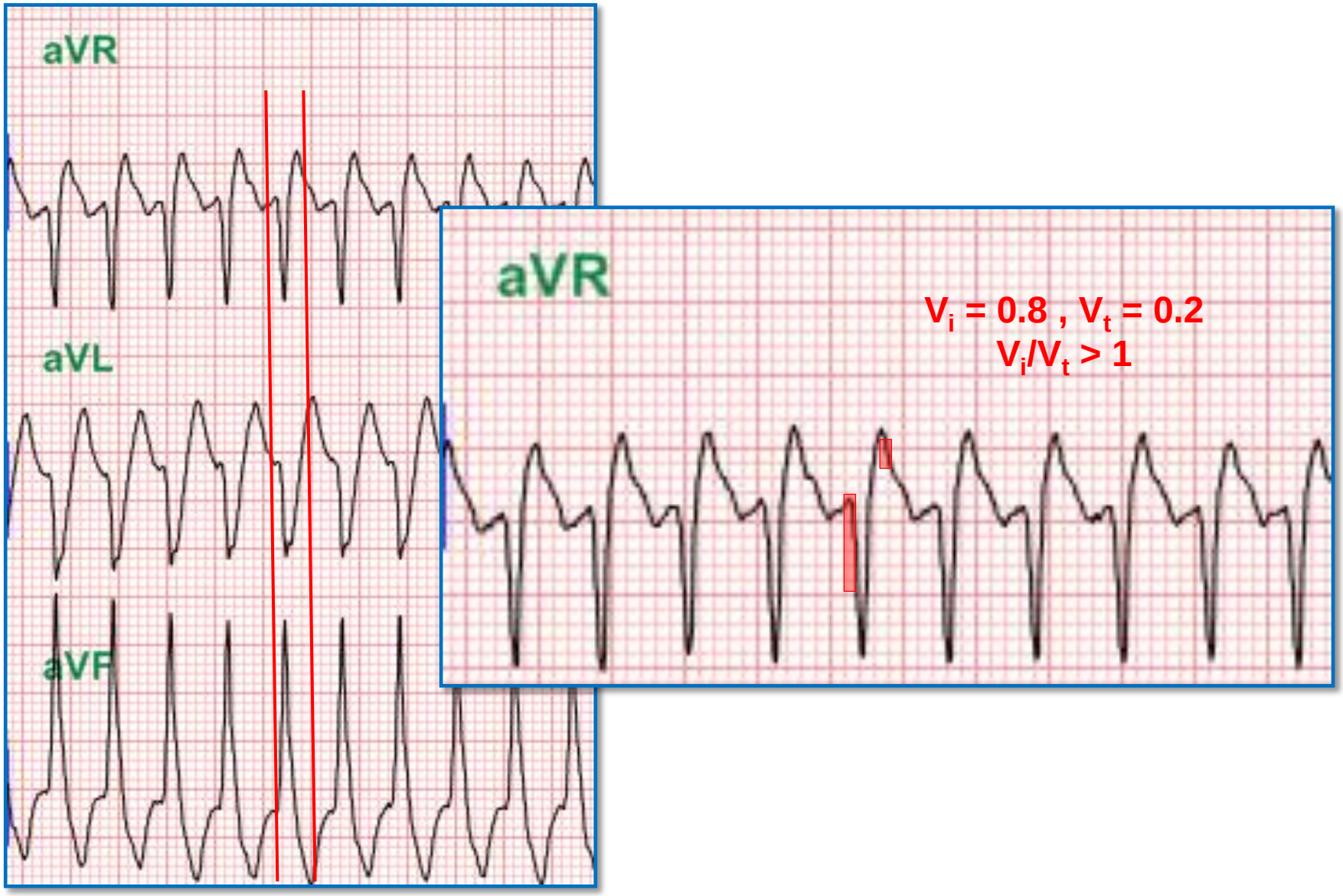




# New aVR Algorithm




*Vereckei A et al., Heart Rhythm 2008*

# New aVR algorithm

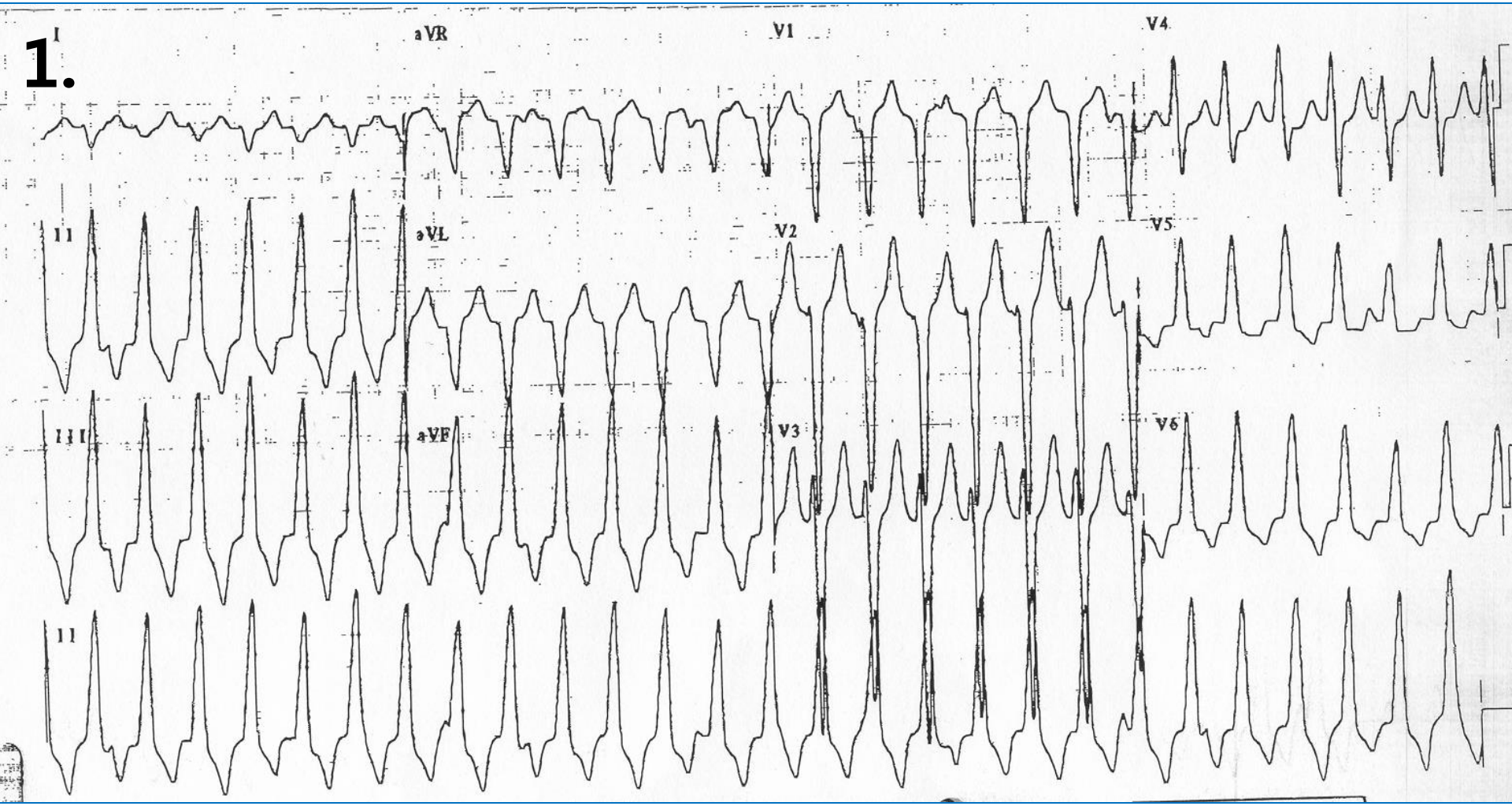


# AVRT using septal bypass tract

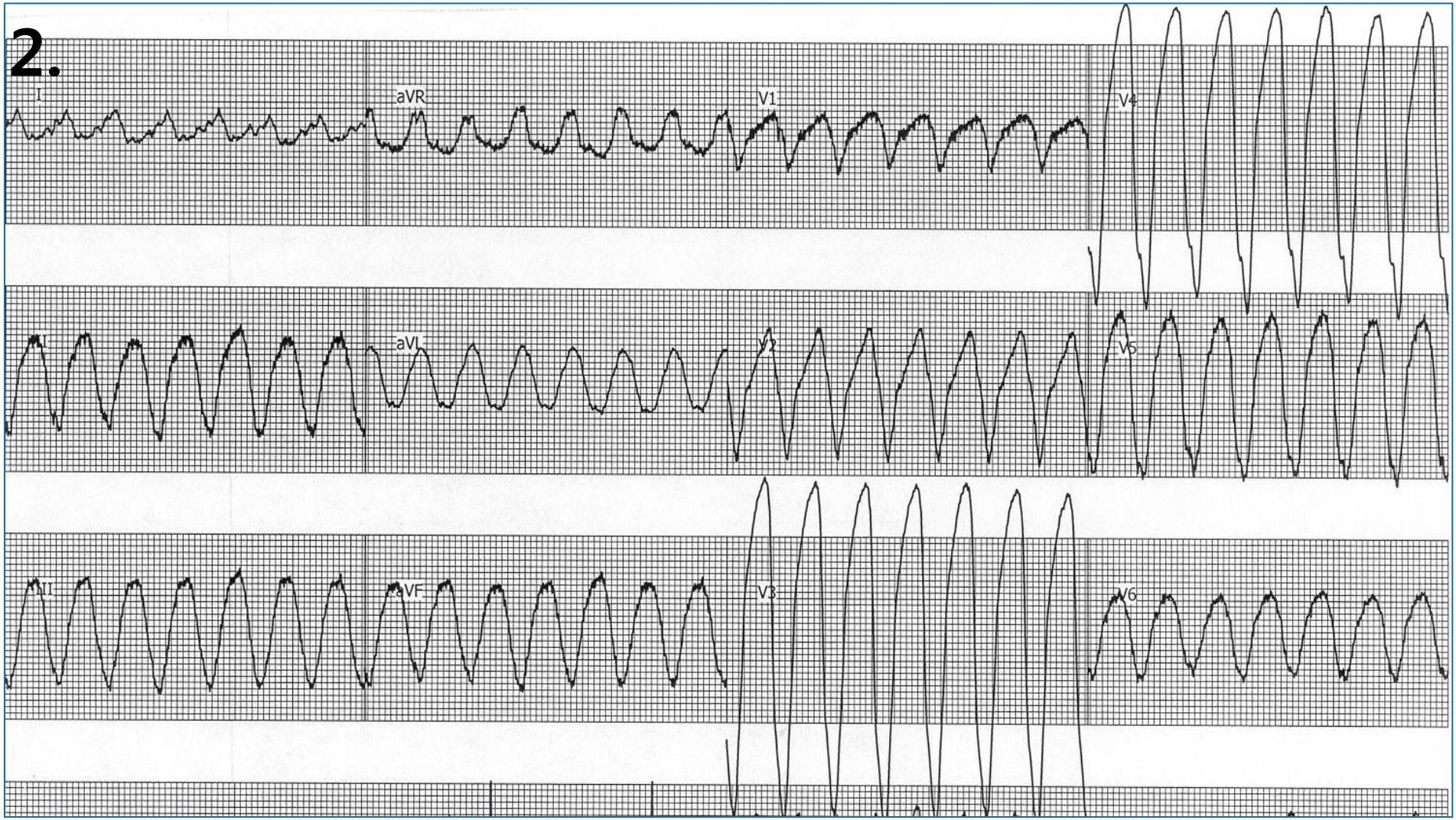
# Case 9.

## Which one is SVT among the following ECGs?

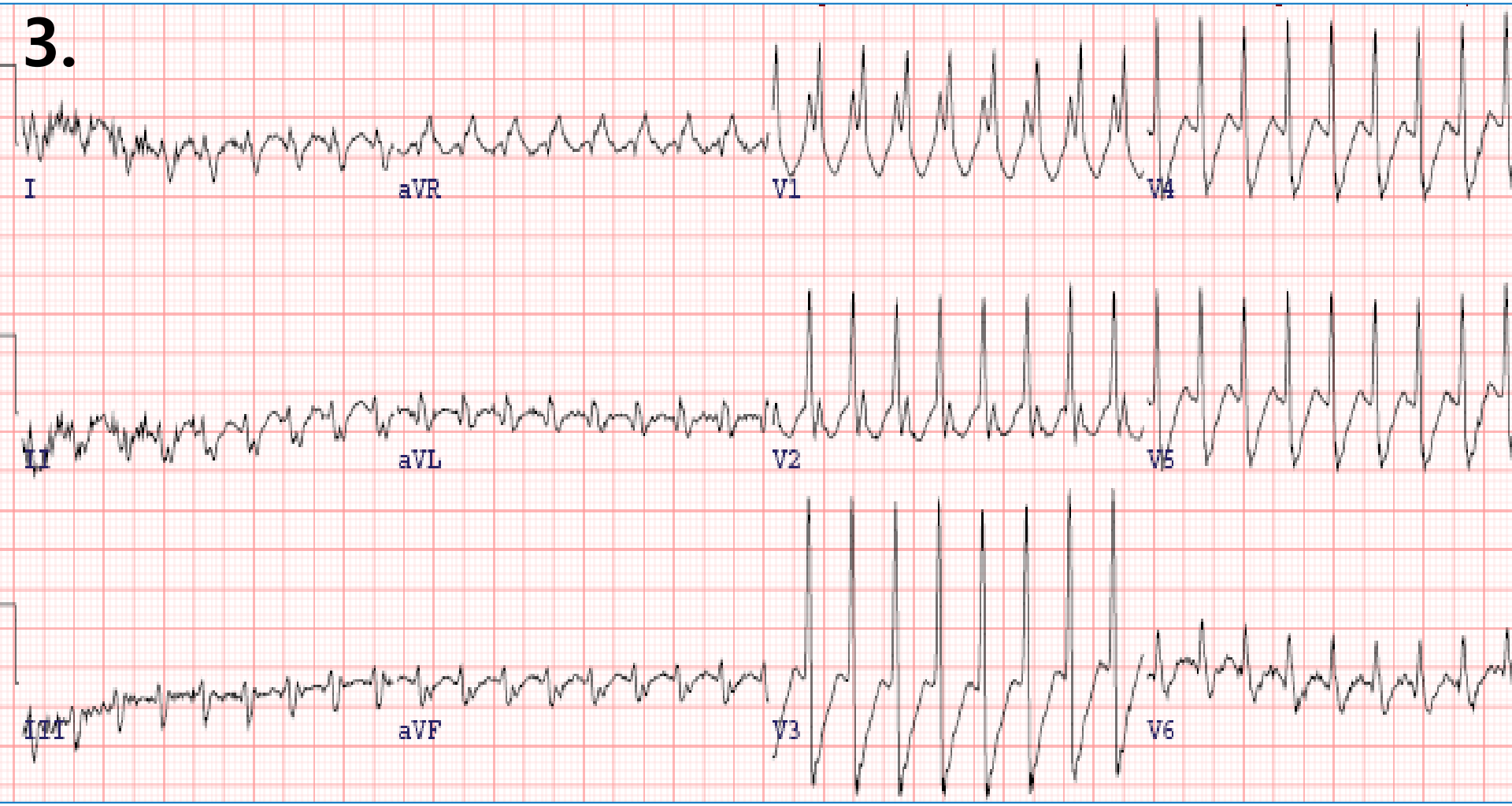
1.



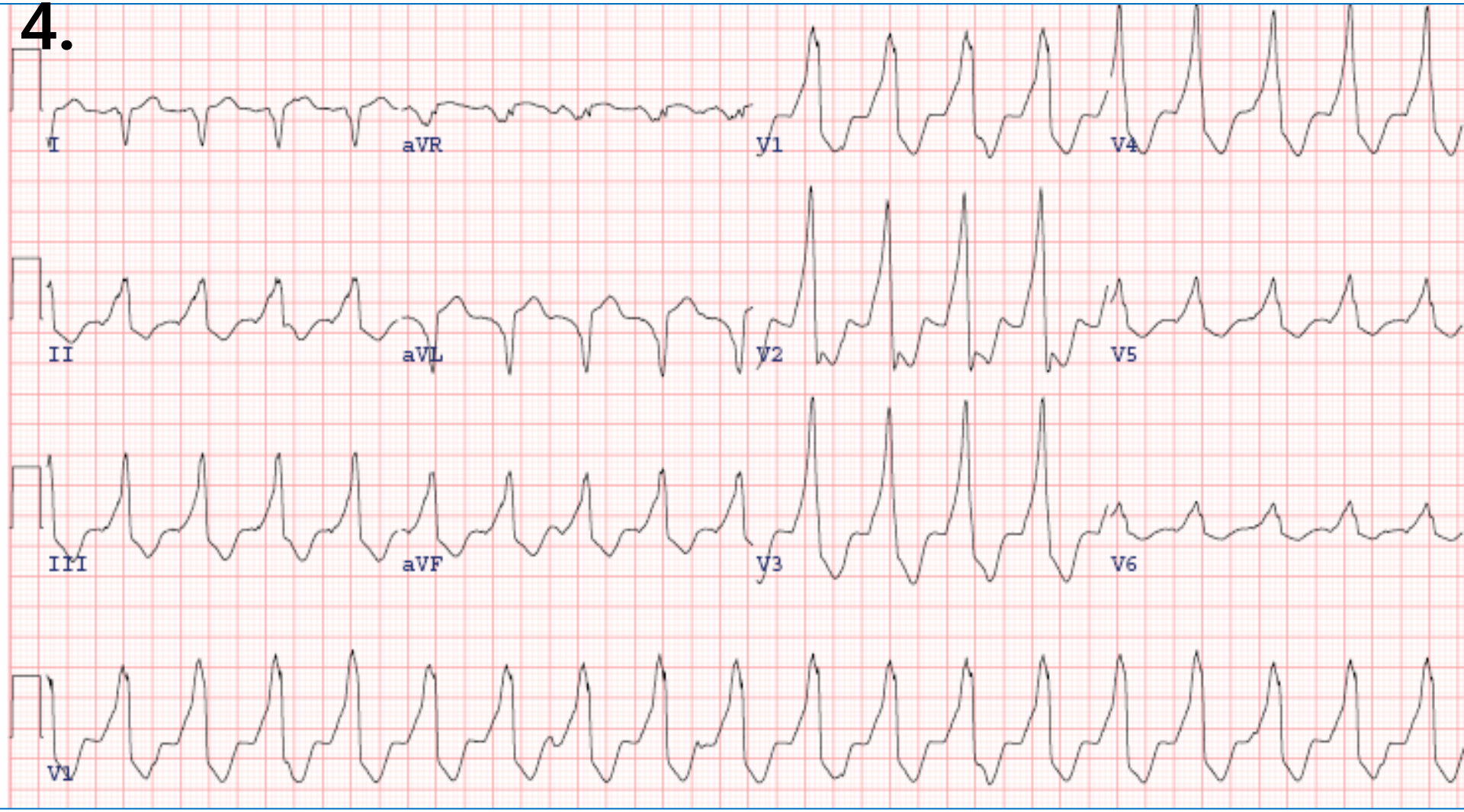
**2.**

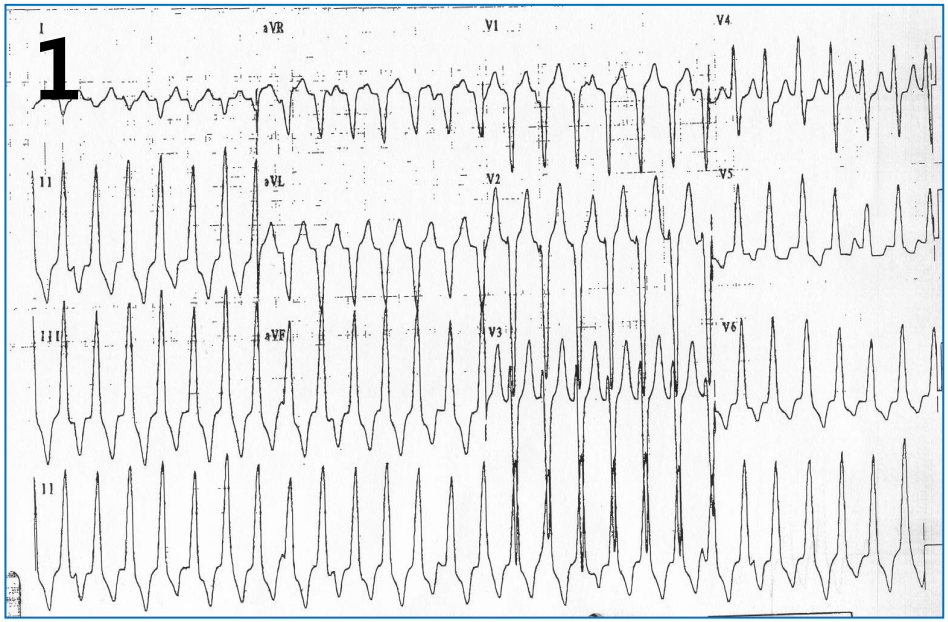


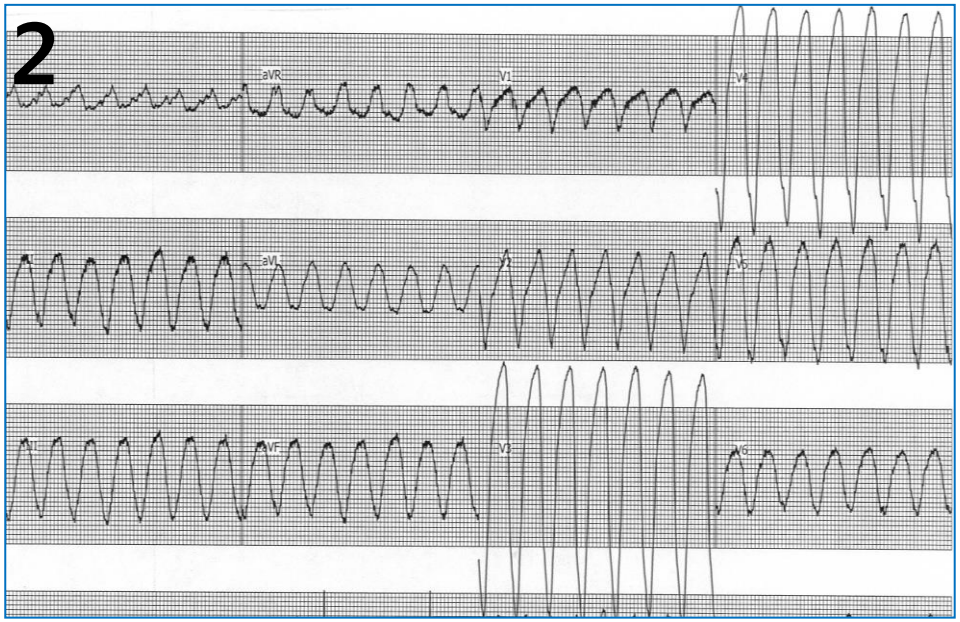
3.

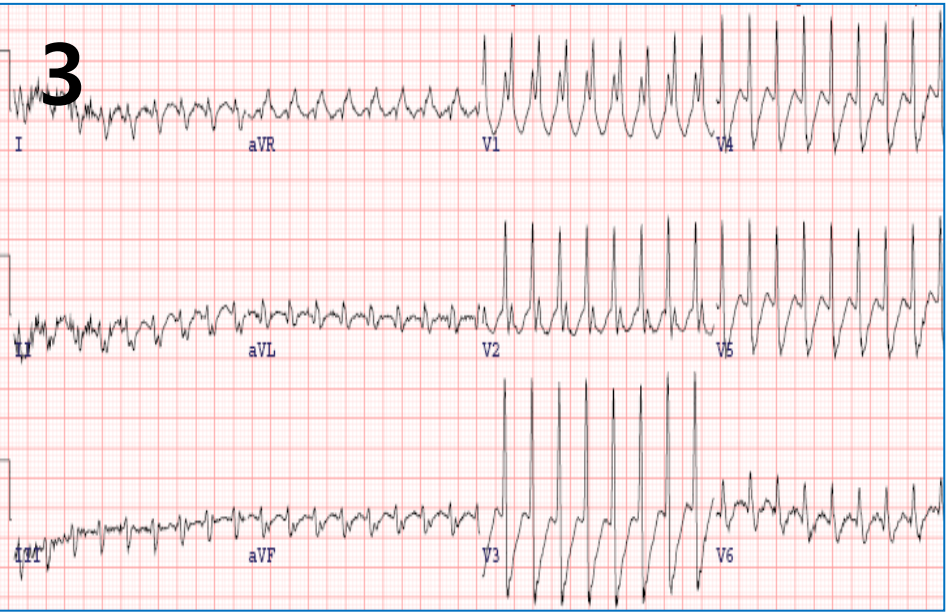


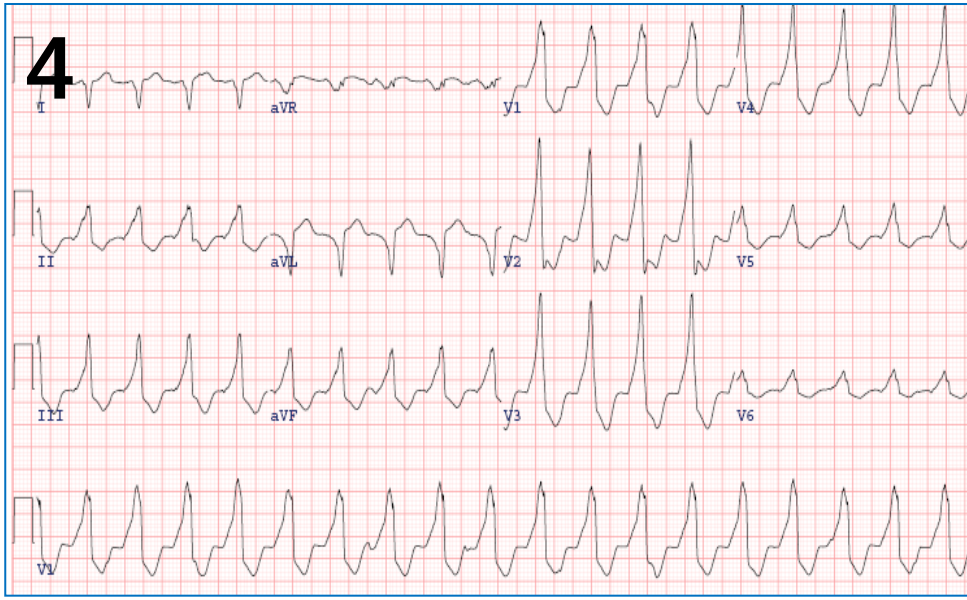
4.




1
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II


2
aVR
V1
aVL
aVF
V2

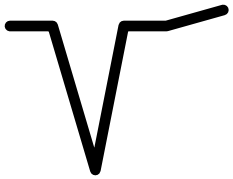

3
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6


4
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

# VT versus SVT Algorithm

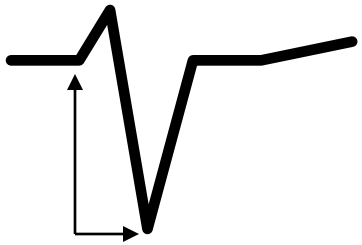
**AV dissociation** → Yes → VT

No ↓



Concordance through precordium → Yes → VT

No ↓



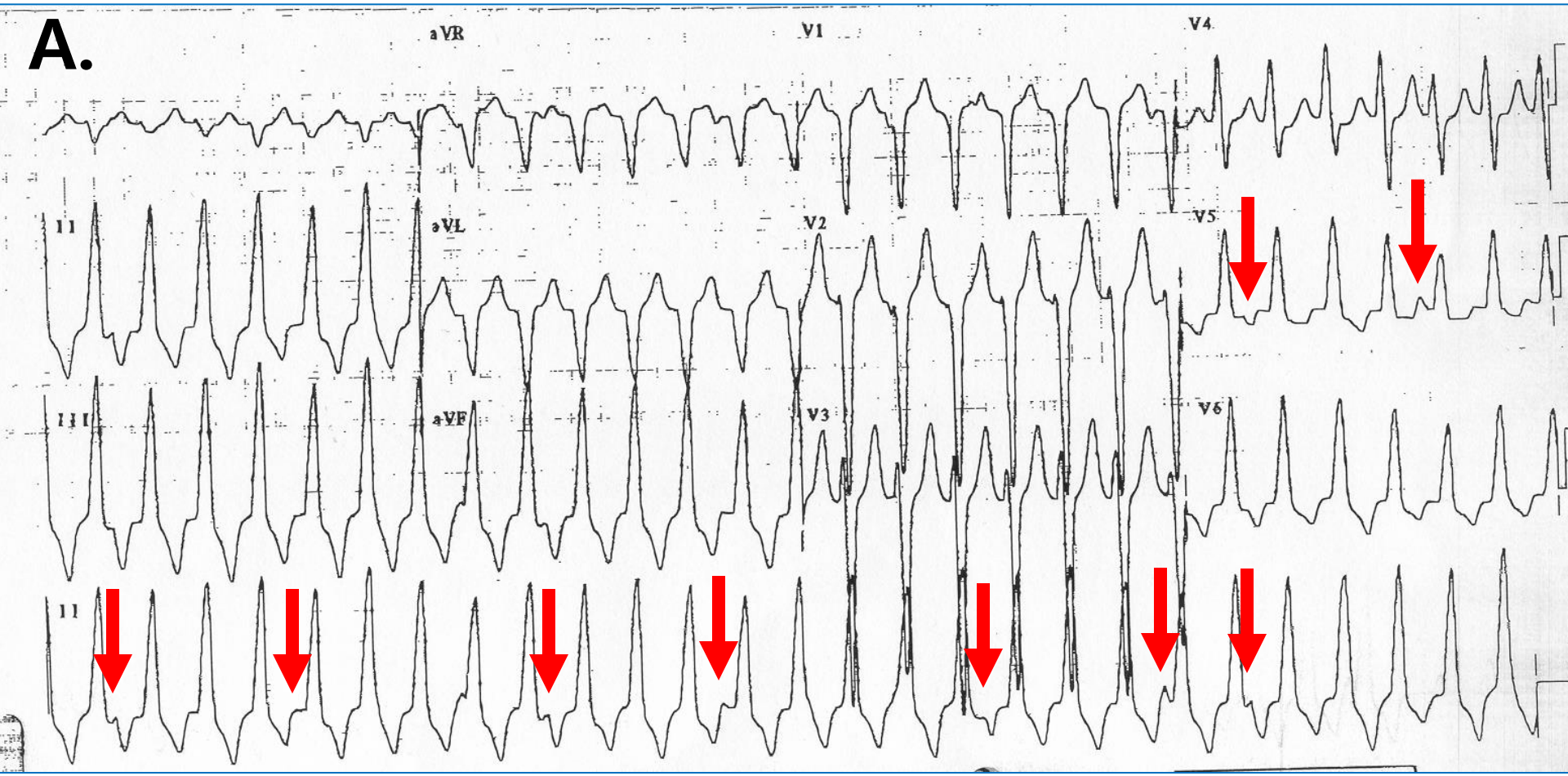
r-S > 100 ms in any of V1 to V6 → Yes → VT

No ↓

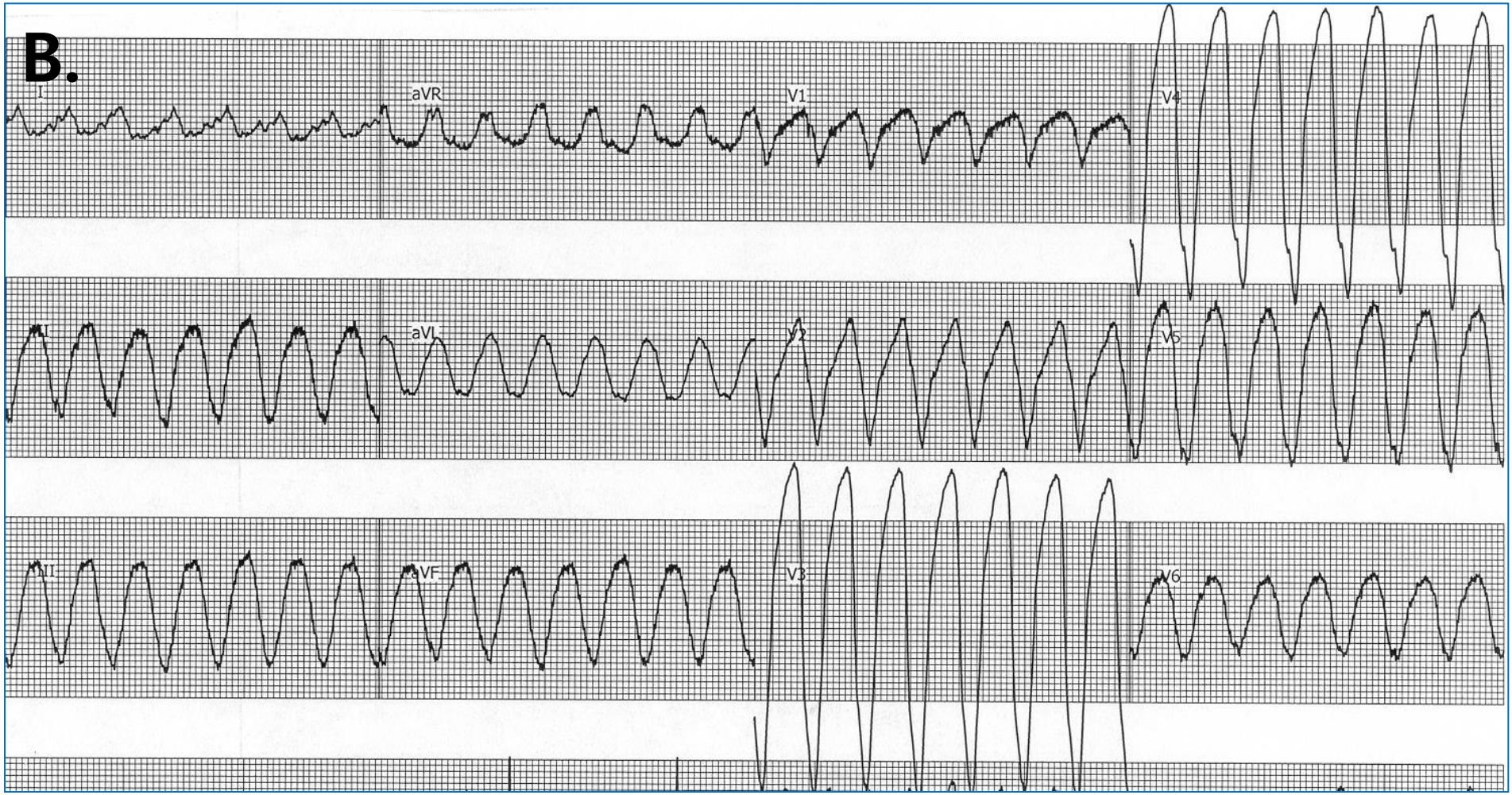
Proceed to morphology criteria for RBBB or LBBB QRS

Brugada et al, *Circulation* 1991

# AV Dissociation

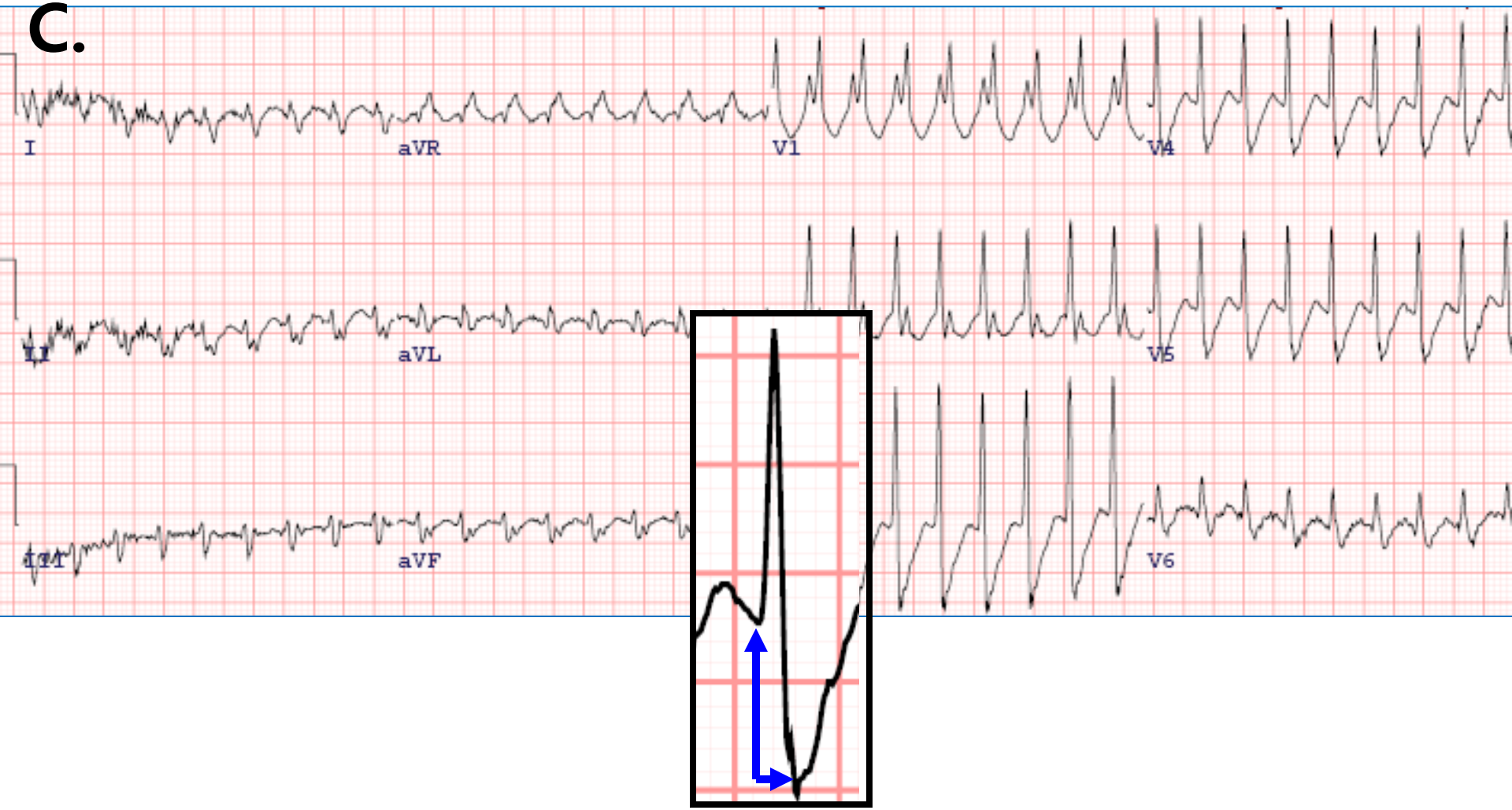


# Negative concordance



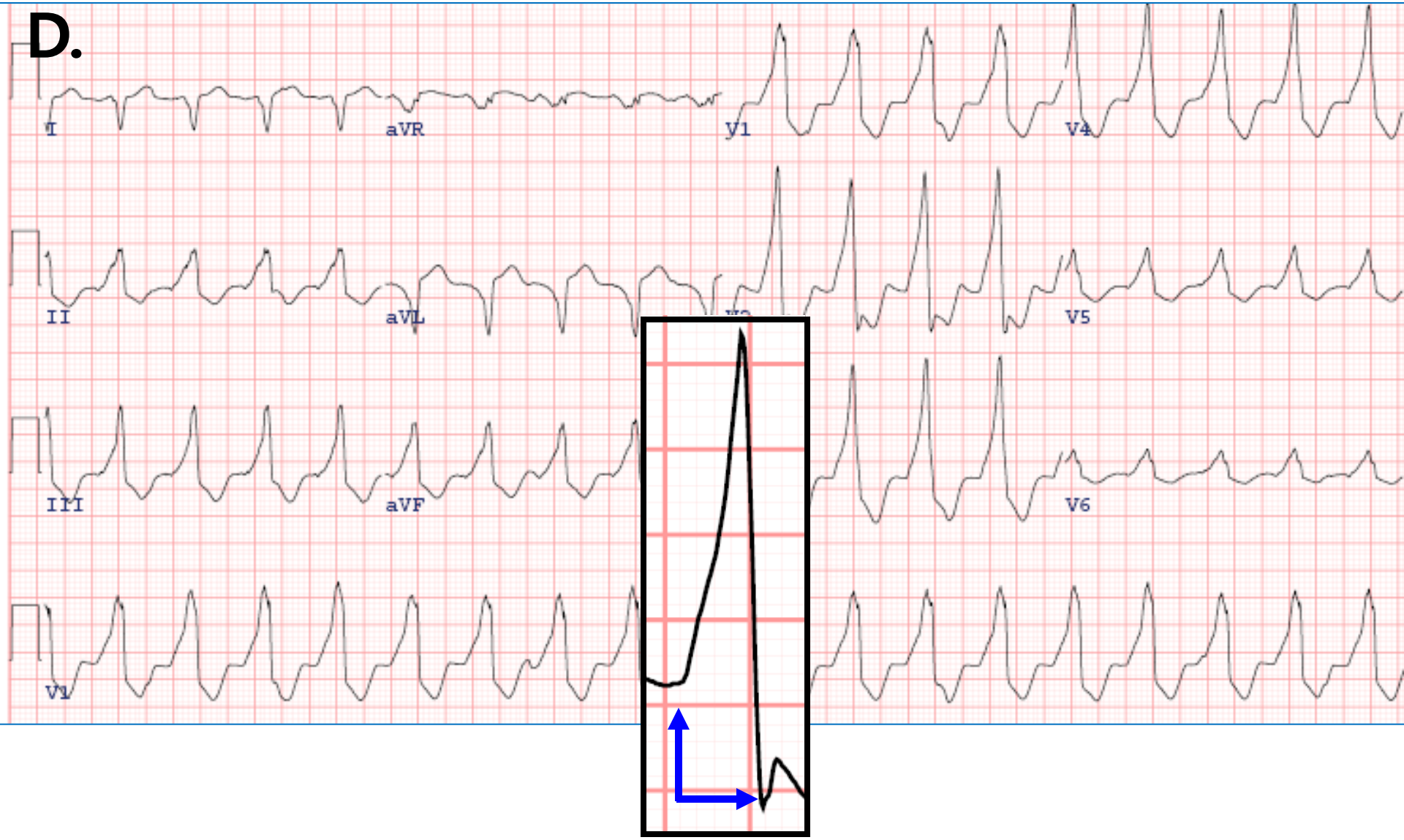
# SVT with Aberrancy

**C.**



# VT

D.



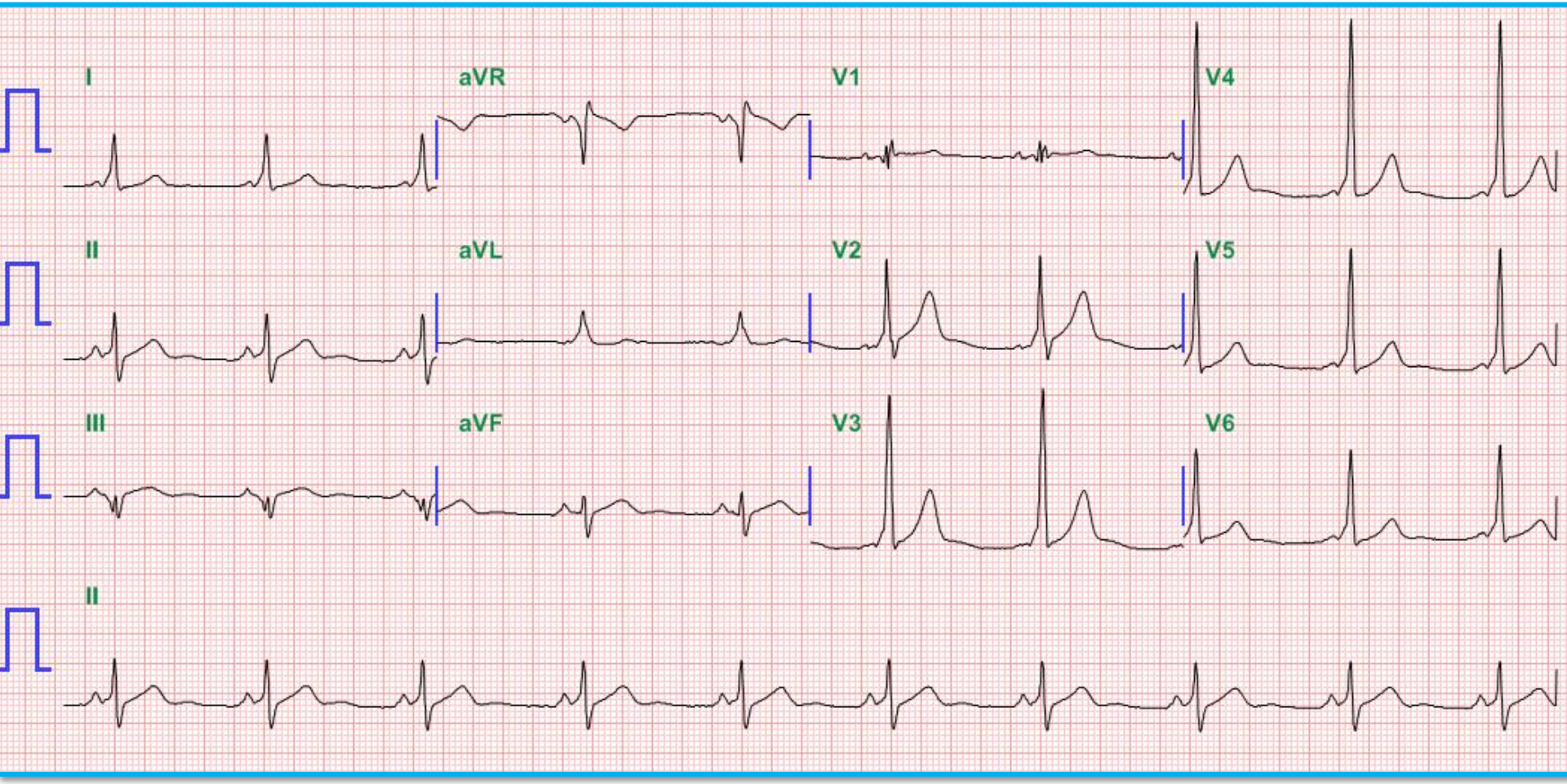
# Case 10.

**34/M**
**Palpitation during exercise**

# Choose incorrect treatment for this tachycardia.

1. IV procainamide or ibutilide
2. DC cardioversion if hemodynamic unstable
3. IV digitalis or calcium channel antagonist
4. Catheter ablation of the accessory pathways

# DC cardioversion 후 심전도

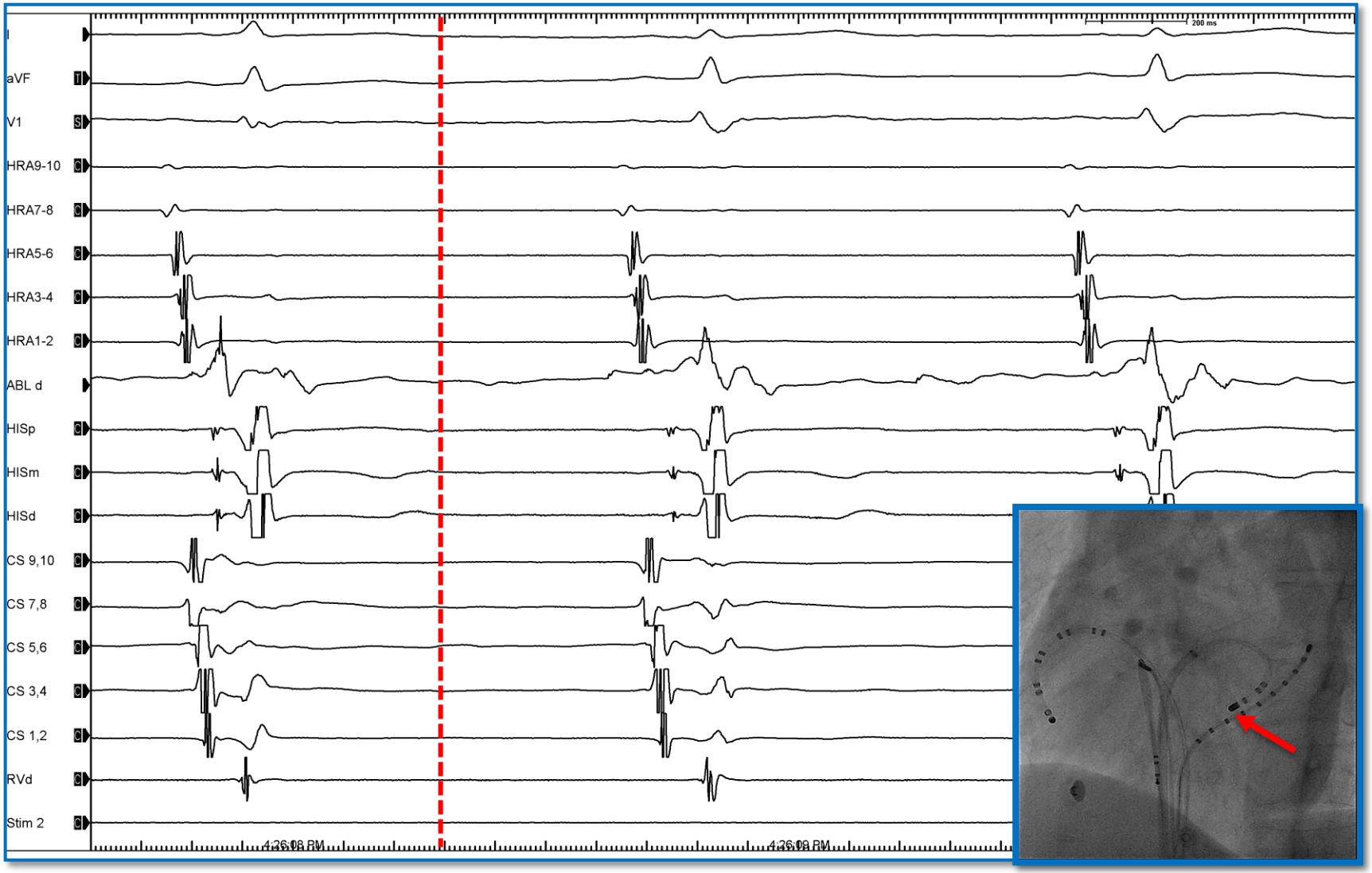


# Atrial fibrillation with WPW

- ✓ 20% of patients with WPW
- ✓ Accessory pathway allows for rapid conduction to ventricle
- ✓ Rapid ventricular rates may result in degeneration to VT or VF
- ✓ Treatment :
  - AV nodal blocking drugs (adenosine, CCB, B-blockers) may increase conduction via accessory pathway
    → Degeneration into VT or VF.
  - Hemodynamically unstable : DC cardioversion
  - Hemodynamically stable : Medical treatment(procainade or ibutilide)

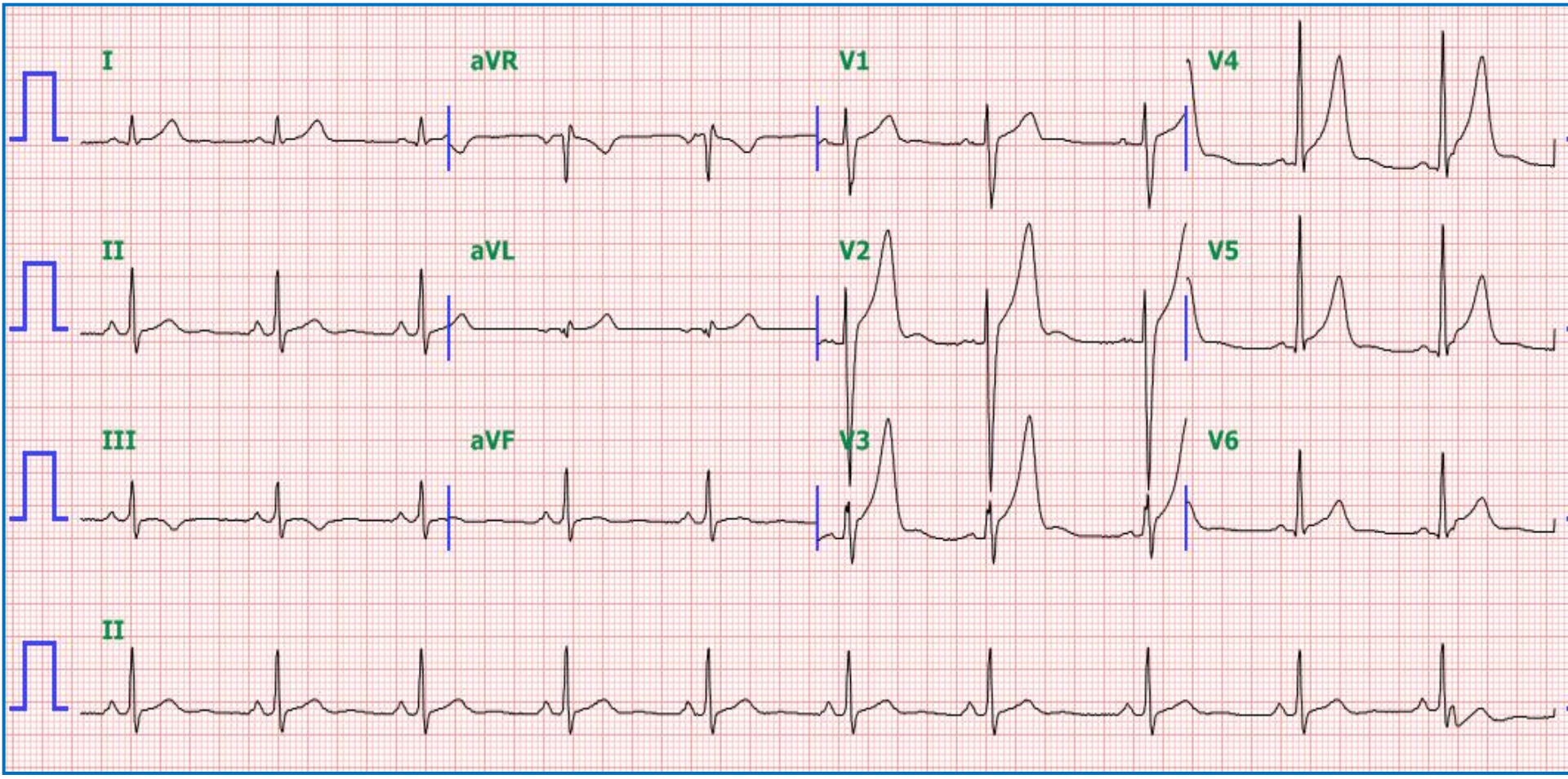
*Bonow RO et al, Braunwald's Heart disease, 9th edtion, 2012*
*Brady WJ et al, Acute care electrocardiography. 2009*

# Radiofrequency catheter ablation




**WPW (Left posteroseptum)**

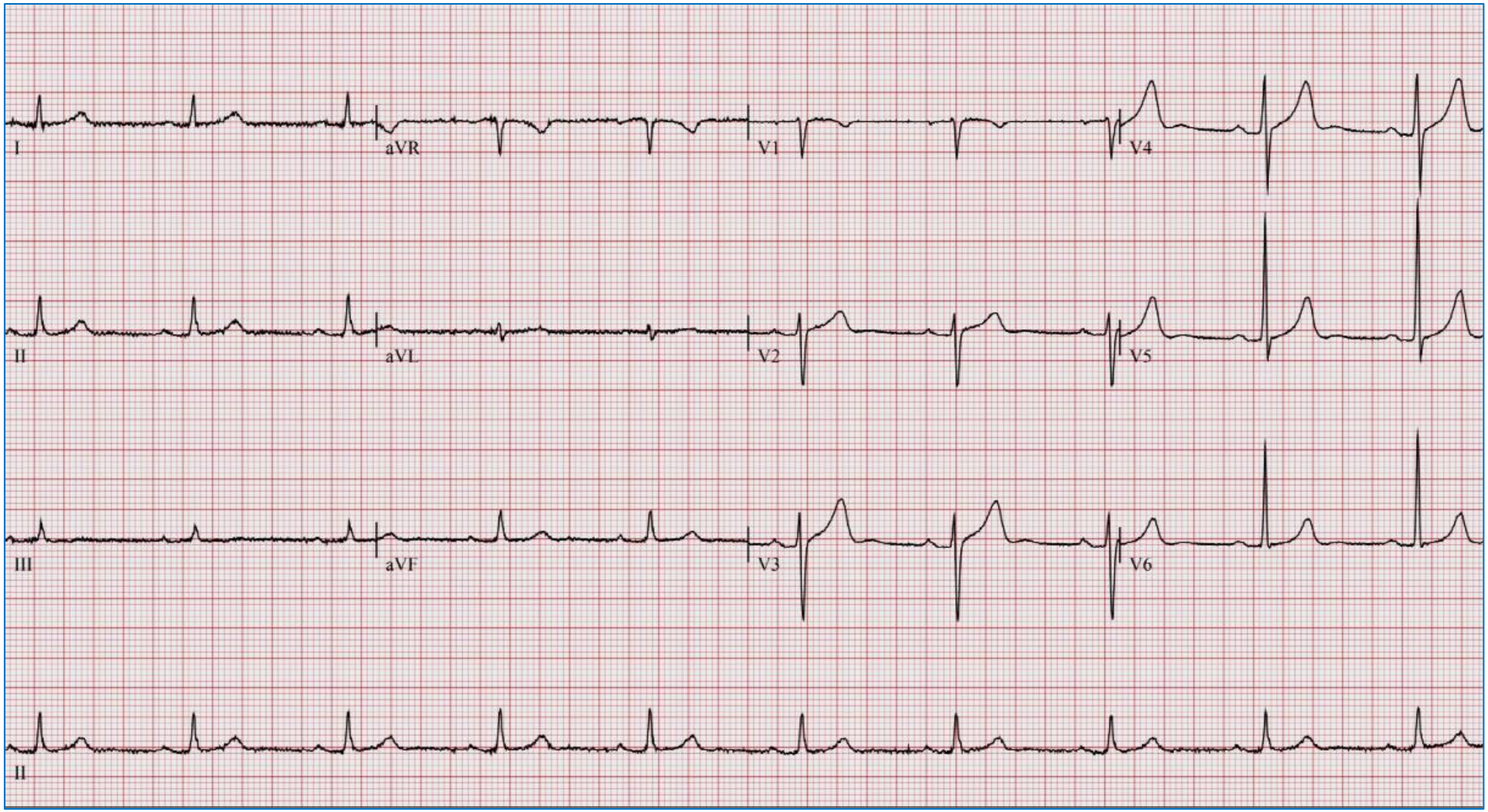
# Catheter ablation 후 심전도



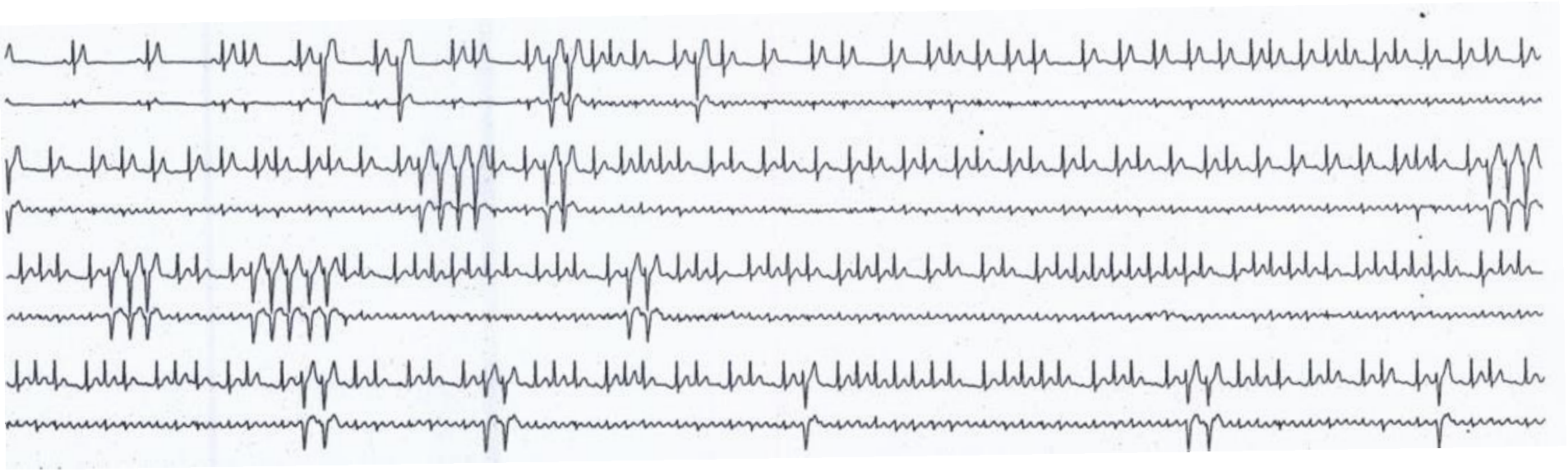
# Case 11.

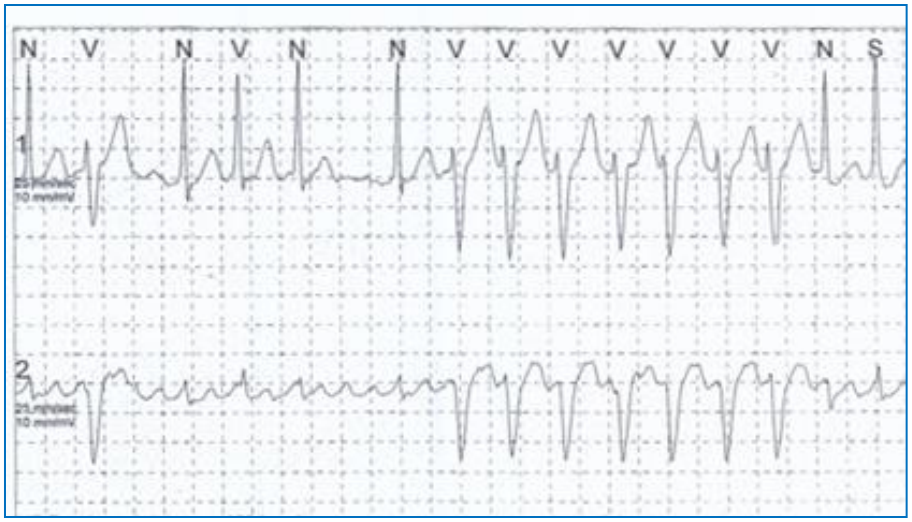
**74/M**

**Syncope after palpitation**



# Holter monitoring



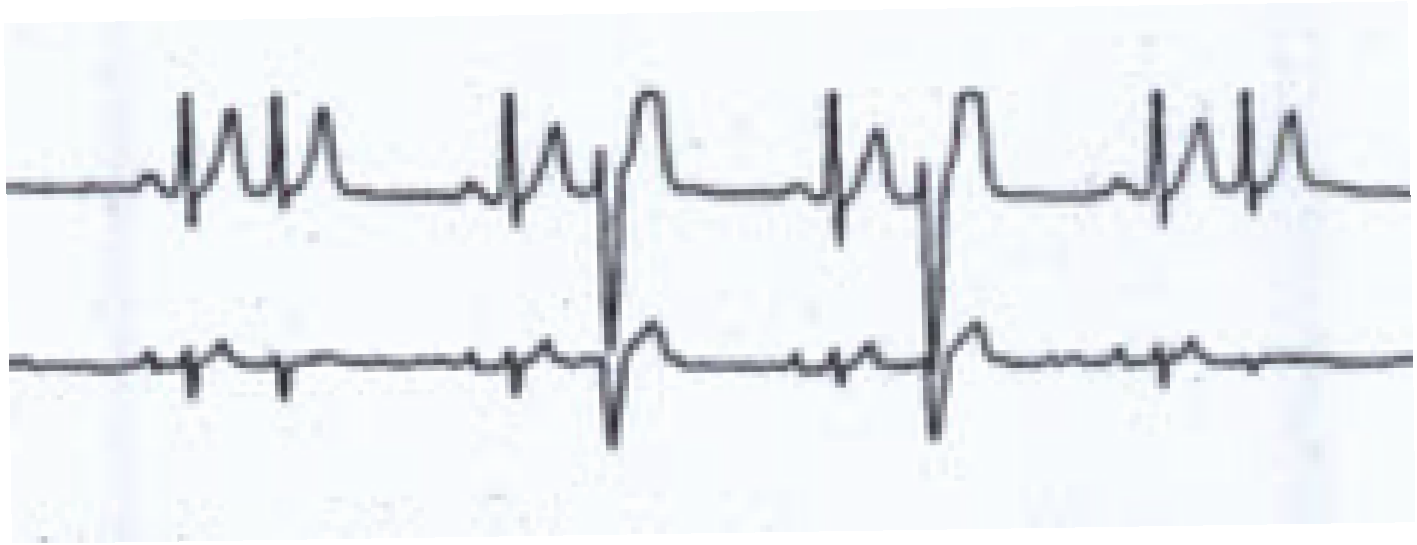



# What is the mechanism of wide QRS tachycardia on holter monitoring?

1. Non sustained VT
2. Atrial fibrillation with aberrant conduction

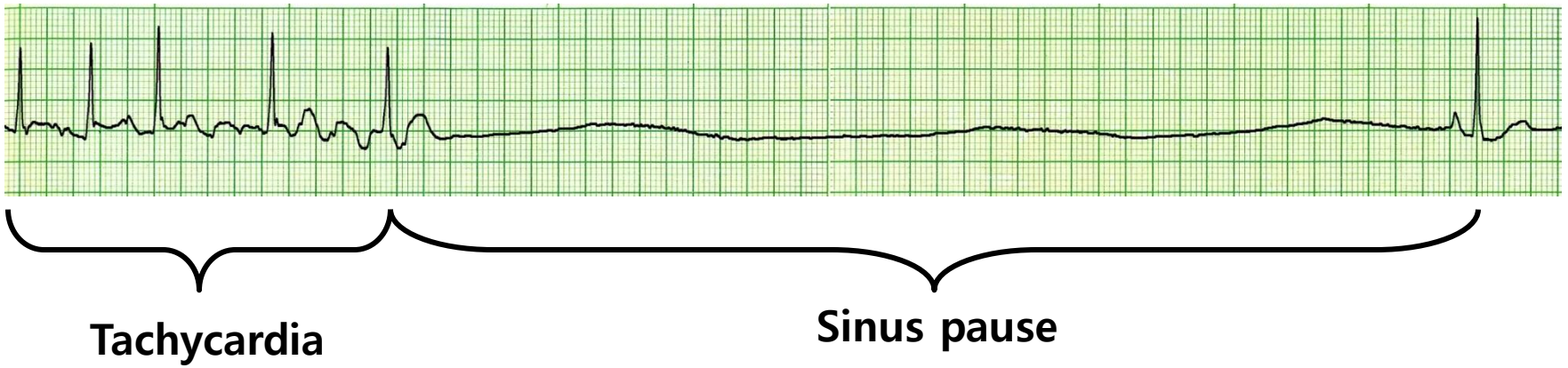
# Ashman phenomenon

- Wide QRS complexes that follow a short R-R interval preceded by a long R-R interval
- Represents an aberrantly conducted complex rather than a complex that originates in ventricle
- Refractory period of bundle branch is proportional to the R-R interval of the preceding cycle



# Telemetry monitoring : dizziness

# Tachycardia-bradycardia syndrome




- Sinus pause following termination of paroxysmal supraventricular tachyarrhythmia

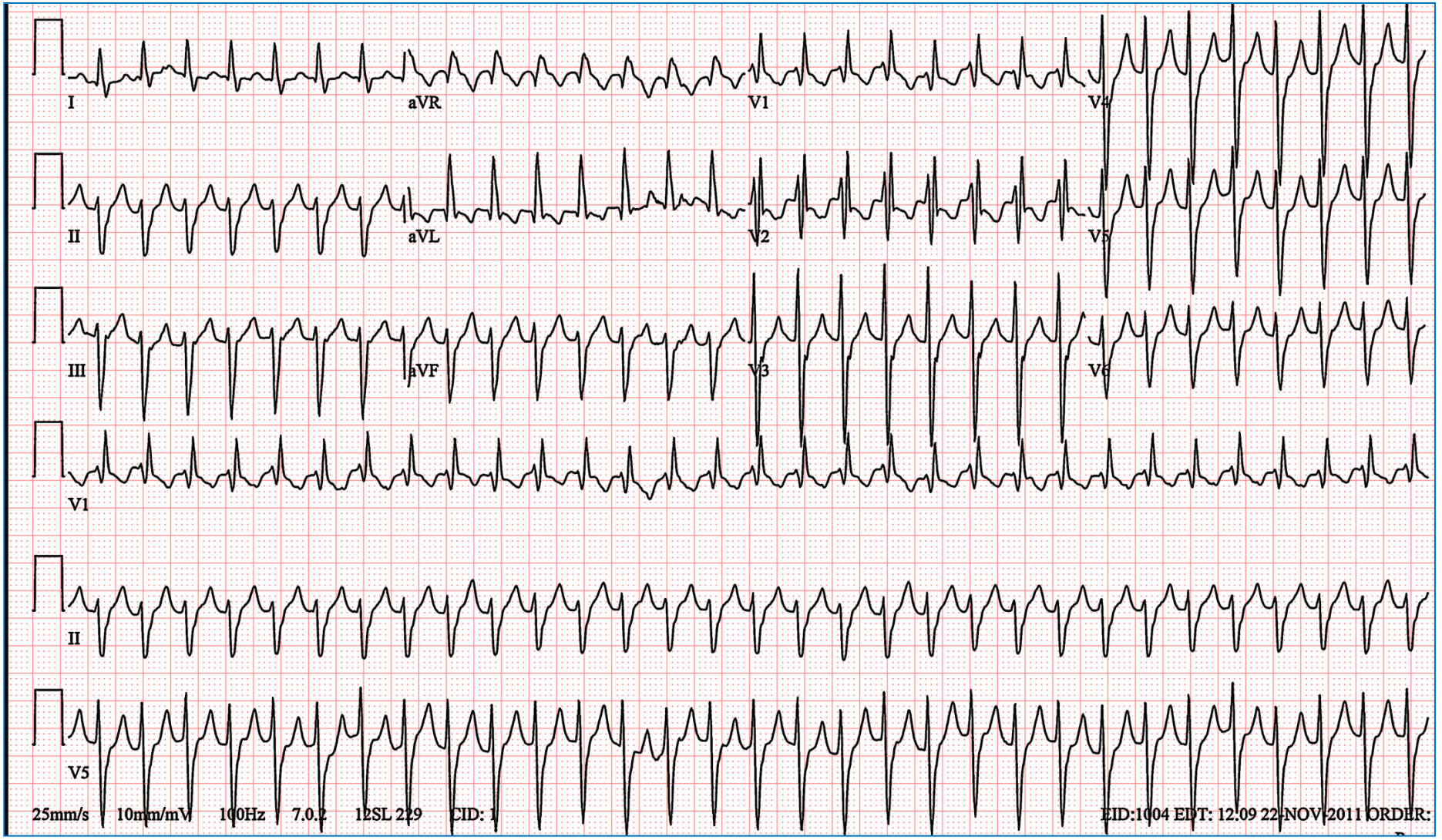
# What is proper management of this patient?

1. PPM insertion with antiarrhythmic drug
2. Ablation of atrial fibrillation
3. All of above

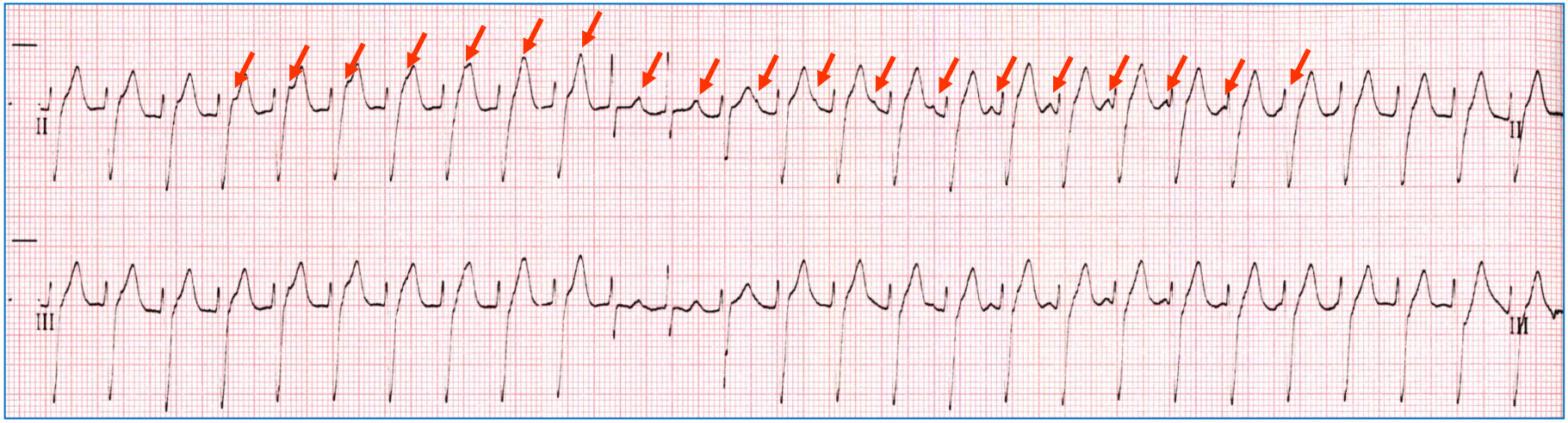
# Case 12.

**13/F, s/p RSO d/t immature teratoma**
**Chest discomfort**

BP 90/50mmHg



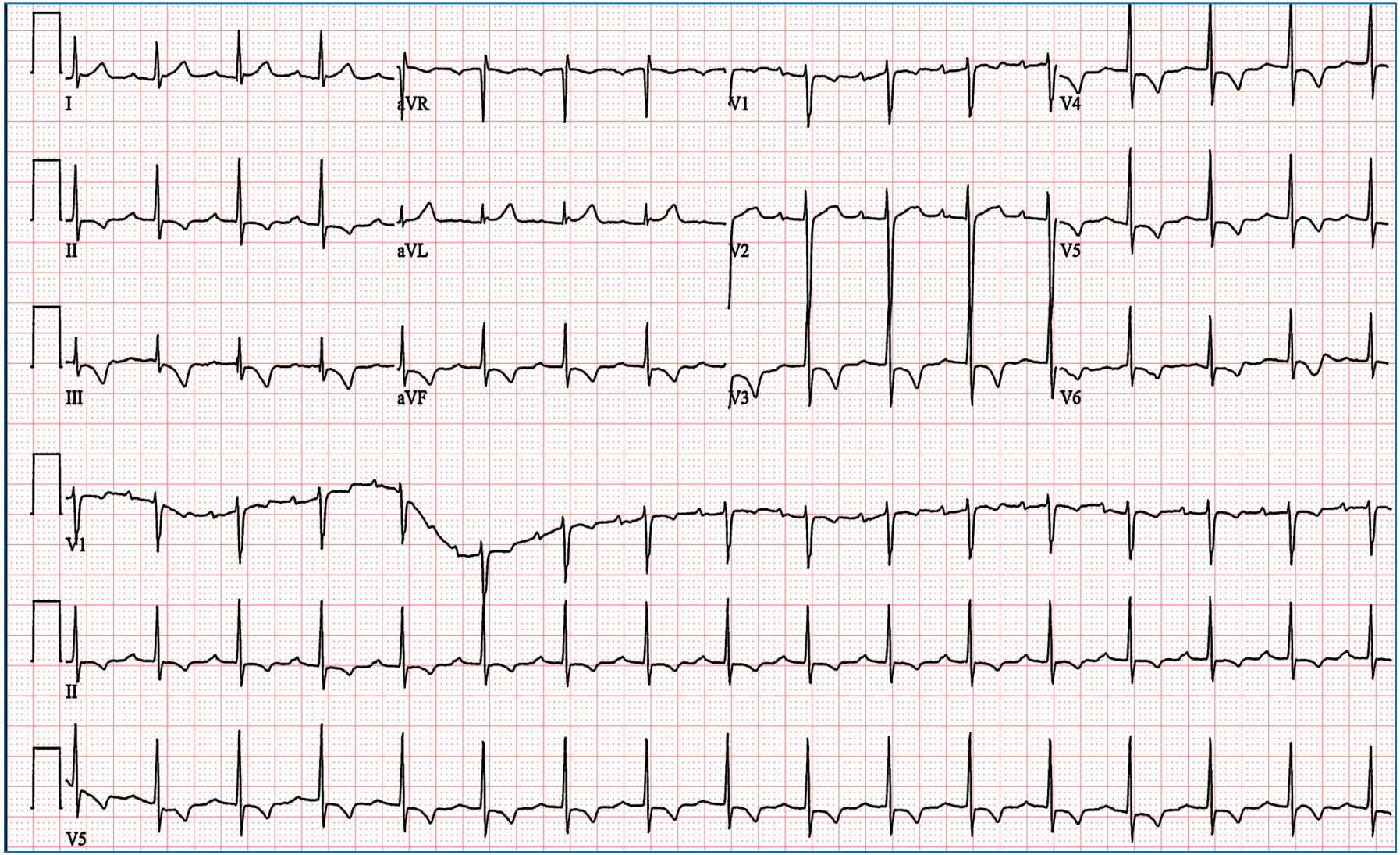
# Rhythm strip




What is the correct finding on ECG Rhythm strip?

1. Wide QRS tachycardia
2. VA dissociation
3. Capture beat
4. Fusion beat
5. All of above

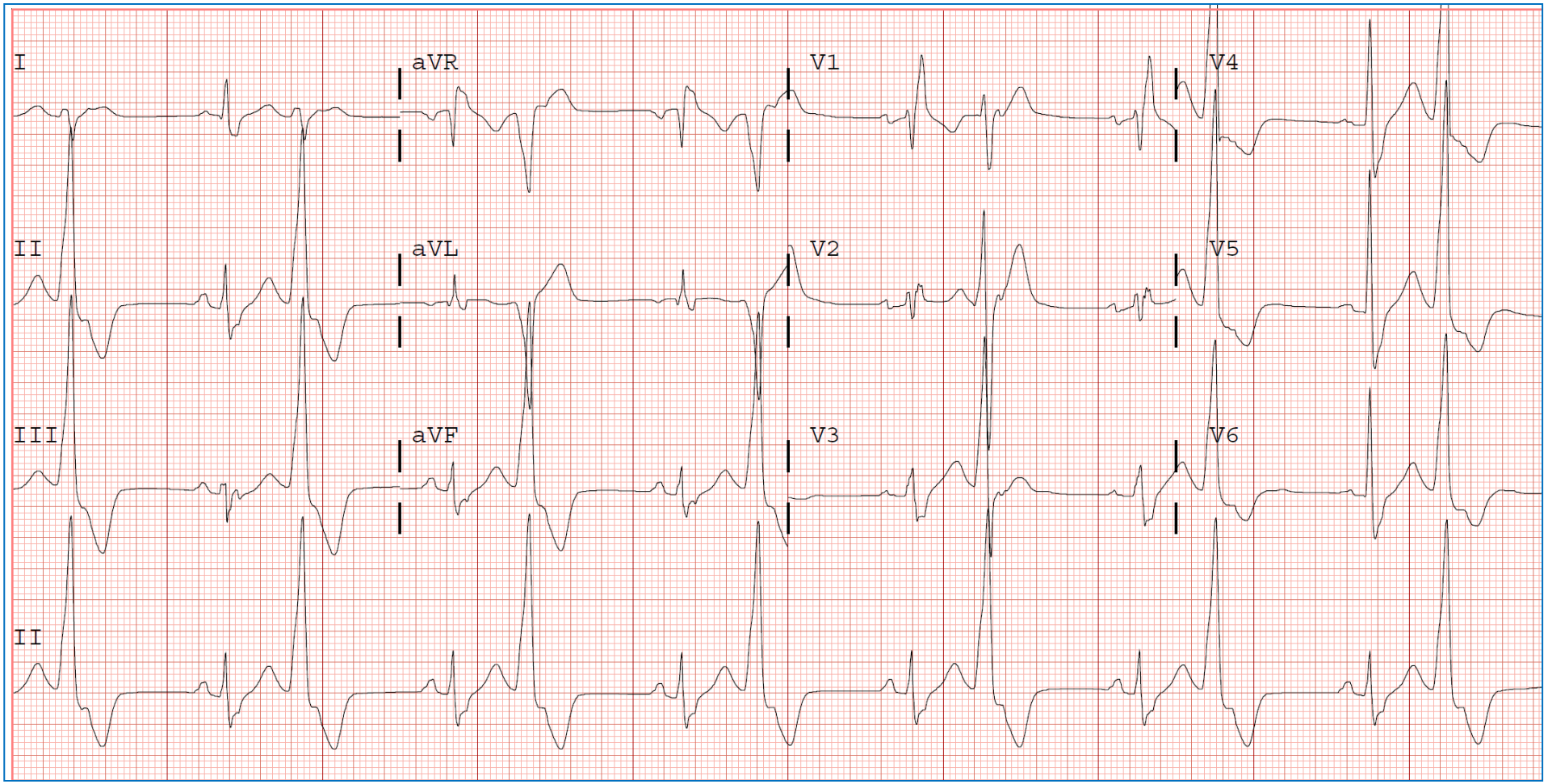
# ECG after verapamil 10mg



# Case 13.

**60/M**

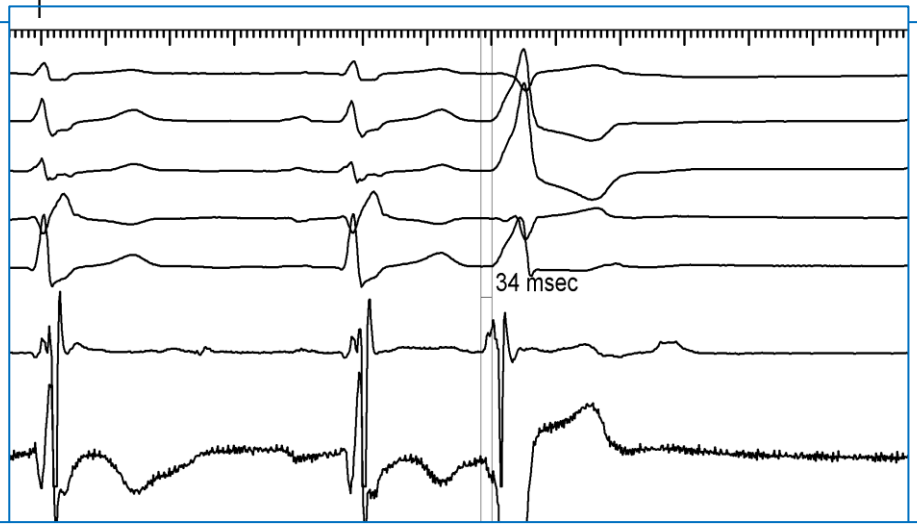
**Dyspnea, bradycardia**

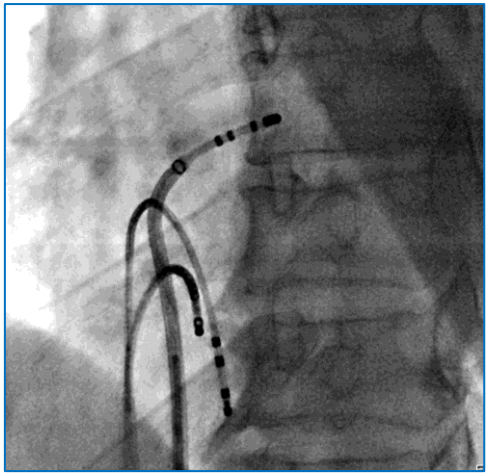


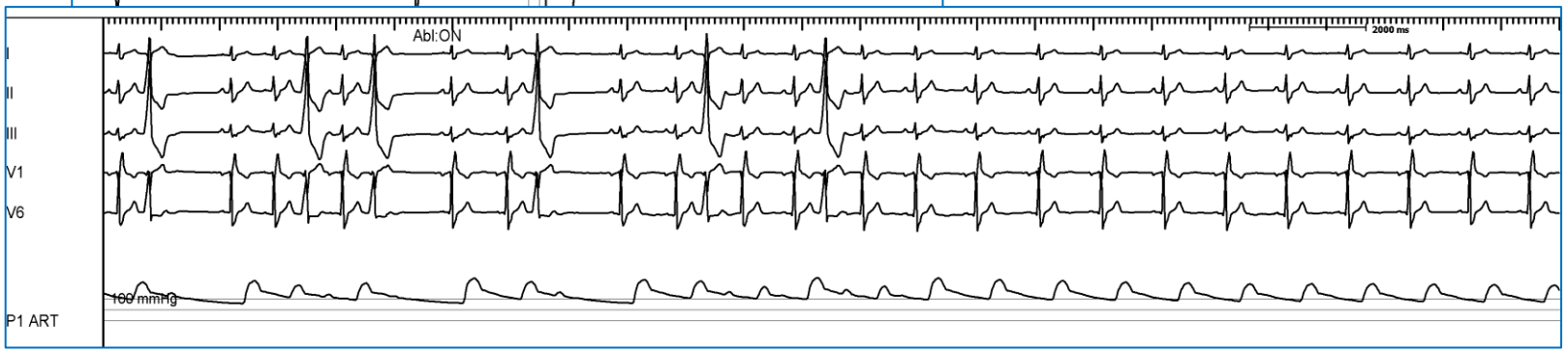
# What is your diagnosis?

1. Sinus rhythm + alternating bundle branch block
2. Sinus rhythm + RBBB + PVC bigeminy
3. Sinus rhythm + RBBB + APC bigeminy with aberrant conduction
4. Sinus rhythm + LBBB + PVC bigeminy

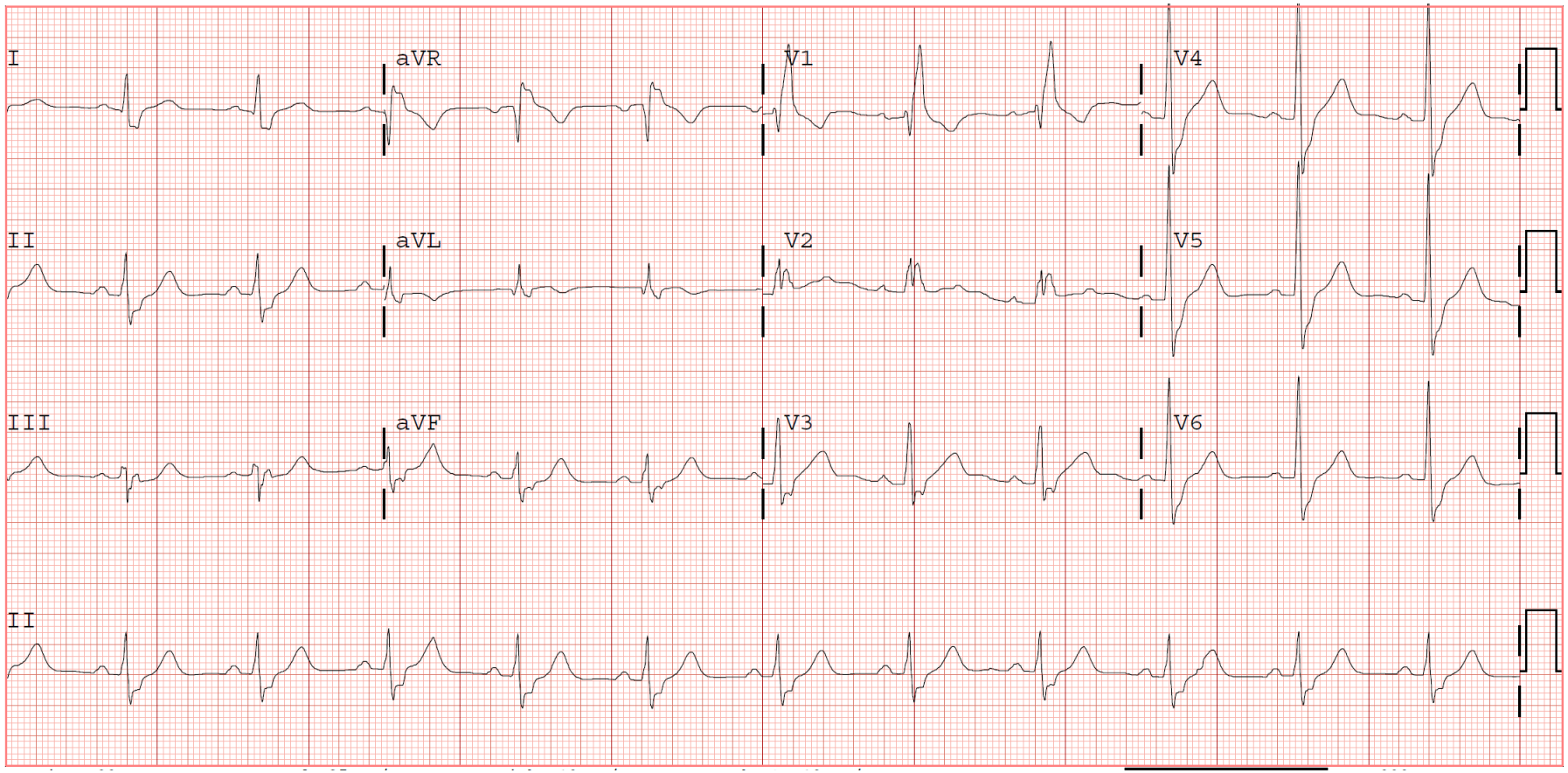

500 ms
I
II
III
V1
V6
HIS 4
HIS 3
HIS 2
HIS 1
RVa d
100 mmHg
P1 ART


34 msec




Abl:ON
2000 ms
I
II
III
V1
V6
100 mmHg
P1 ART

# 치료 후

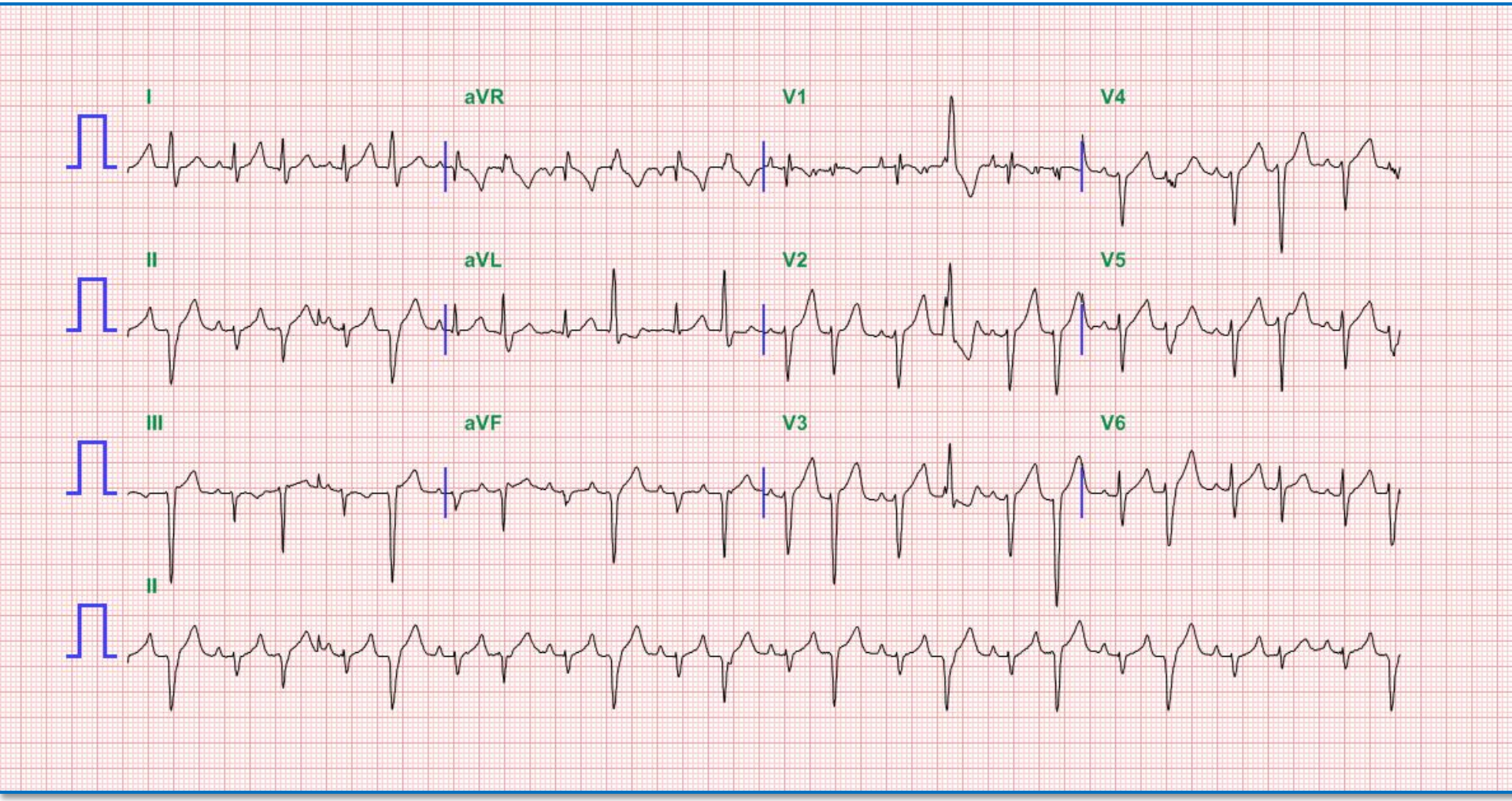


# F/U Echocardiogram

| | Before RFCA | After RFCA |
|---|---|---|
| LVEF, % | 41 | 59 |
| LVESD, mm | 54 | 39 |
| LVEDD, mm | 68 | 50 |
| No of PVC/day | 47549 | 3 |
| % PVC | 44.76 | 0.00 |
| Triplet/day | 59 | 0 |

# Case 14.

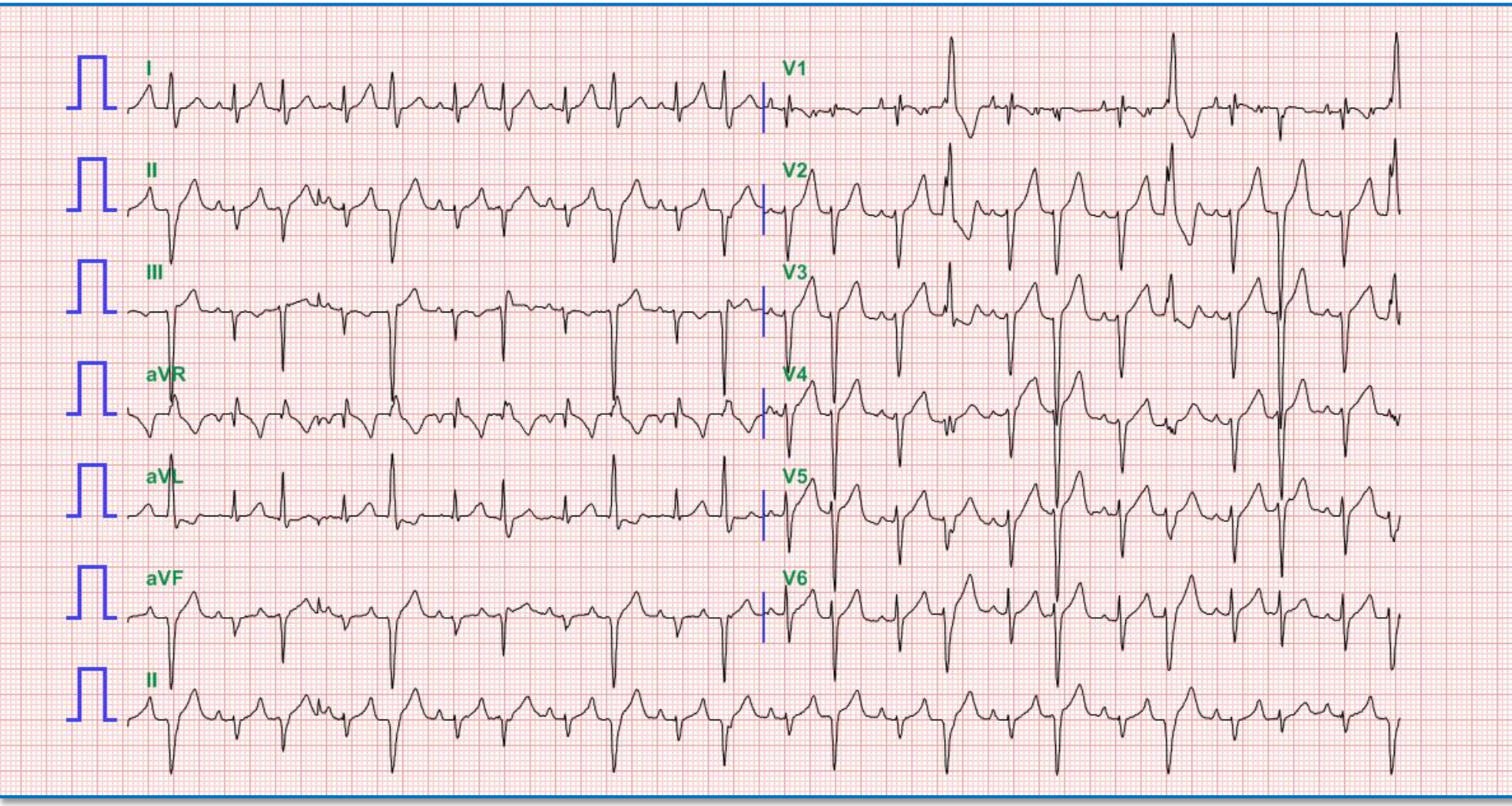
45/M
Chest discomfort



# What is your diagnosis?

1. Sinus arrhythmia
2. PVC bigeminy
3. PAC bigeminy with aberrant conduction
4. Alternating PACs and PVCs
5. Sinus rhythm with electrical alternans

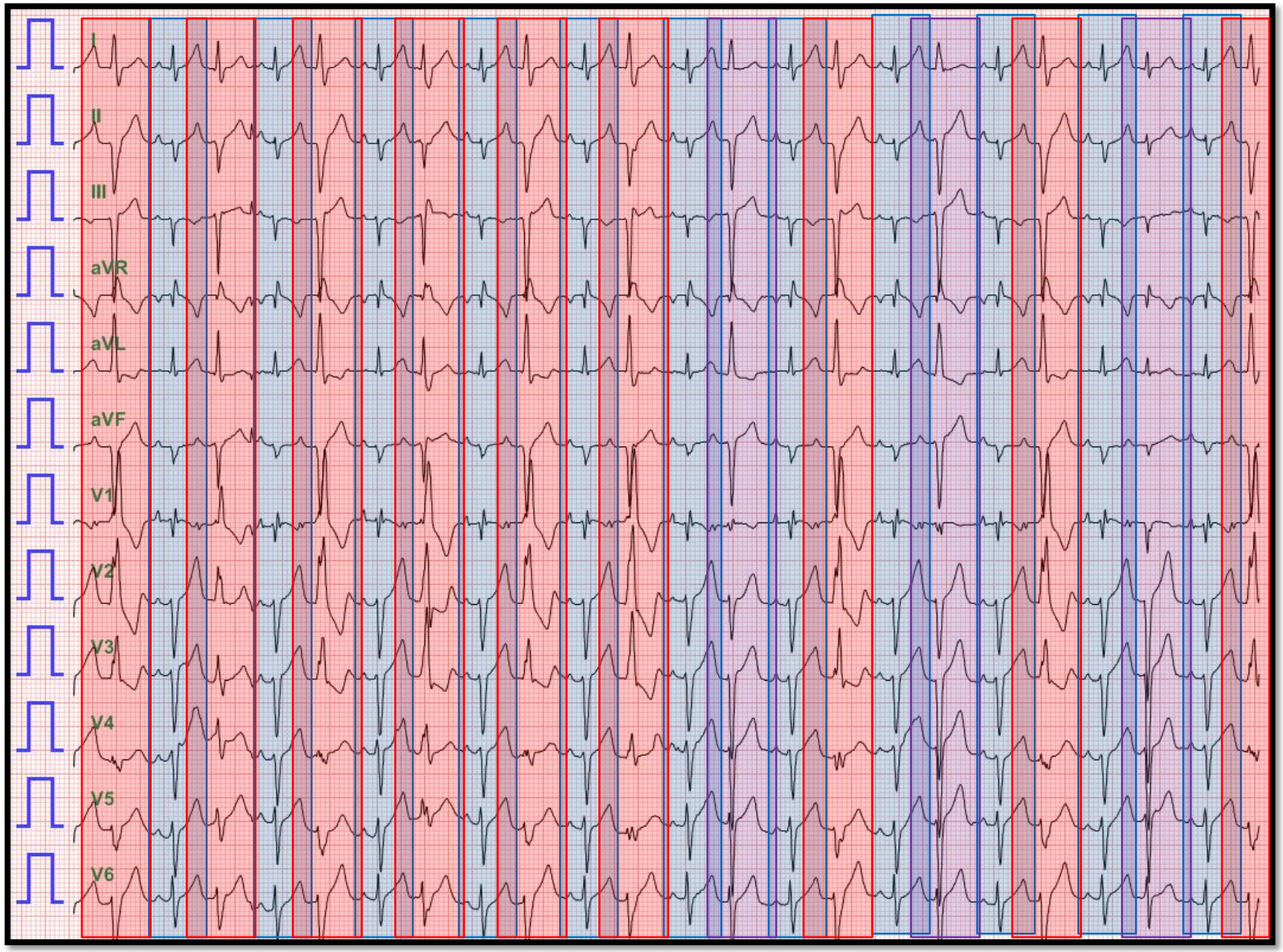
# ECG in different mode



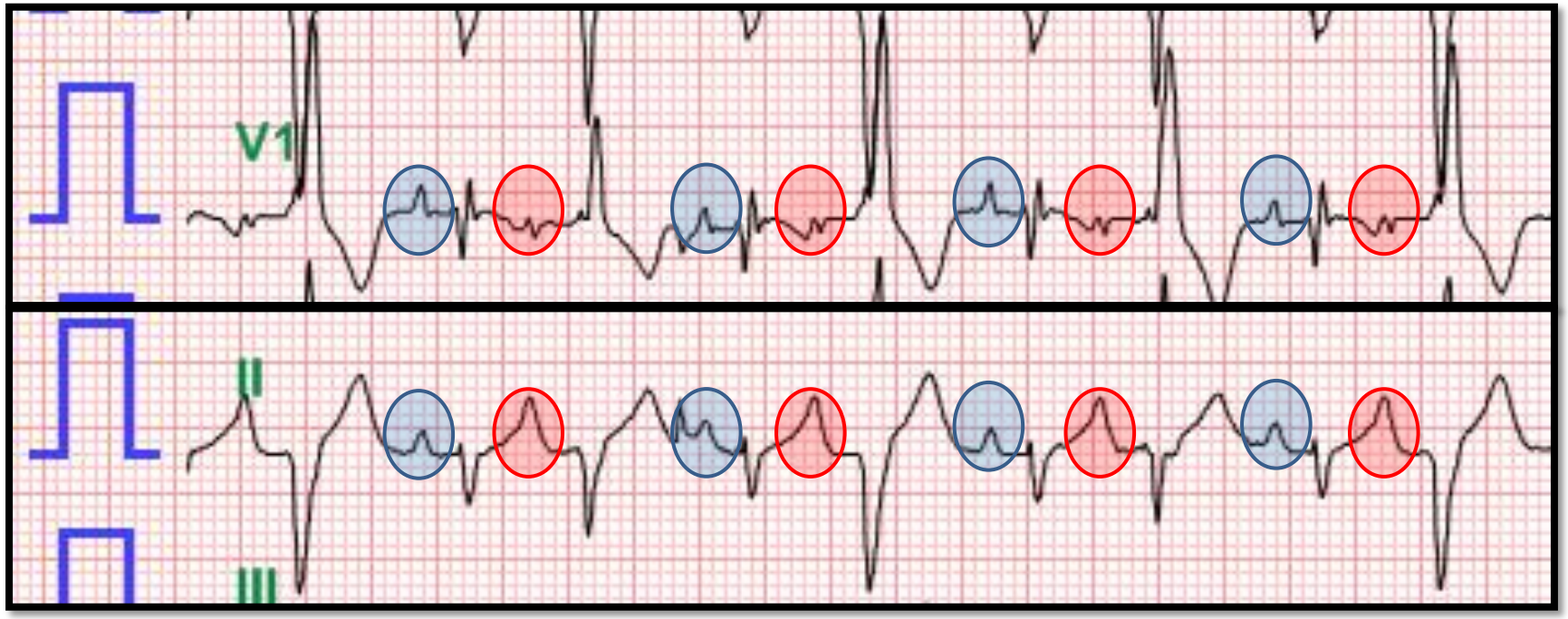
# What is your diagnosis? (second chance)

1. Sinus arrhythmia
2. PVC bigeminy
3. PAC bigeminy with aberrant conduction
4. Alternating PACs and PVCs
5. Sinus rhythm with electrical alternans

# ECG in different mode

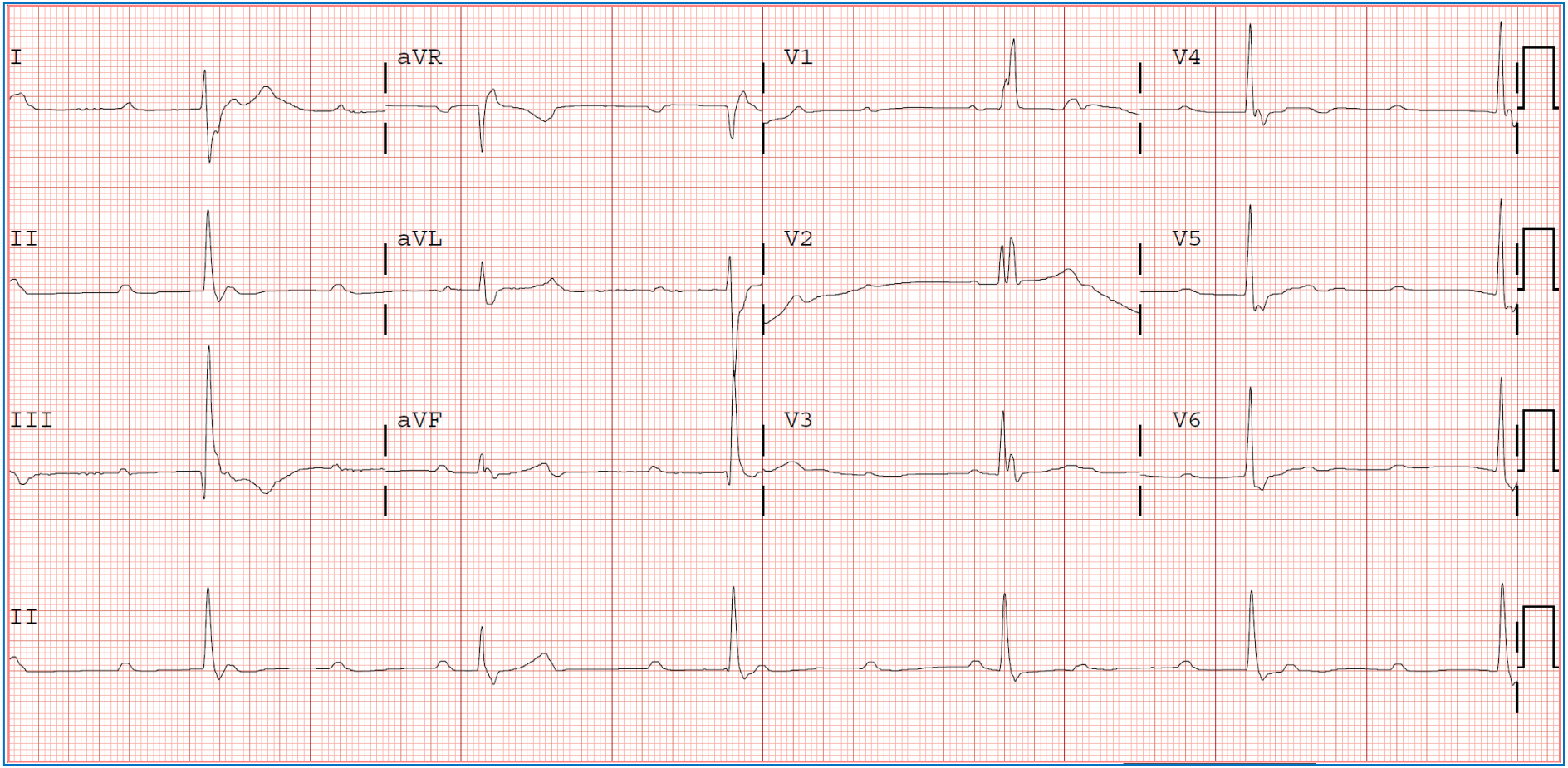


# PAC bigeminy with aberrant conduction

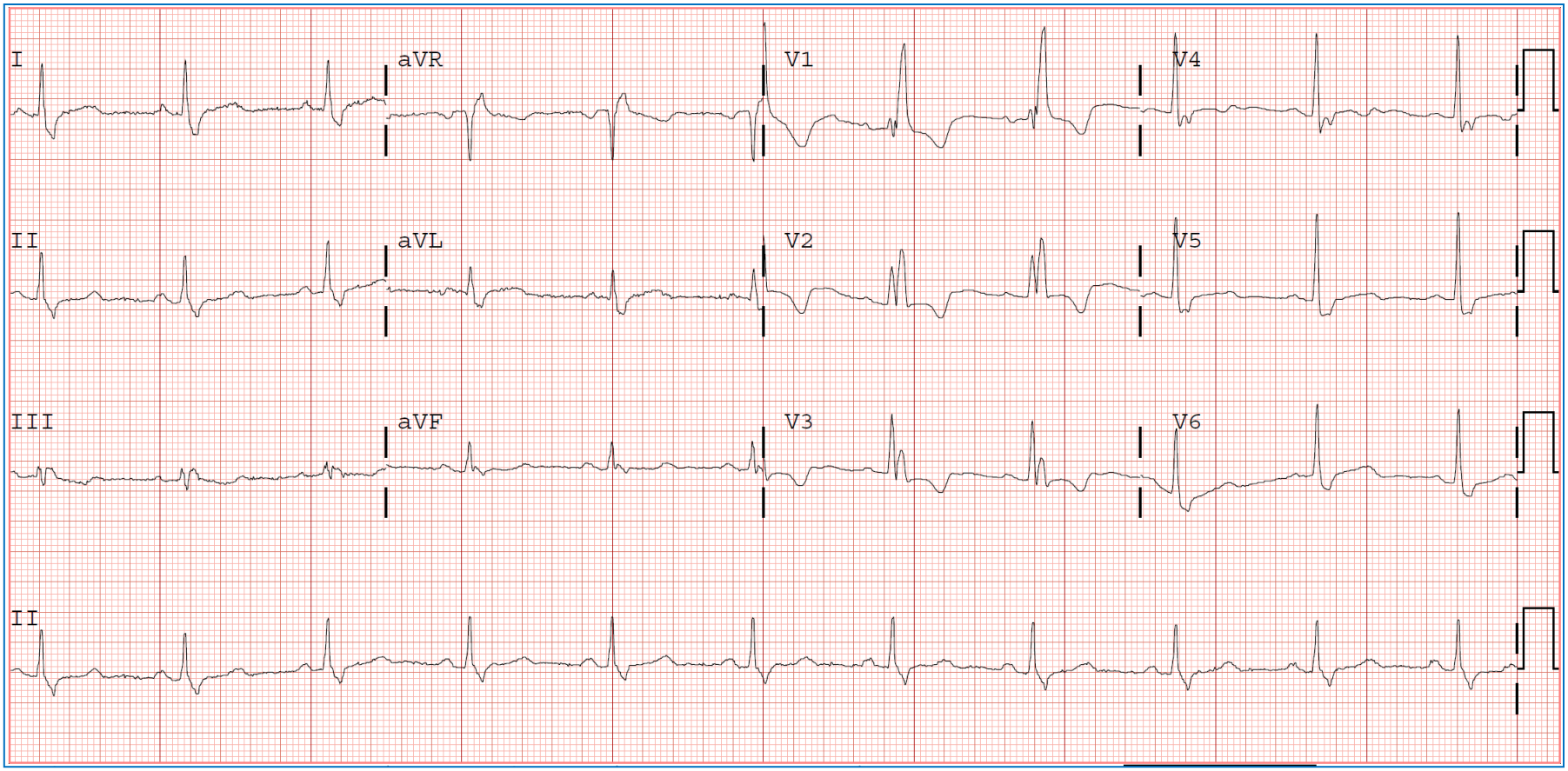


# Case 15.

**71/F, Hypertension (carvedilol, losartan)**
**Dyspnea, dizziness**



# 3 days after discontinuing of beta blocker



# Additional test for diagnosis?

1. Holter monitoring
2. Treadmil test
3. Echocardiography
4. Coronary angiography
5. Electrophysiology study

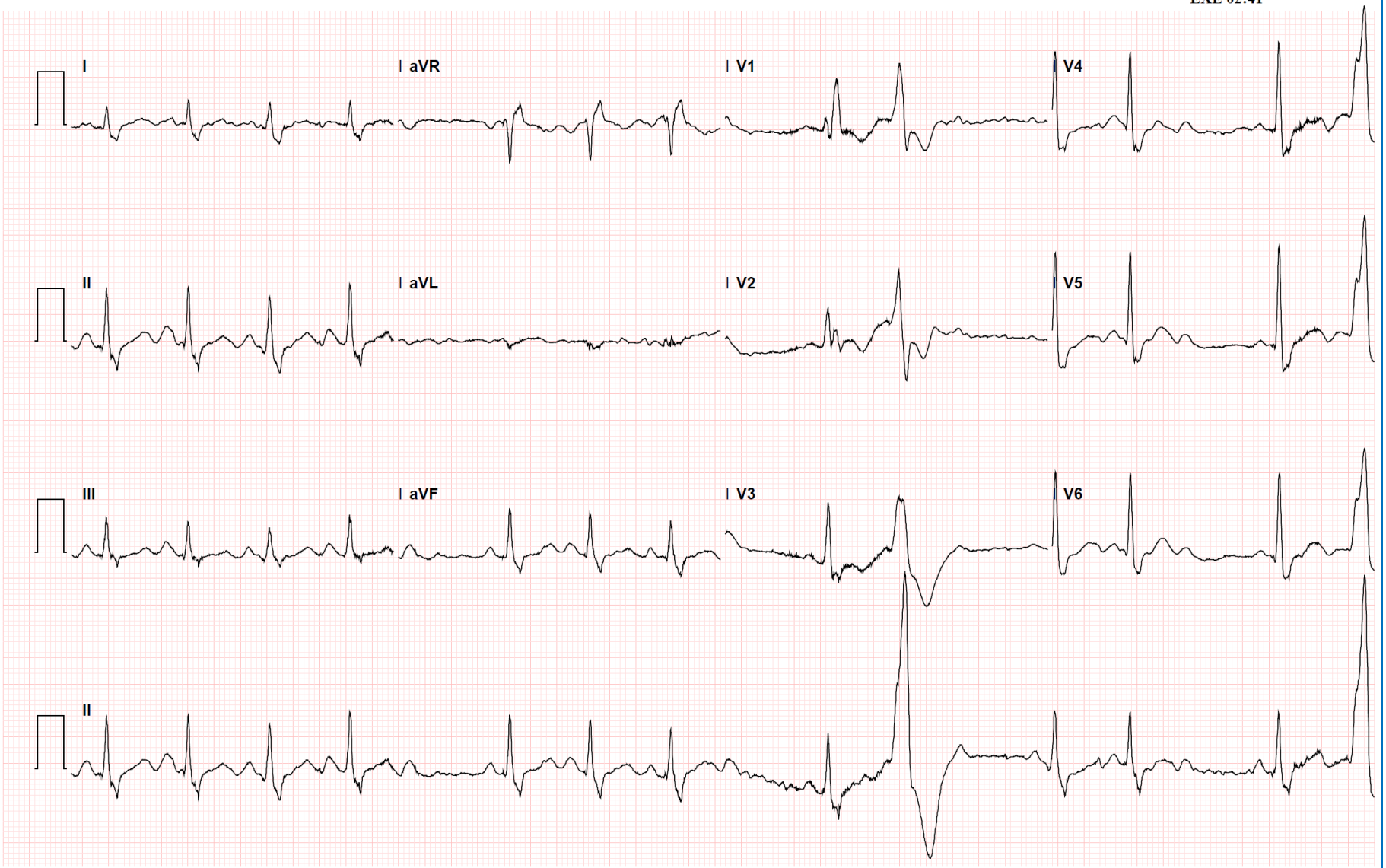
ok reum KIM
136128568
BRUCE

Exam Start: 03-04-2013 11:23
Date of Birth: 10-22-1948
Gender: Female

03:23 EXER
00:23 STAGE 2

4.0 km/h
12.0 %

RATE 84
BP 202/101
EXE 02:41



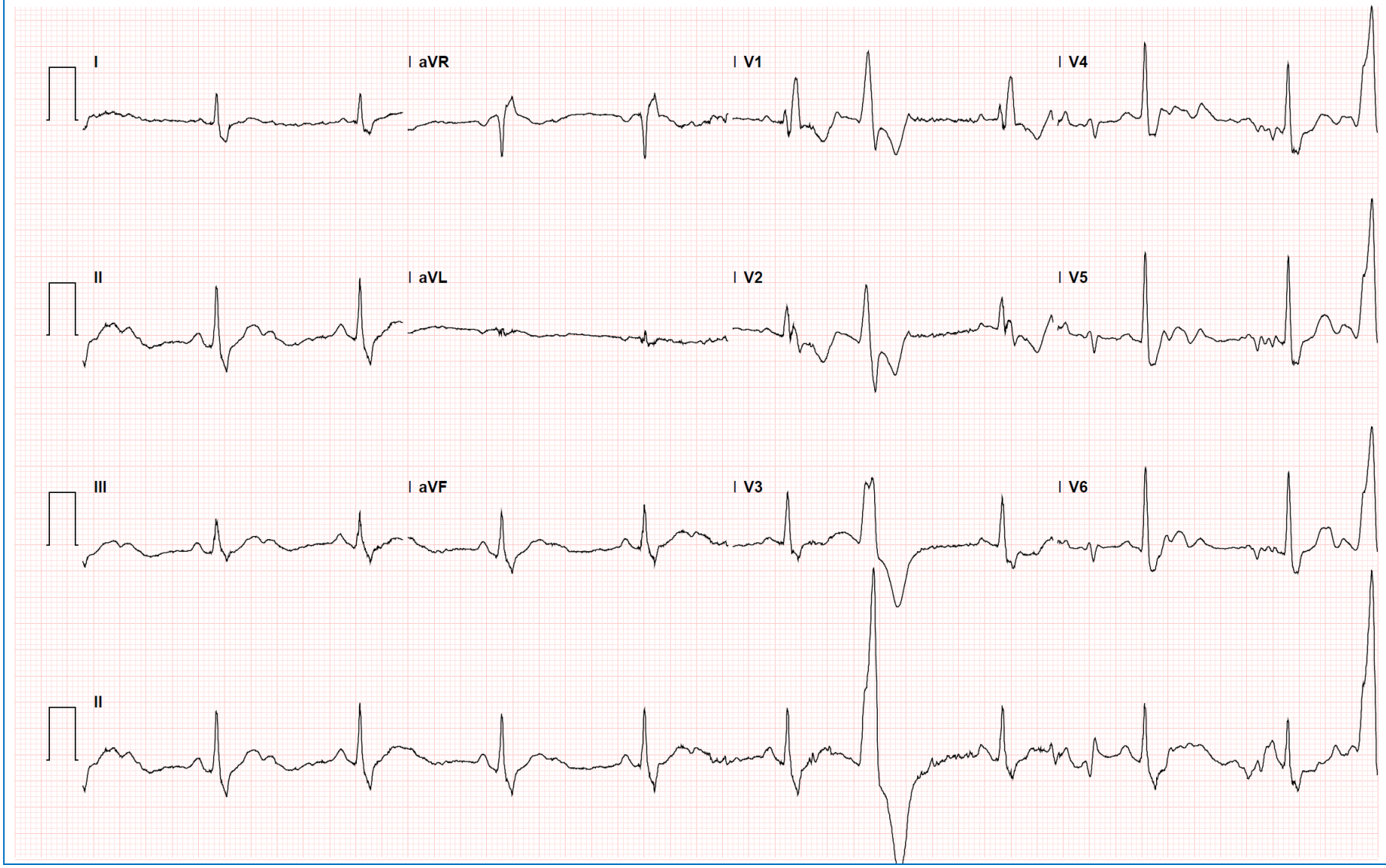
ok reum KIM
136128568
BRUCE

Exam Start: 03-04-2013 11:23
Date of Birth: 10-22-1948
Gender: Female

05:51 EXER
00:28 REC

--- km/h
---%

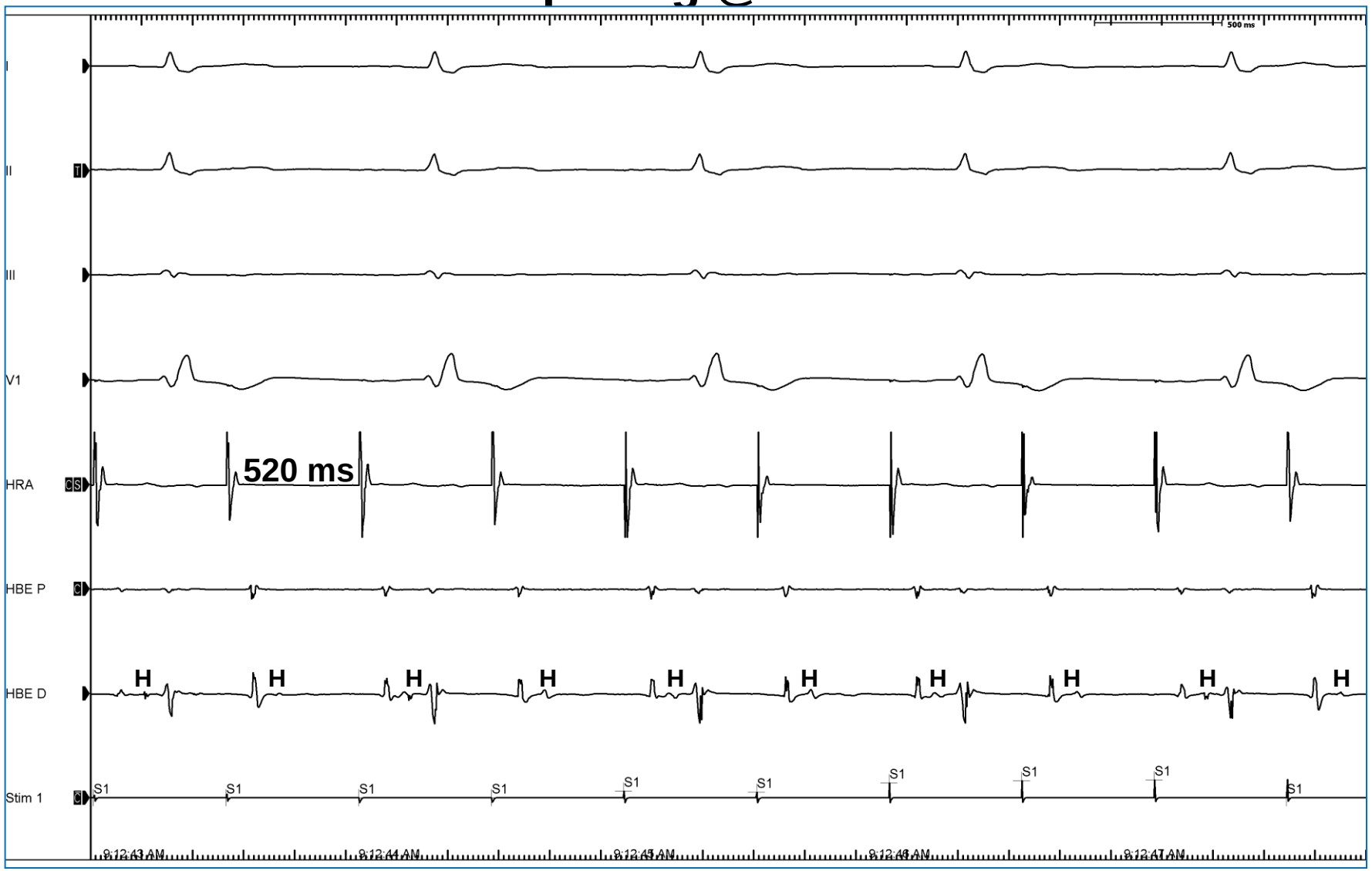
RATE 63
BP 222/128
EXE 05:46



# What is your diagnosis?

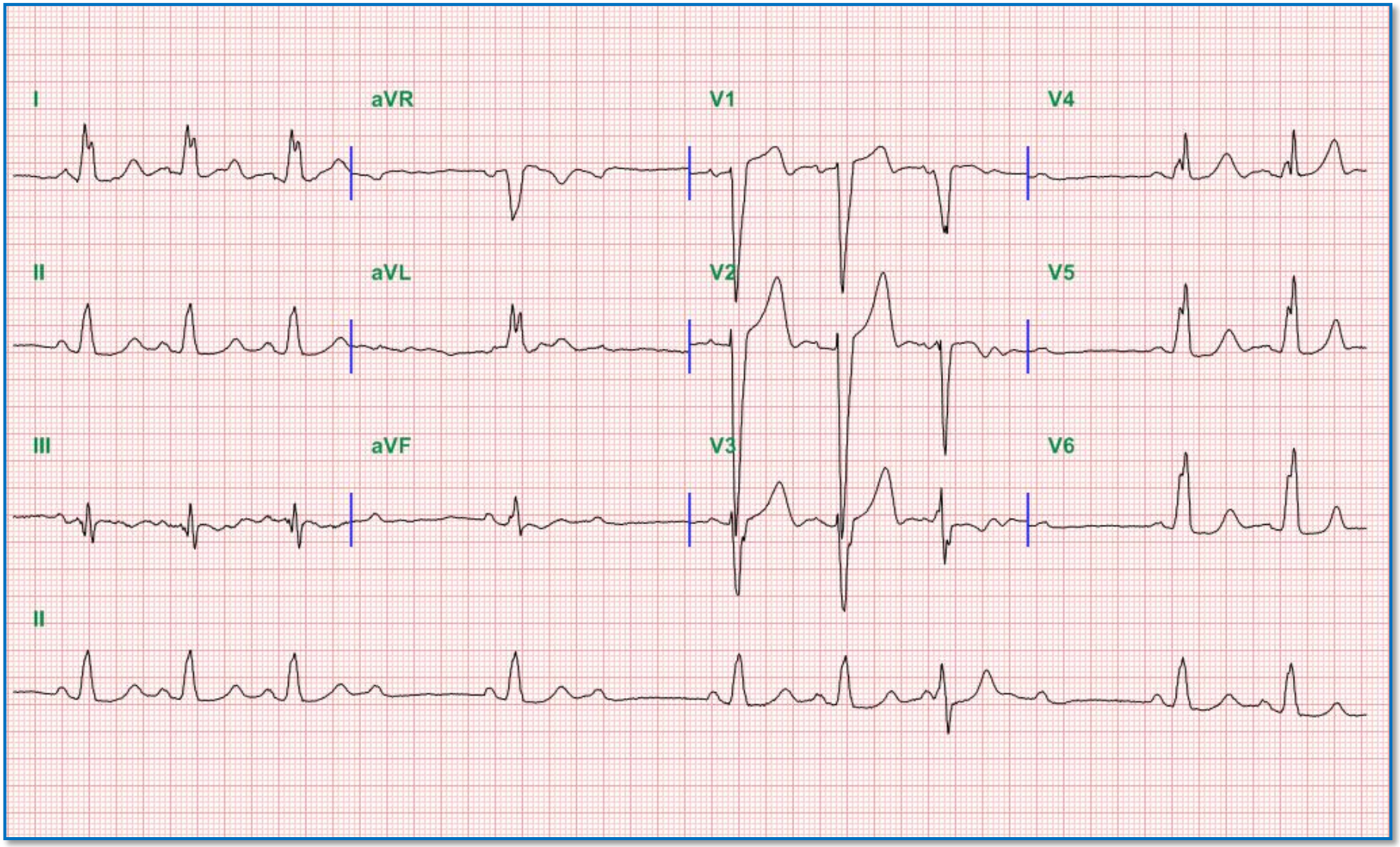
1. Chronotrophic incompetence
2. Type I second-degree AV block
3. Type I second-degree AV (infrahisian) block
4. Type II second-degree AV (infrahisian) block
5. 3rd degree AV block

# Two to one infrahisian block
# HRA pacing @ 520 ms



# Case 16.

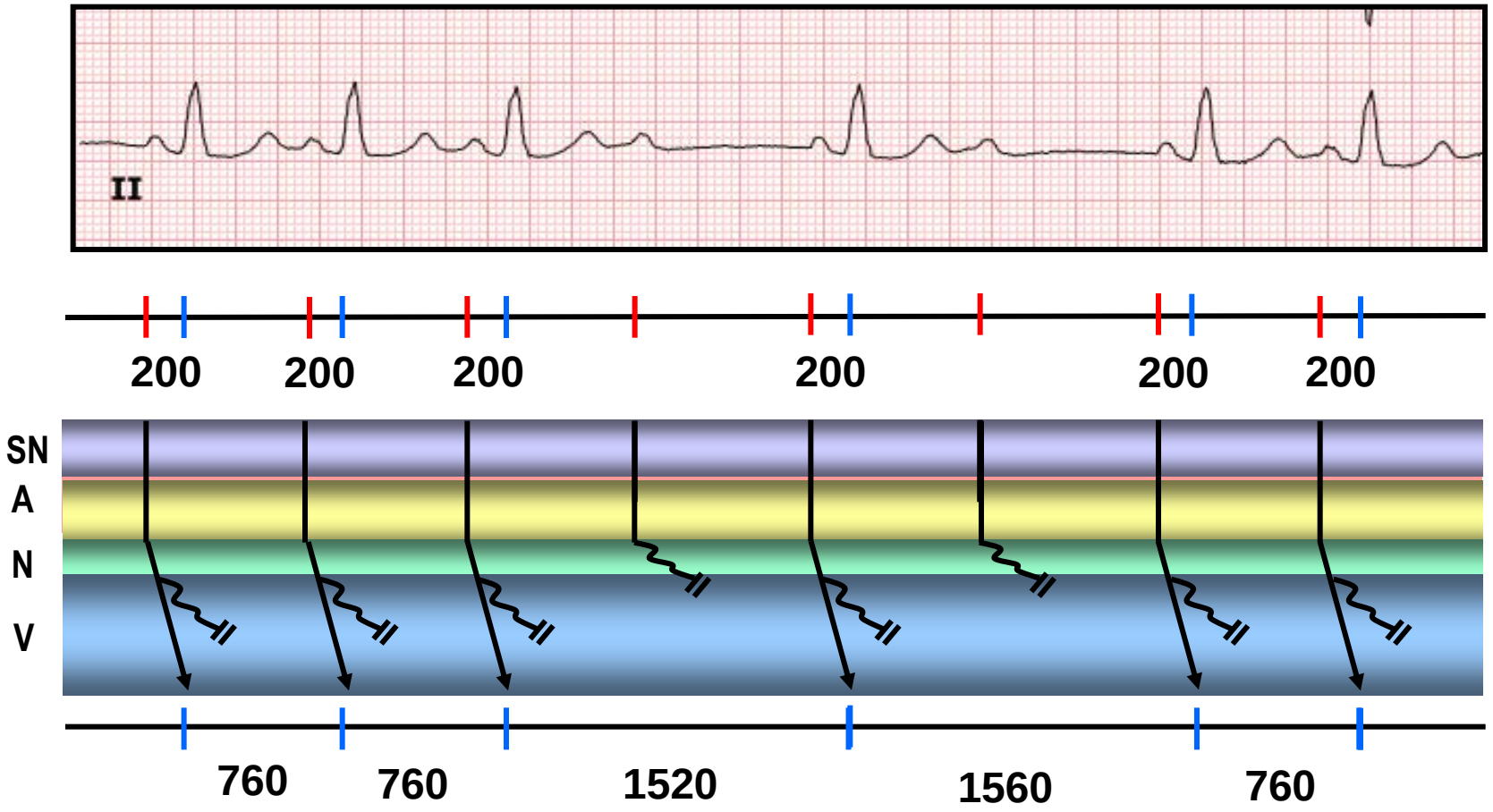
**79/F**
**Dizziness**



# What is your diagnosis?

1. Sinus pause
2. Nonconducted PAC
3. Mobitz type I AV block
4. Mobitz type II AV block
5. Complete AV block

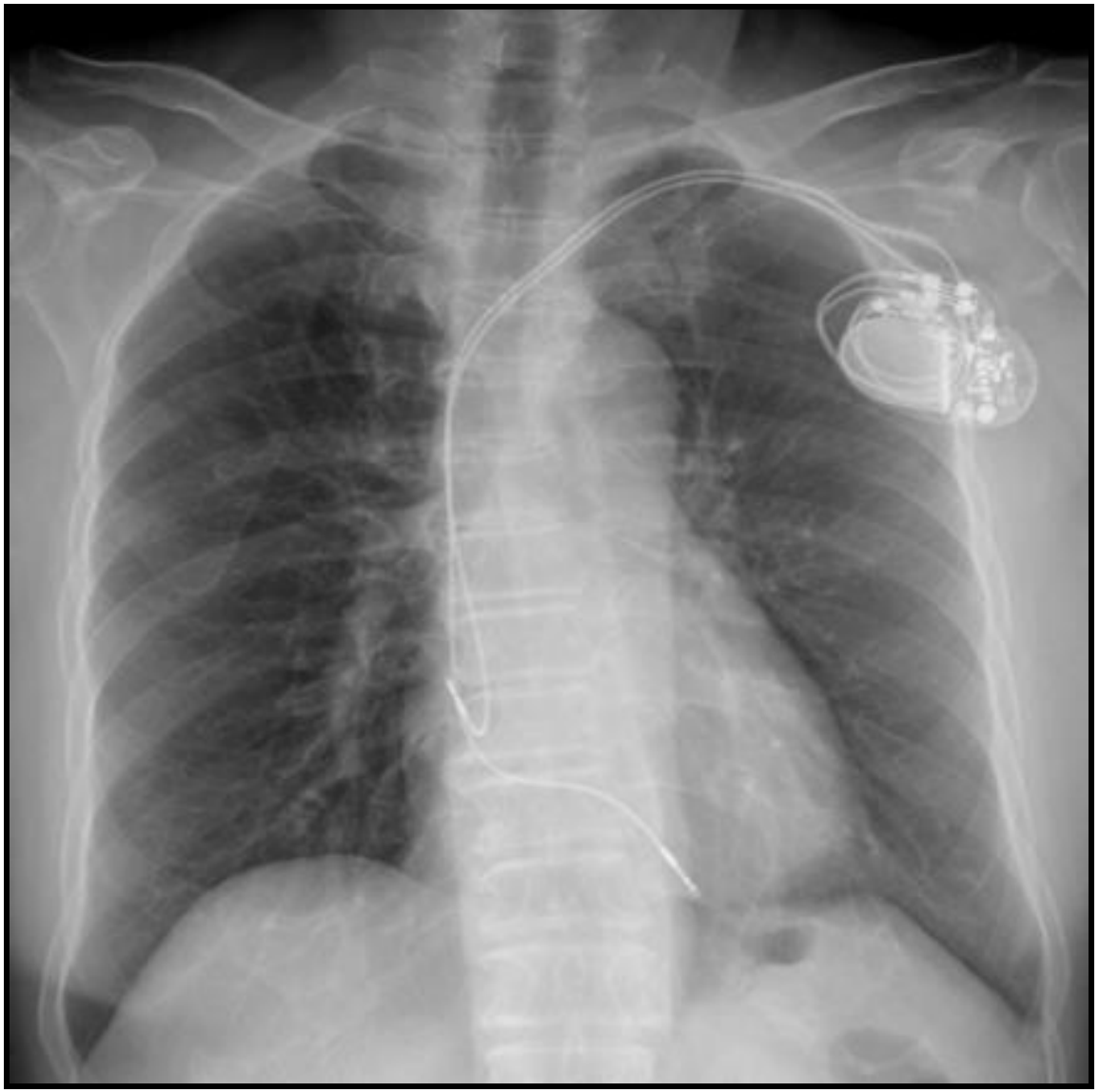
# 2nd degree AV block Mobitz type II



# Electrophysiology study

# High degree AV block during study

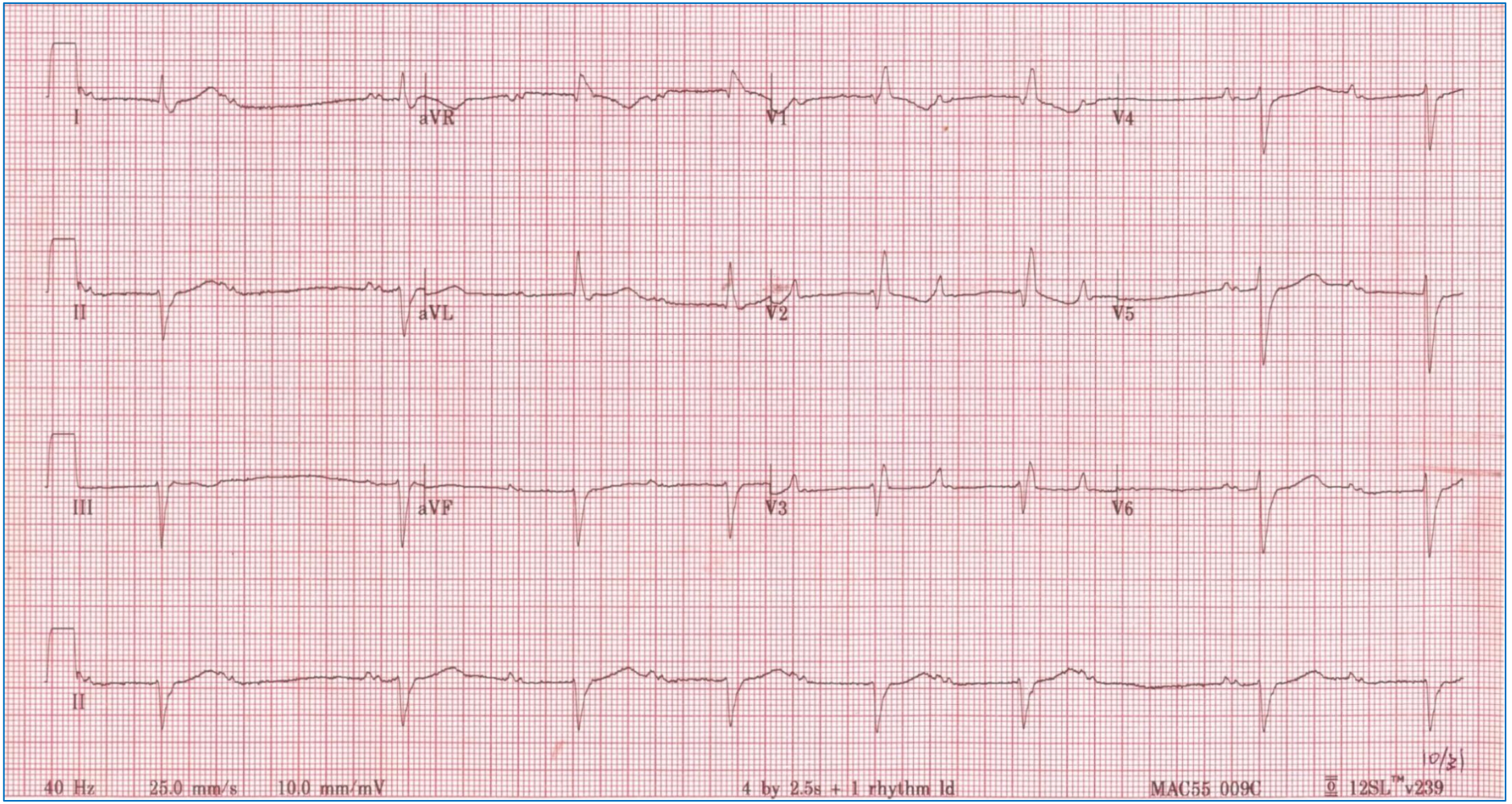
# Permanent Pacemaker (DDD)



# Case 17.

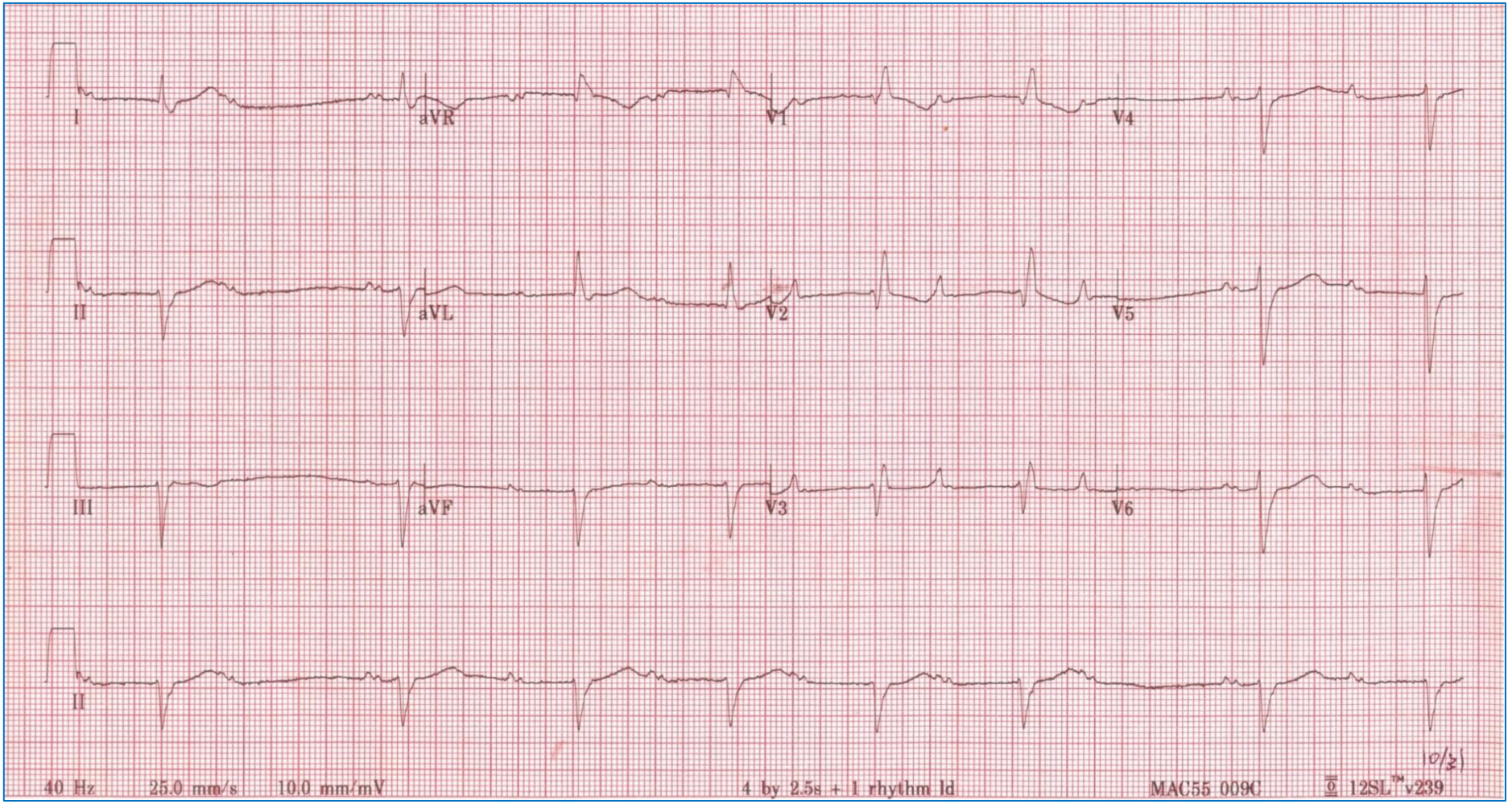
**70/M**

**No specific complaints**

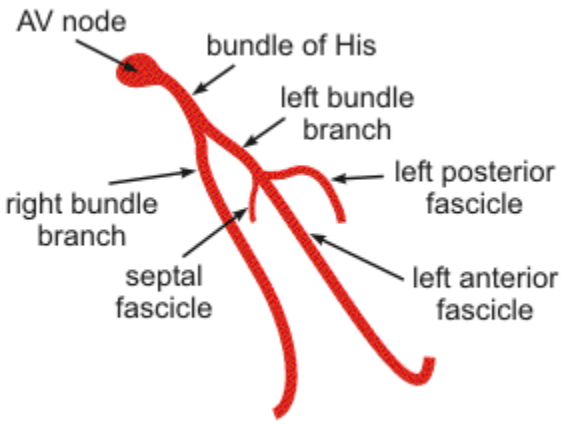


# Where is the conduction disturbance?

1. AV node
2. Right bundle
3. Left bundle anterior fascicle
4. All of above

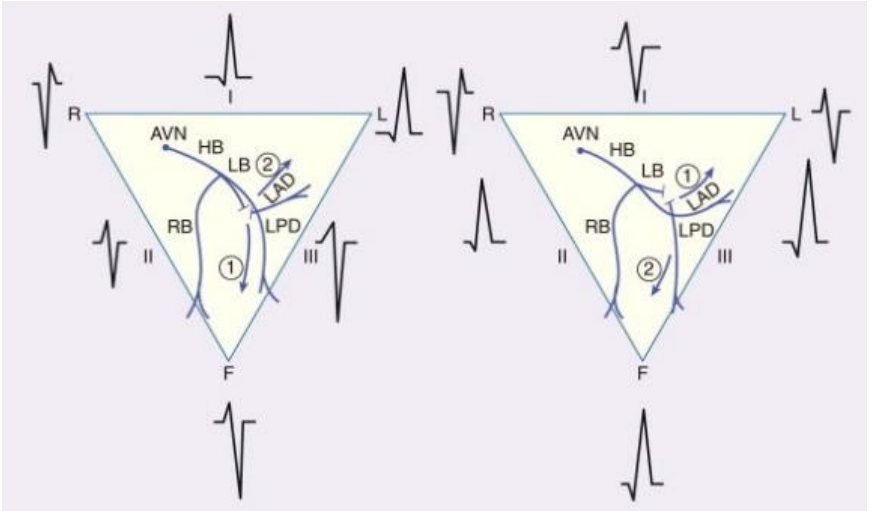

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
40 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 1 rhythm ld
MAC55 009C
12SL™v239

# Bifascicular block

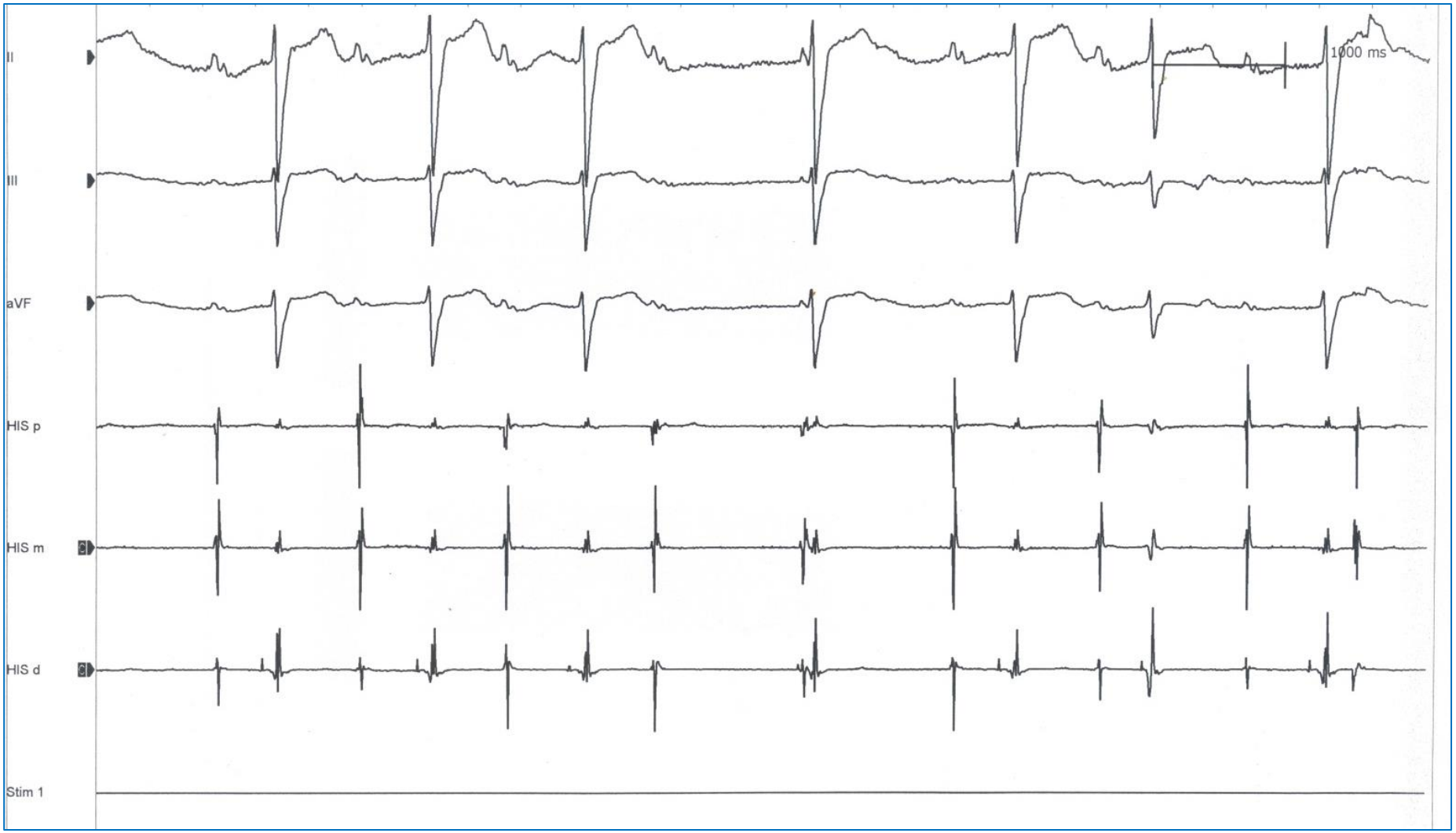



- RBBB with LAFB :
  RBBB + left axis deviation > −45 degrees

- RBBB with LPFB :
  RBBB + axis deviation to the right >+120 degrees



# His bundle electrogram



# What is the correct management for this patient?

1. Observation
2. Permanent pacemaker insertion

# PPM indication of chronic bifascicular block

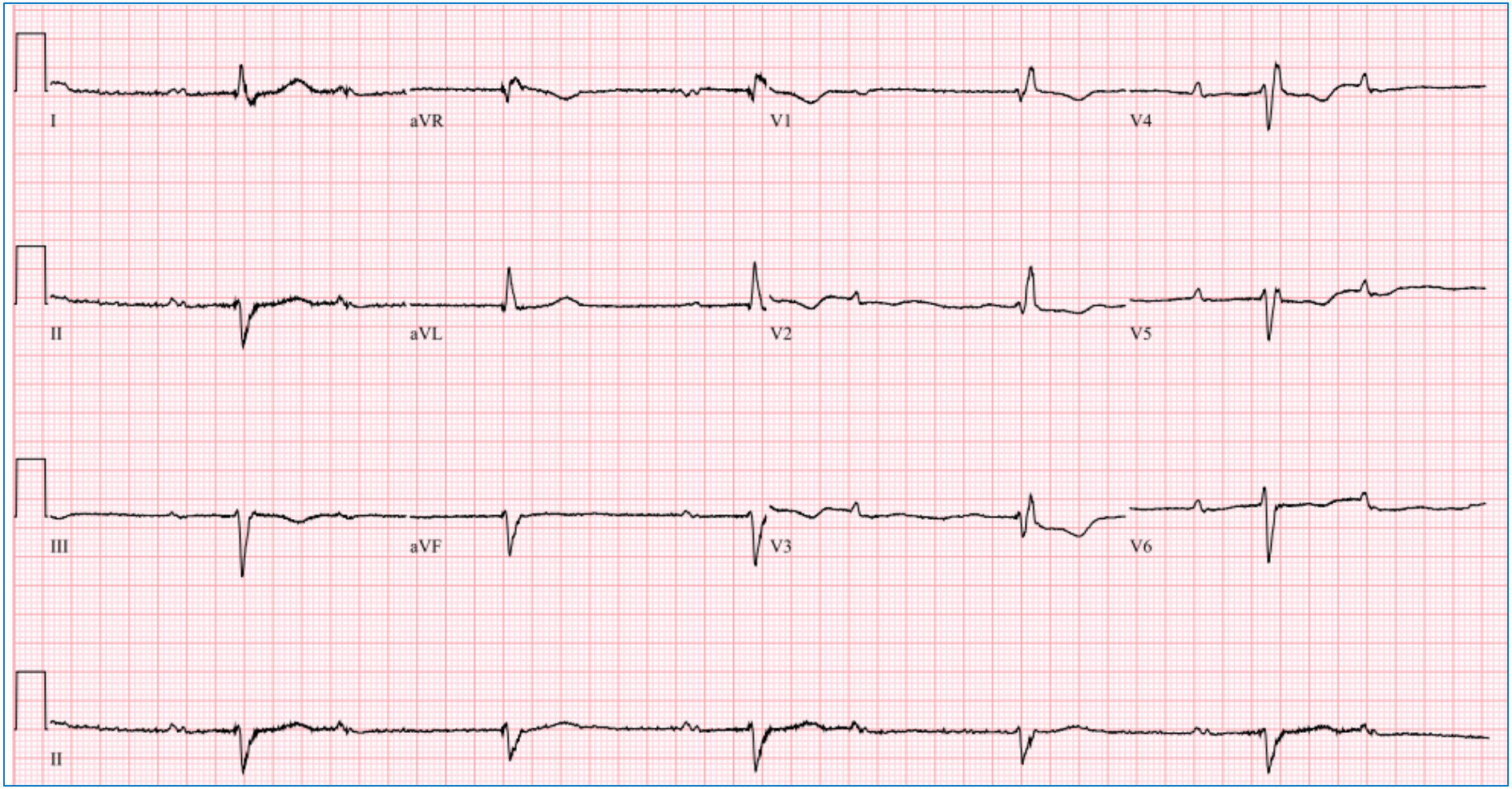
## Class I

1. Intermittent third-degree AV block
2. Type II second-degree AV block
3. Alternating bundle branch block

## Class IIa

1. Syncope not demonstrated to be due to AV block when other likely causes (e.g., ventricular tachycardia) have been excluded
2. Incidental finding at EP study of a markedly prolonged HV (>100 ms) in asymptomatic patients
3. Incidental finding at EP study of pacing-induced infra-His block that is not physiologic

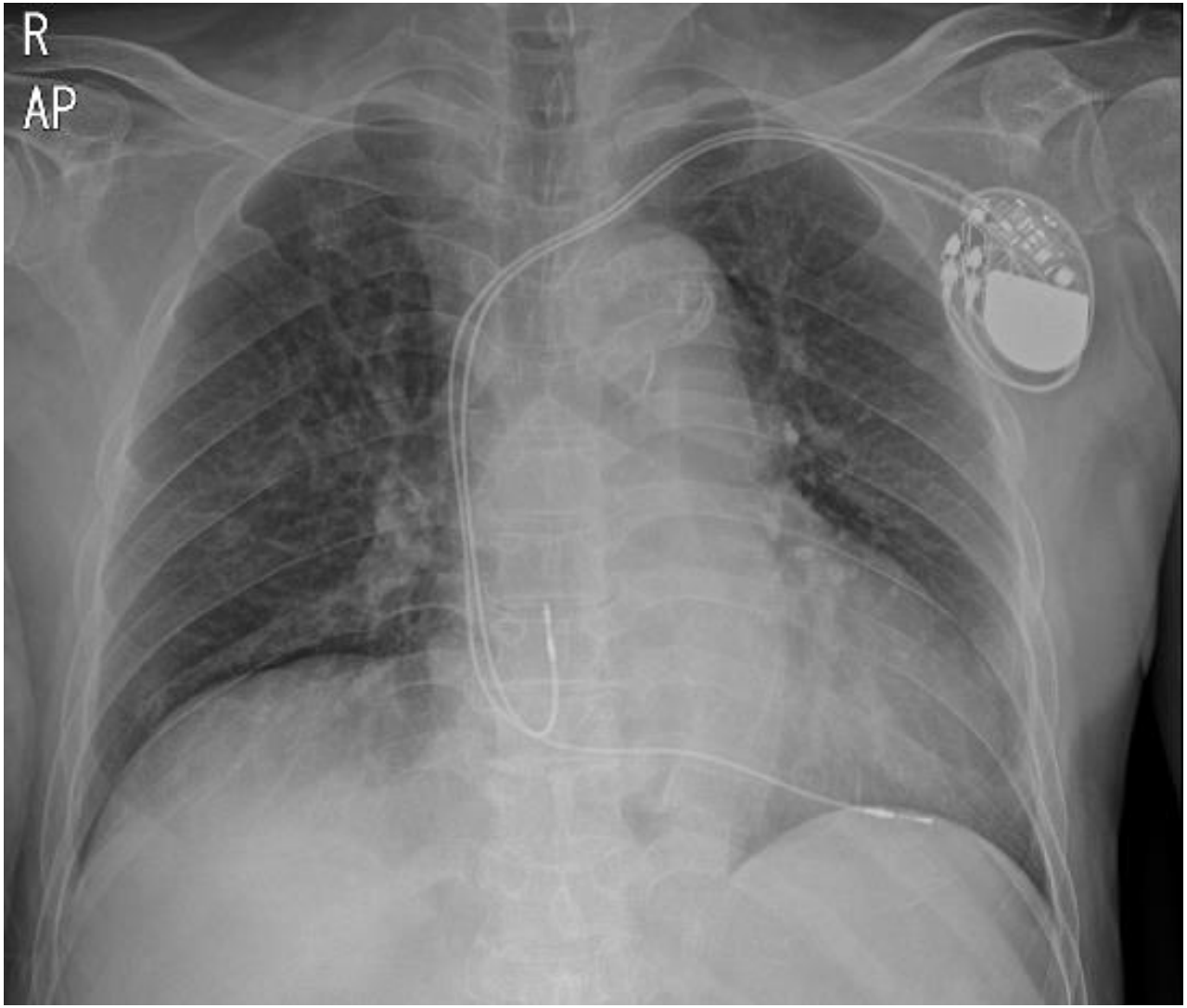
# F/U ECG (with dizziness)



# What is the correct management at this time?

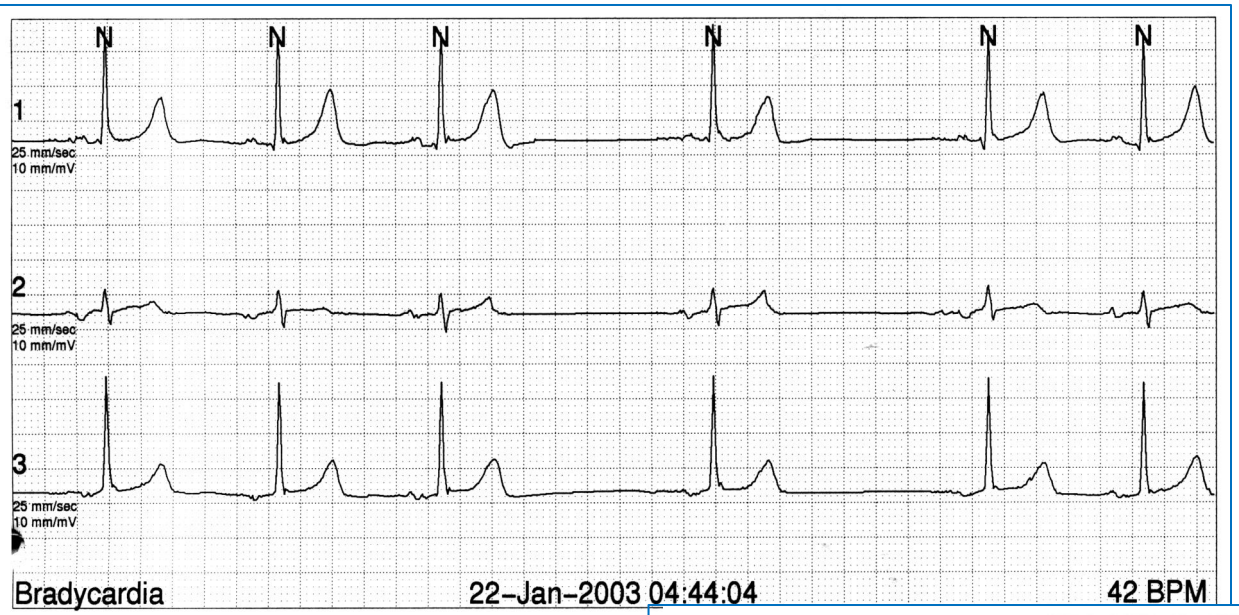
1. Observation
2. Permanent pacemaker insertion

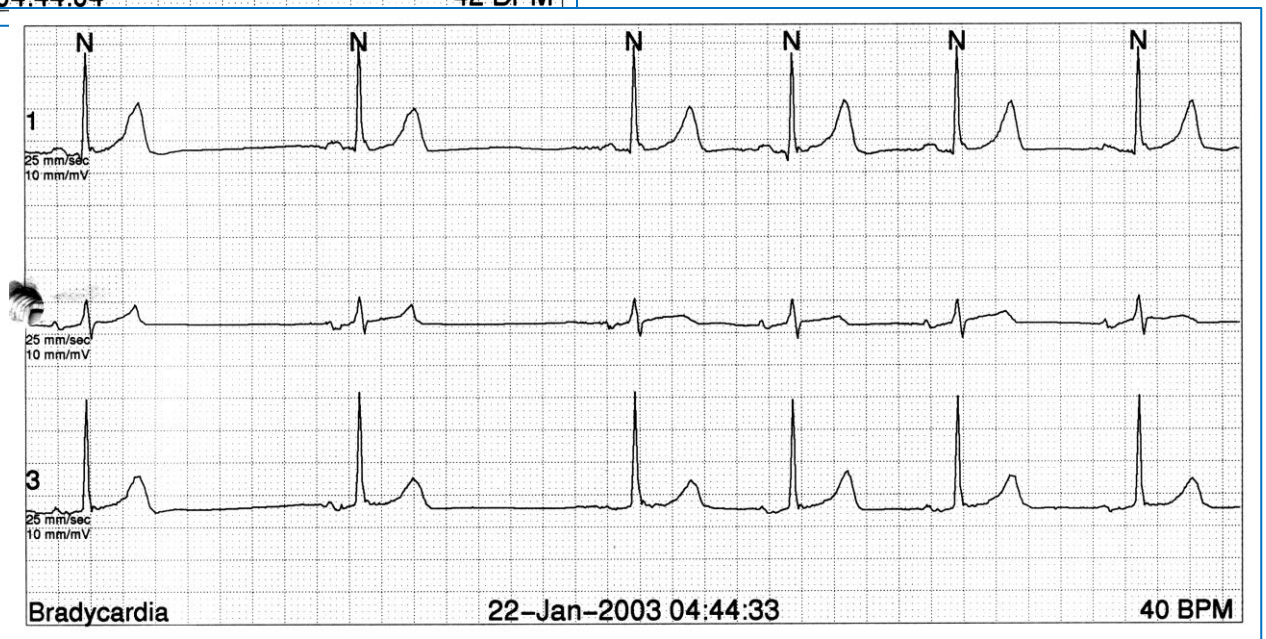
# PPM insertion : DDD type



# Case 18.

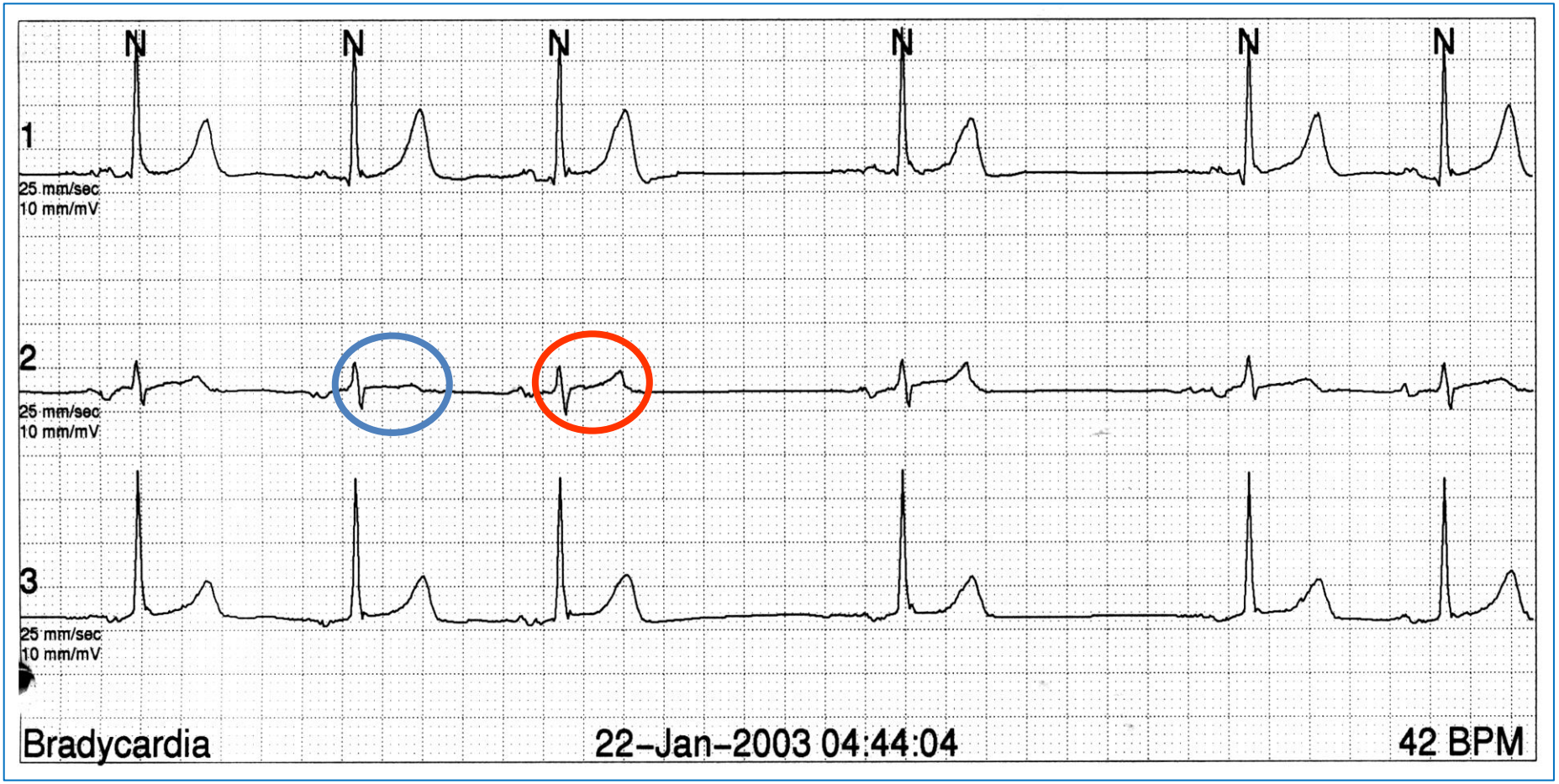
## 55/M ECG abnormality in health screening



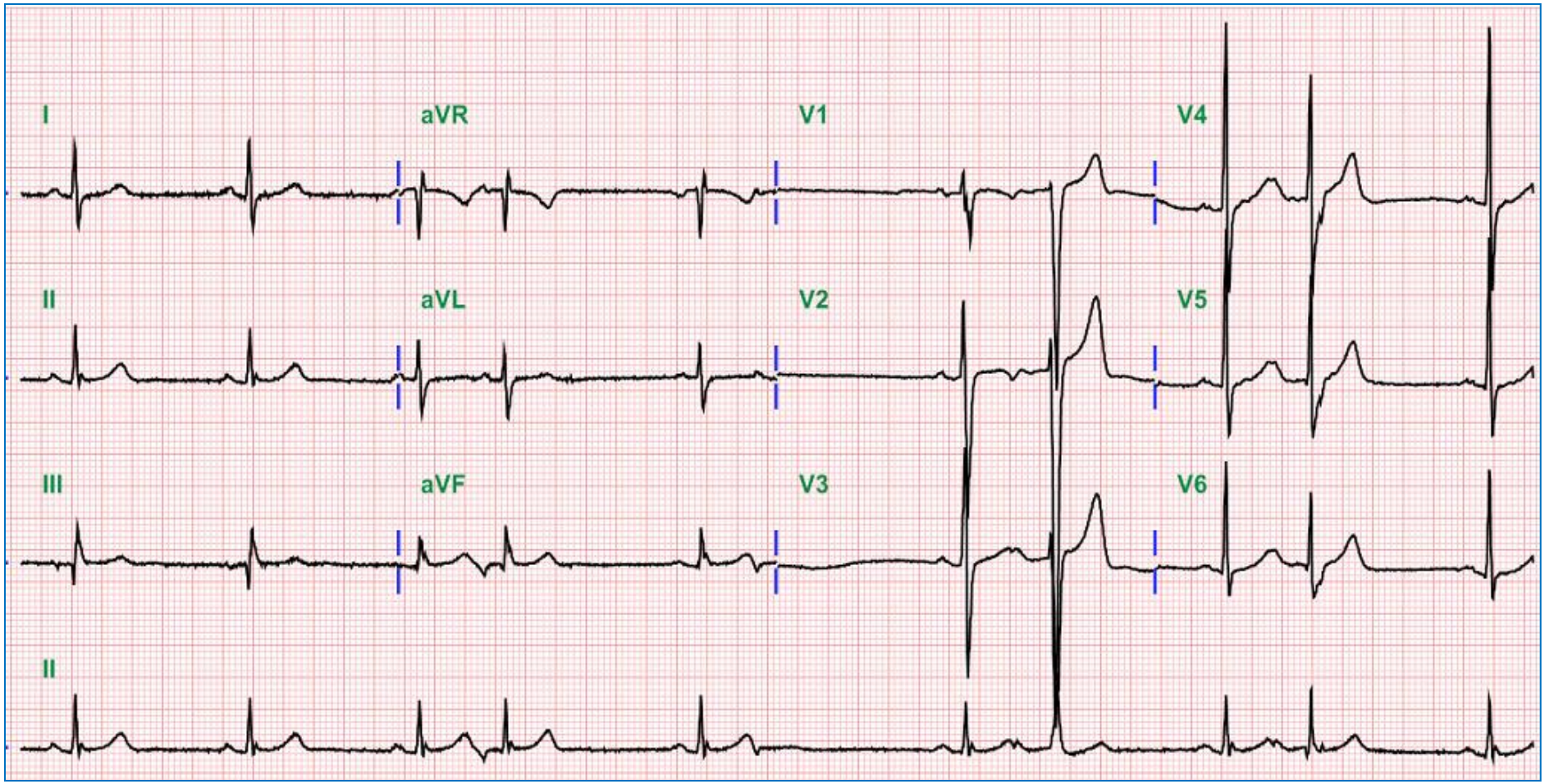
# What is your diagnosis?

1. Sinus pause
2. Sinus arrhythmia
3. AV block
4. Blocked atrial premature beat

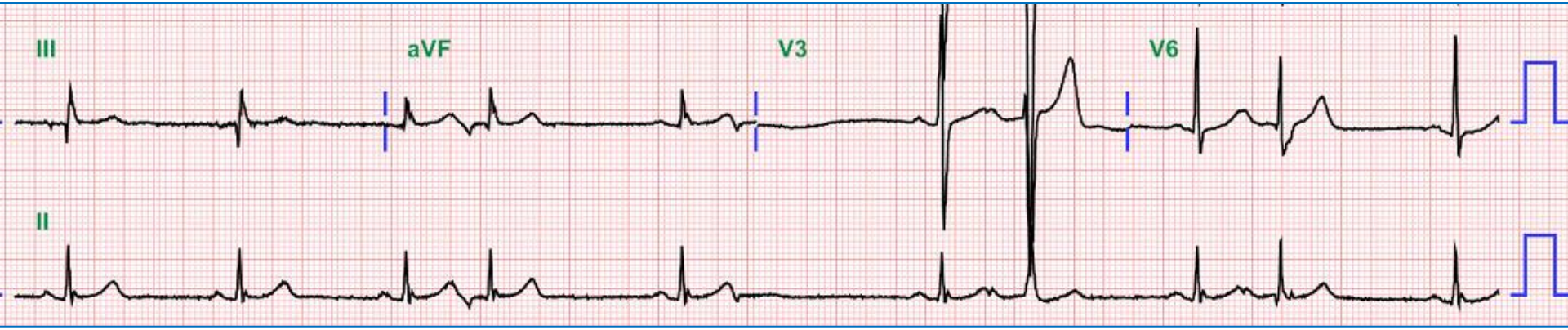

N
N
N
N
N
N
1
25 mm/sec
10 mm/mV
2
25 mm/sec
10 mm/mV
3
25 mm/sec
10 mm/mV
Bradycardia
22-Jan-2003 04:44:04
42 BPM

# Case 19.

62/M
Skipped beats



# What is an <u>incorrect</u> answer of the following description?

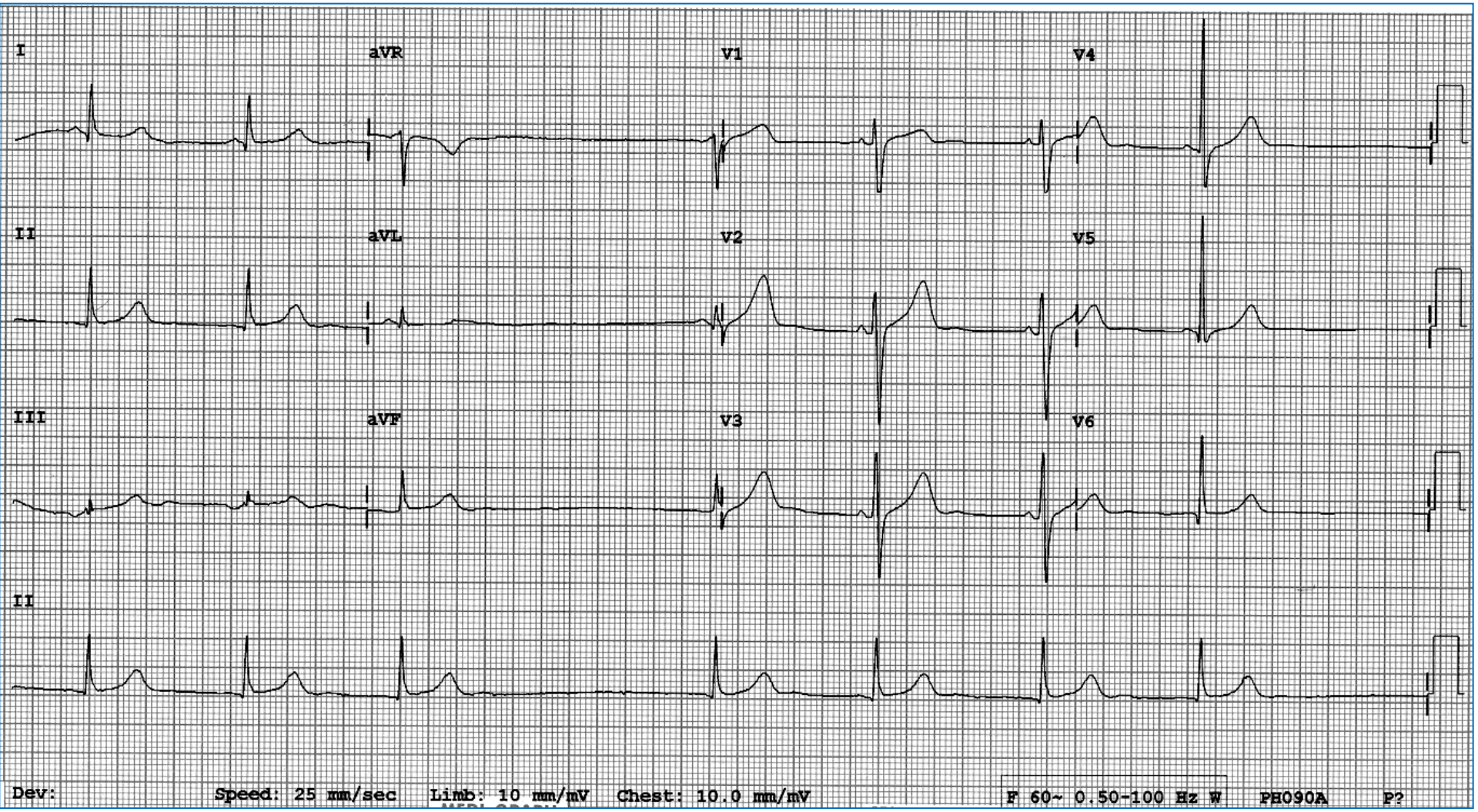



1. There is a premature atrial complex (PAC).
2. There is a PAC without ventricular conduction.
3. There is a PAC with aberrant conduction.
4. This patient has AV node conduction disease.

# Case 20.

66/F

Dyspnea on Exertion ,



# What is an <u>incorrect</u> answer of the following description?


1. 환자의 심전도 진단은 sick sinus syndrome 이다.
2. 3초 이상의 sinus pause 가 있으면 영구형 심박동기를 삽입하여야 한다.
3. 서맥으로 인한 증상이 확인되면 심박동기 고려 대상이다.
4. 이론적으로 현재 상태에서는 atrial pacing 만 해줘도 충분하다.

## 입원초진기록-Freetext(JCI)

[입원]2012/09/03 ~ 2012/09/07 진료과:순환기내과 주치의:[redacted] 입원회차 :1

작성과 : 순환기내과 진료일자 : 2012-09-03 21:57

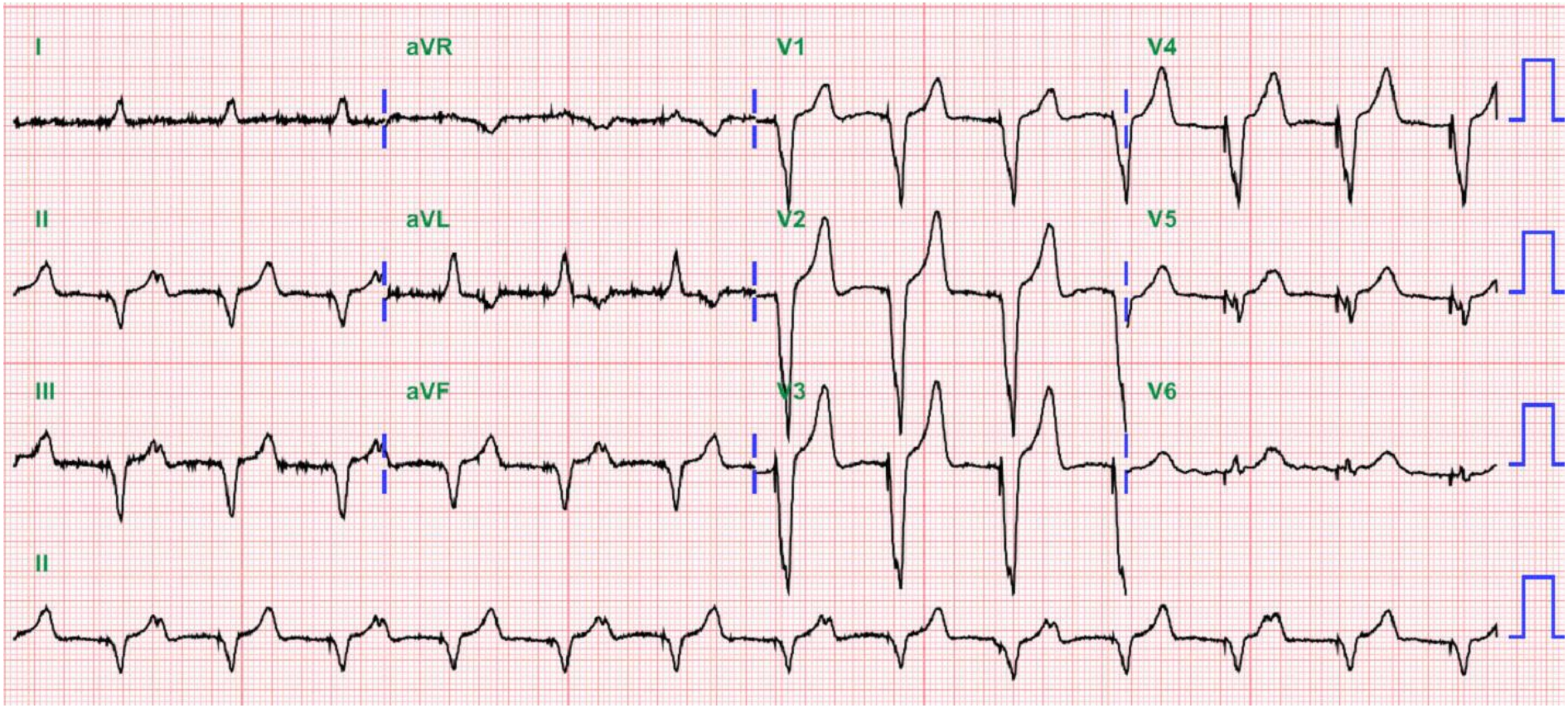
**주호소**

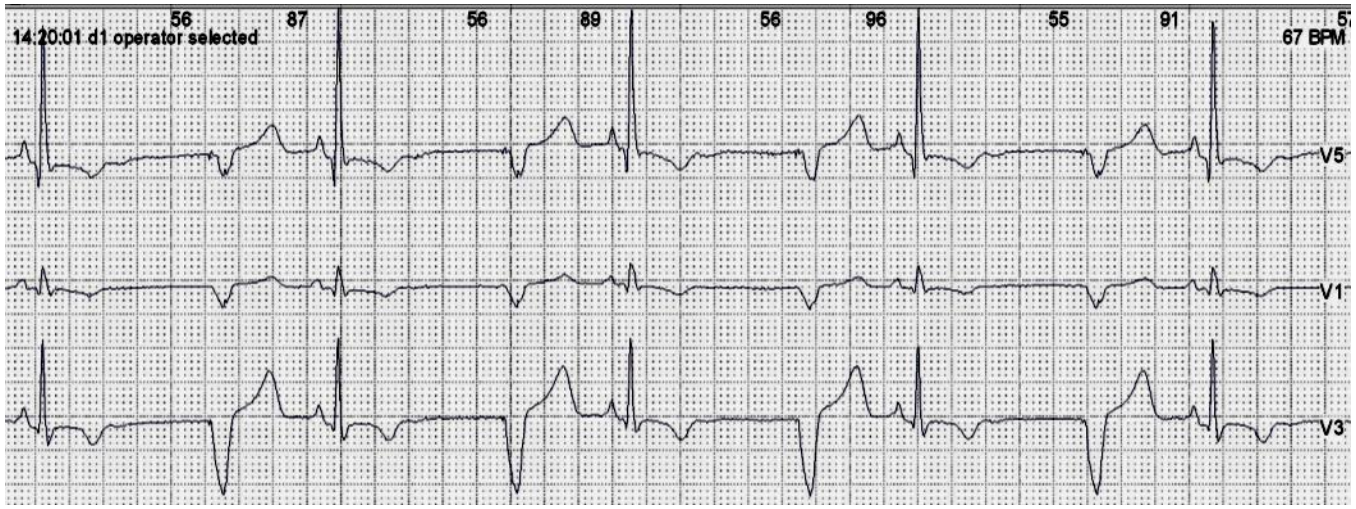
Dizziness

**현병력**

F/66, 2009년도에 dizziness, dyspnea 등 증세 있어 [redacted] 방문하였고, 판막 부전증 및 부정맥 있다고 이야기 들으셨다고 하며, 이에 대해 Pacemaker (VV) 삽입하였음.

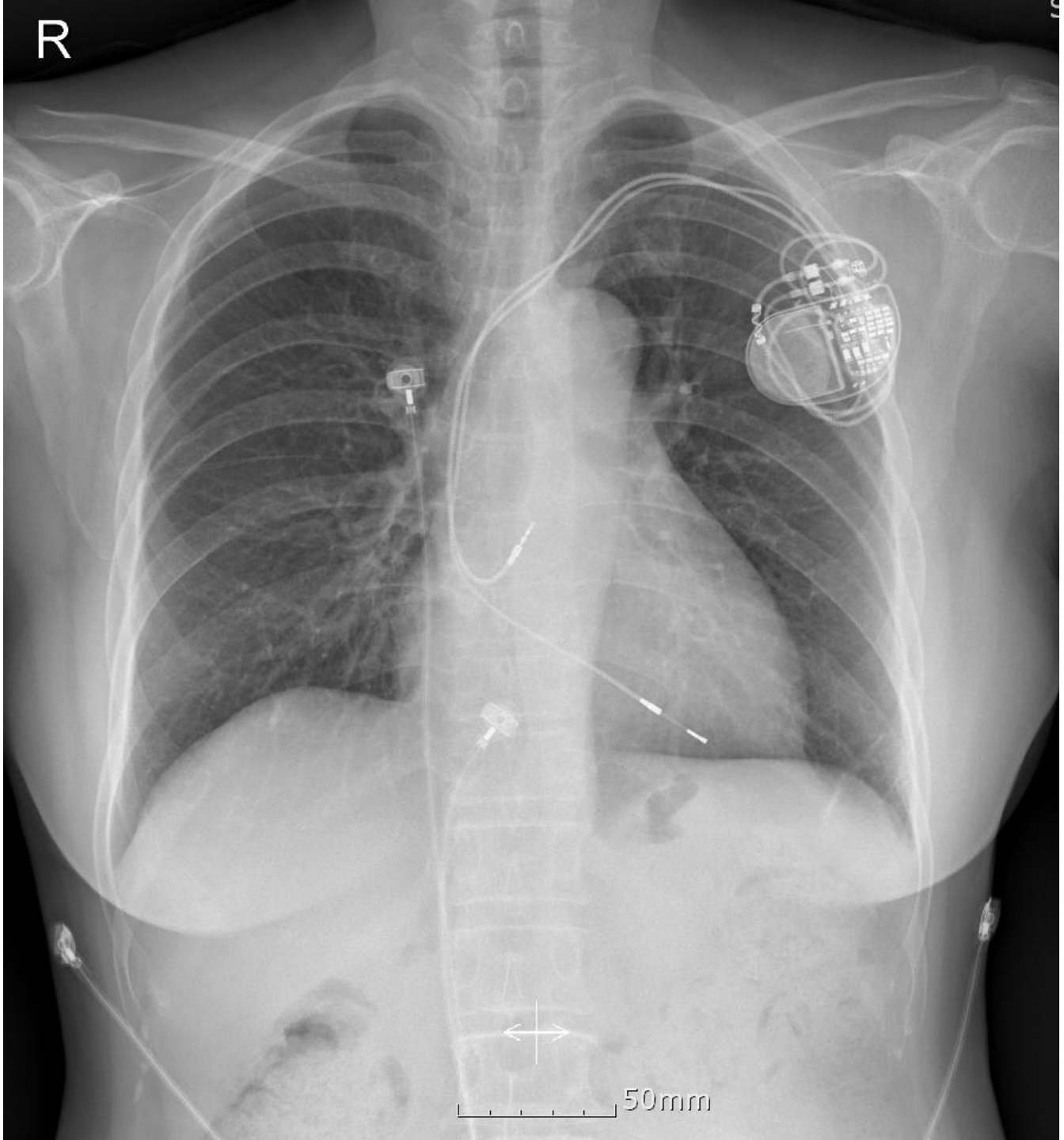
이후 흉부 불편감, Dyspnea, dizziness 심했고 시간이 지나면서 조금씩 호전되었으나 여전히 증세 지속되어 본원 외래 내원하였고, [redacted]

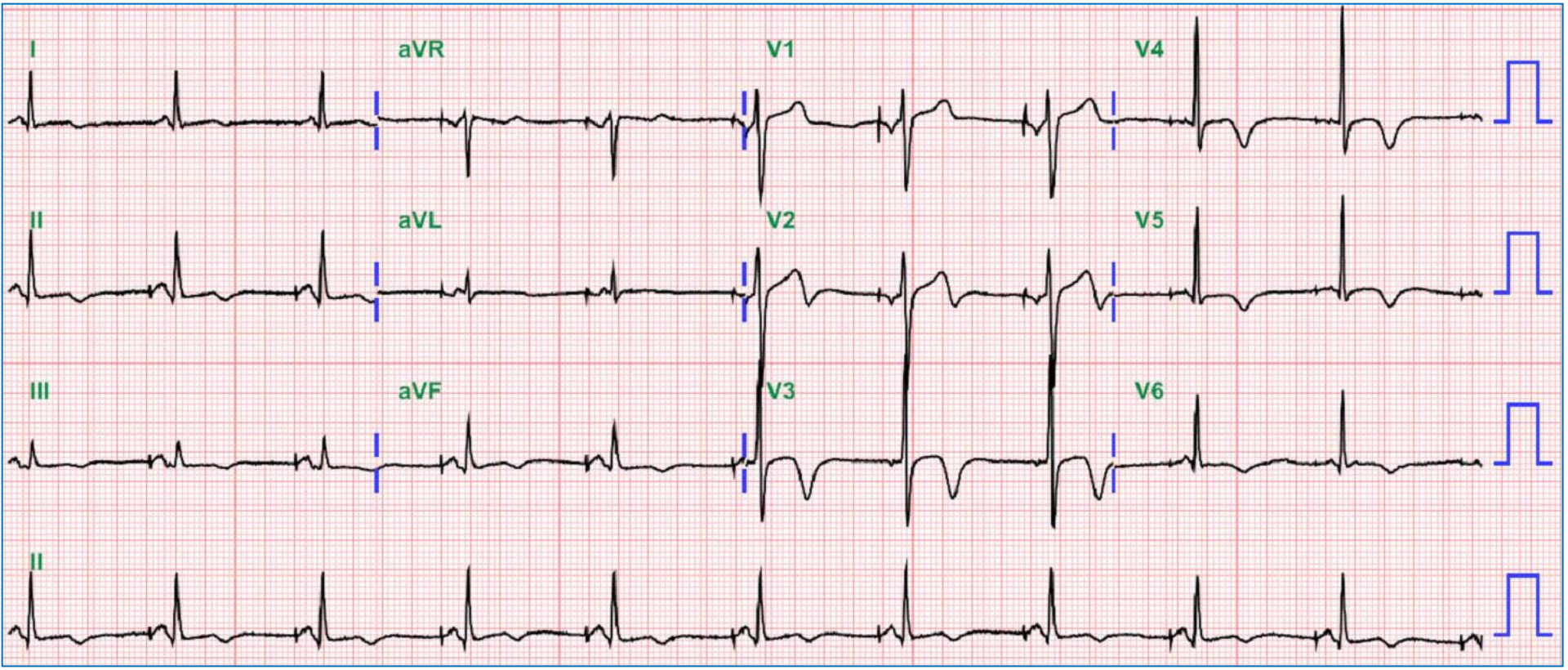

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II


56
87
56
89
56
96
55
91
14:20:01 d1 operator selected
67 BPM
V5
V1
V3

# What is the correct answer of the following description?


1. VVI mode 인 것으로 생각된다.
2. 간간히 intrinsic sinus rhythm 이 있다.
3. 환자의 증상을 A-V synchrony 가 안되는 것으로 설명할 수 있다면, pacemaker syndrome 이라고 할 수 있다.
4. 모두 맞음


R
50mm


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

# Pacemaker mode selection

- Theoretically,
  - SSS (AAI) and AV block (VDD, DDD)
  - minimize ventricular pacing

- Limitations of other modes
  - AAI
    - High upgrade rate (to DDD, 20% / 5yr)
  - VDD
    - Atrial sensing failure 35% compared with DDD (10%)
    - Chronotrophic incompetence
    - No chance to atrial pacing

- Any indication with permanent AF -> VVI
- Otherwise -> DDD

# Case 21.

79/F, s/p DDDR pacemaker for complete AV block (2006.12.8)
Chest discomfort

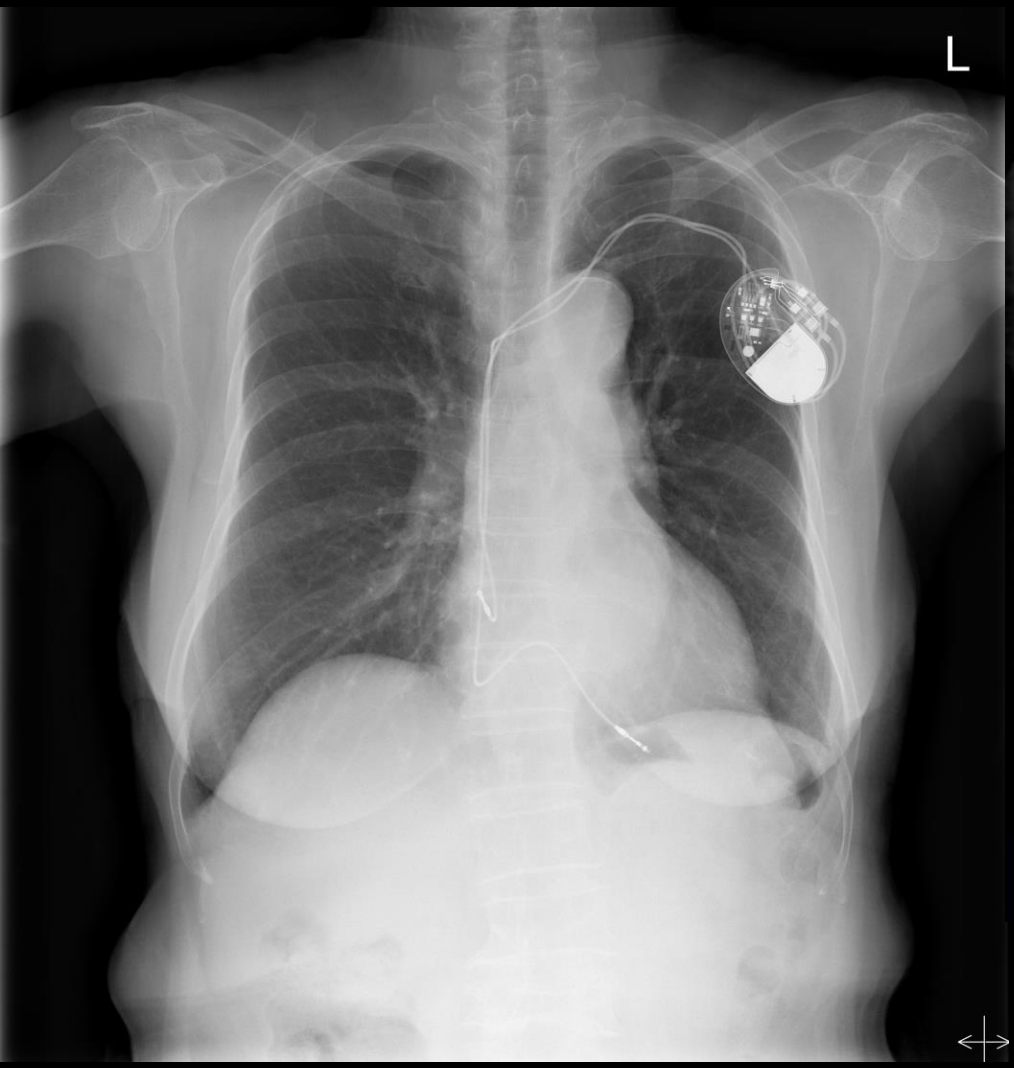
Initial PPM parameter

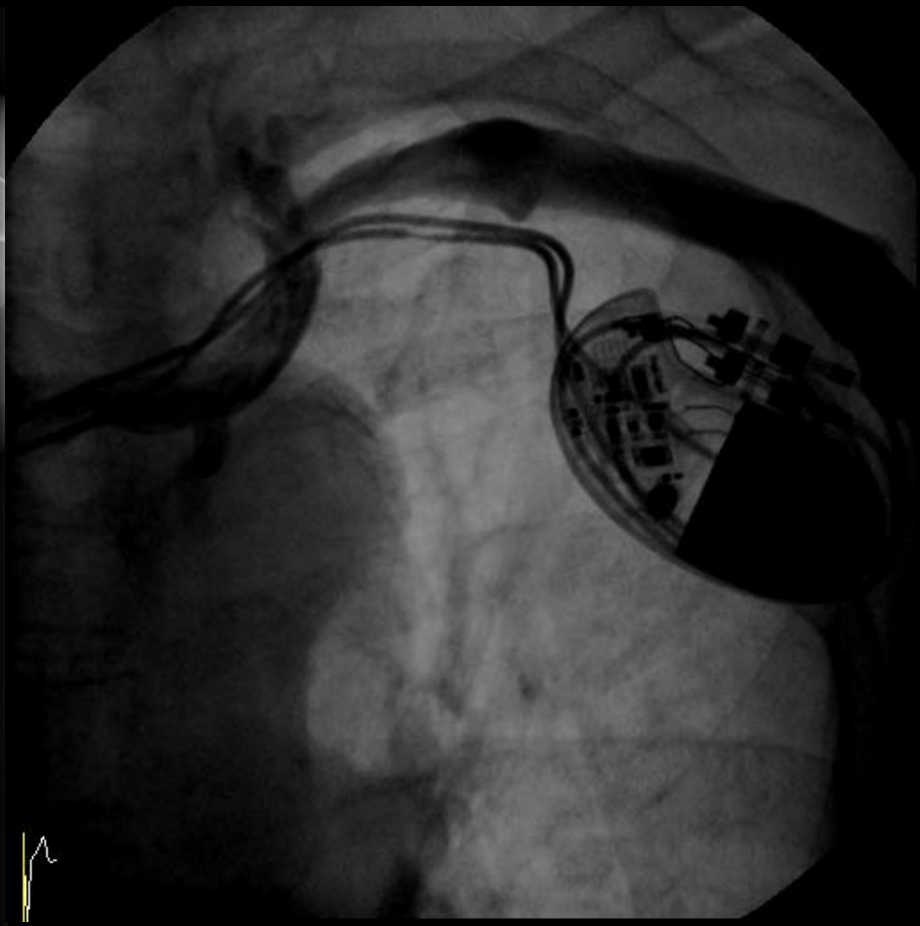
| | Atrium | Ventricle |
|---|---|---|
| P/R, mV | 1.4 | 12.0 |
| Threshold, V@ 0.4 ms | 0.75 | 0.5 |
| Impedance, Ohm | 467 | 509 |

# What is your diagnosis?

| | Atrium | Ventricle |
|---|---|---|
| P/R, mV | 1.25 | 7 |
| Threshold, V@ 0.4 ms | 0.5 | 0.75 |
| Impedance, Ohm | 371 | 2332 |

1. Insulation break of atrial lead
2. Lead fracture of atrial lead
3. Insulation break of ventricular lead
4. Lead fracture of ventricular lead

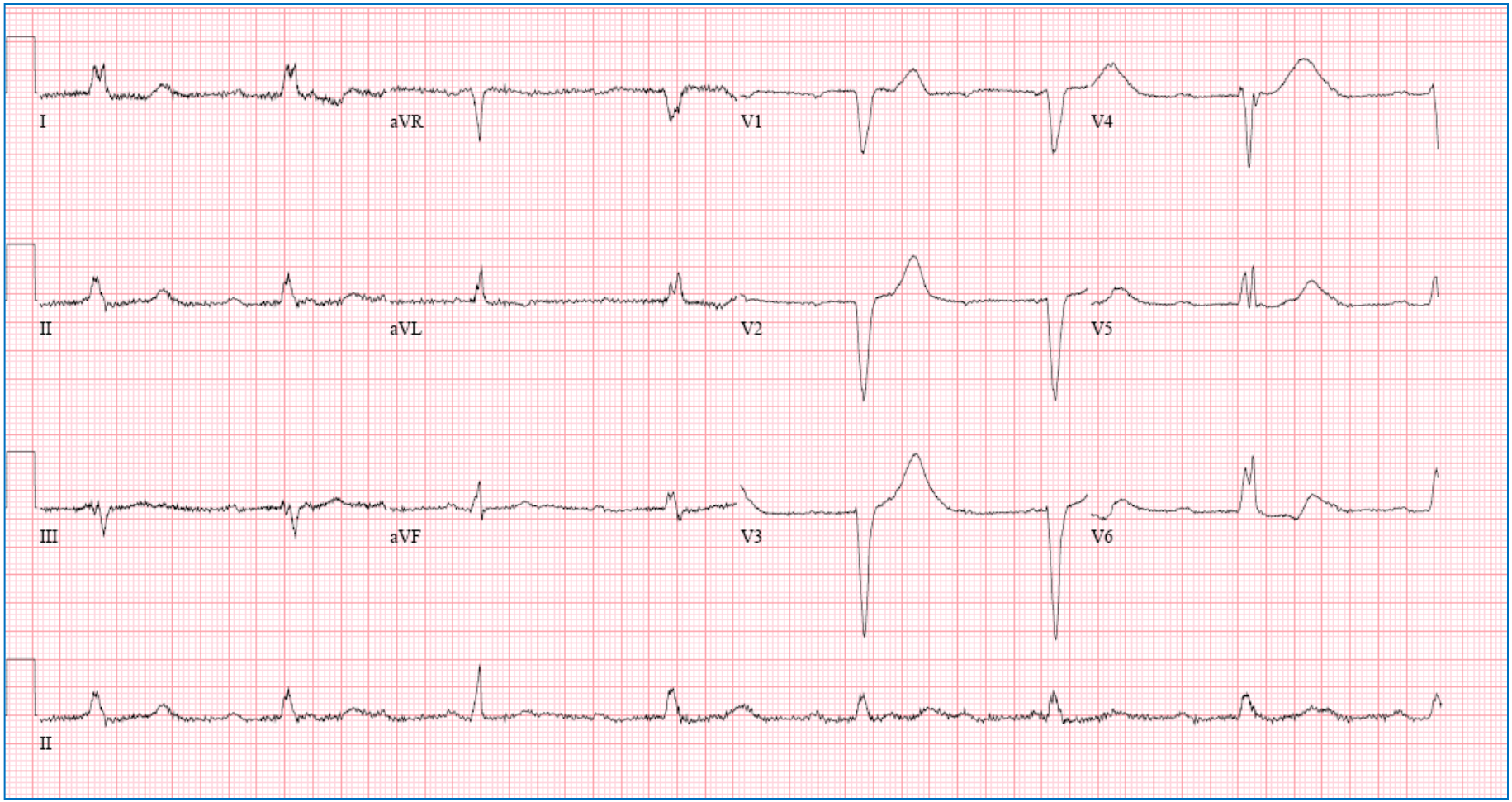


Intact function of a new ventricular lead during 5 years

# Case 22.

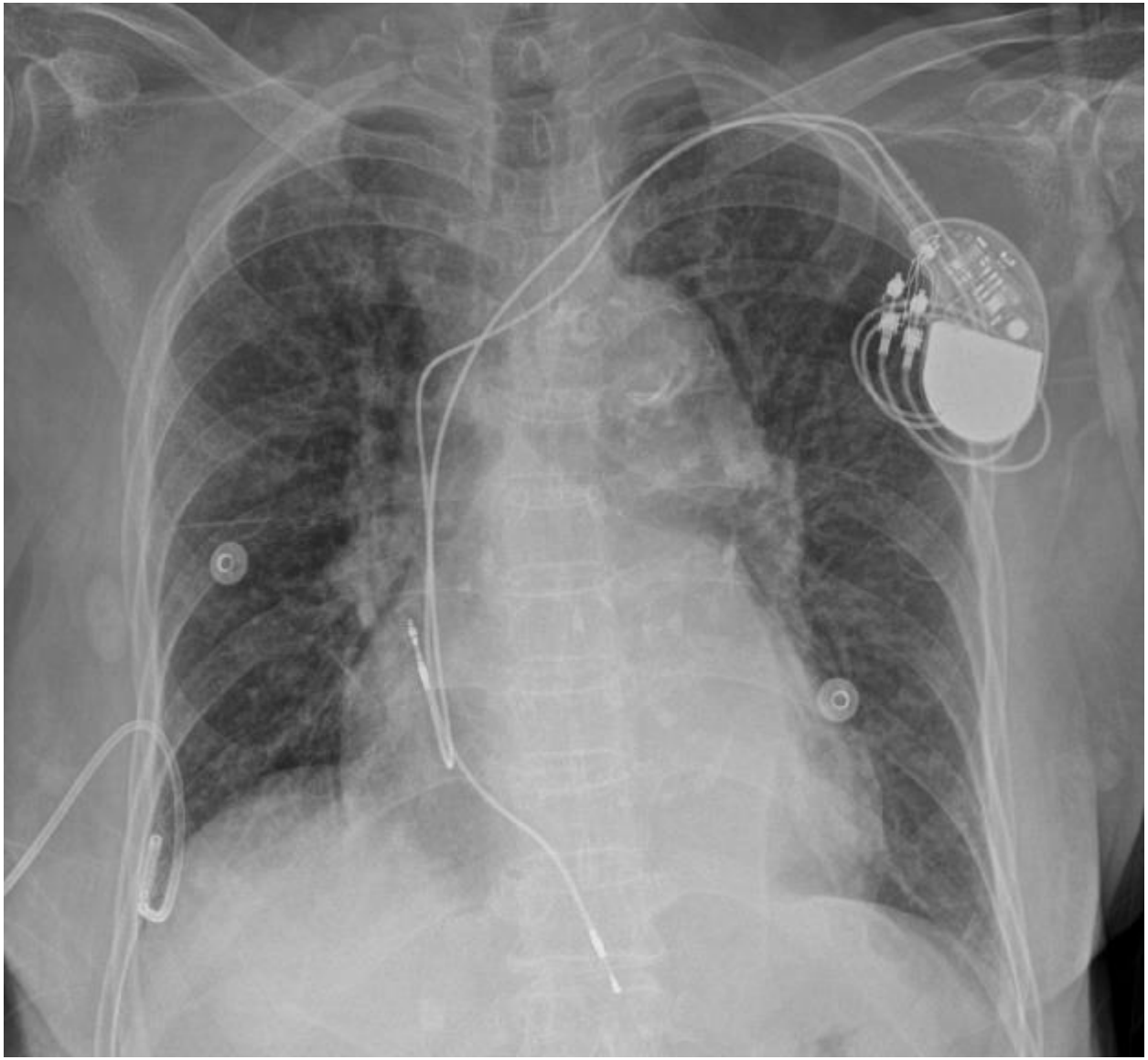
**70/F**
**Dizziness, syncope**



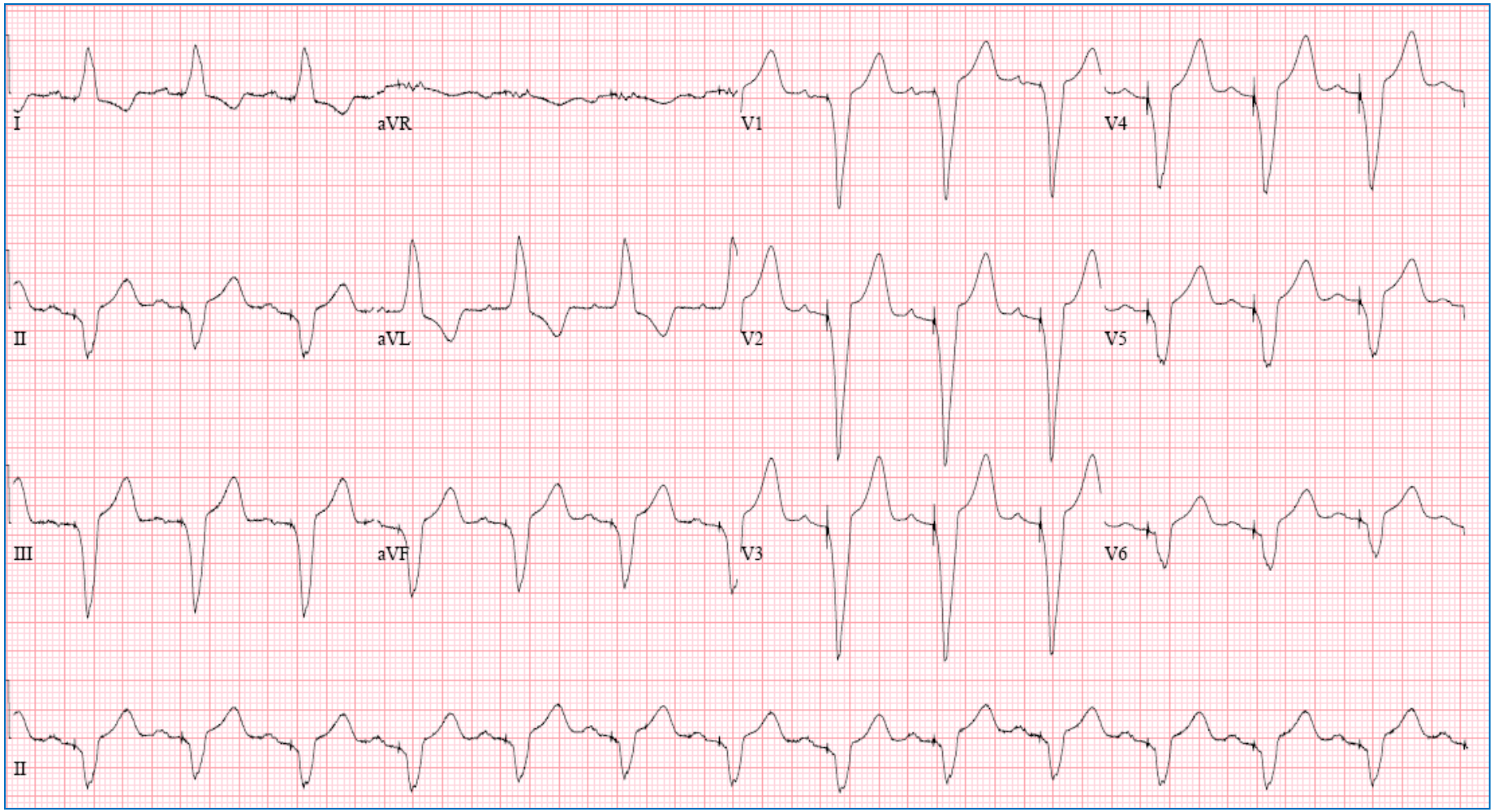
# What is your diagnosis?

1. Iso-rhythmic AV dissociation
2. Juntional bradycardia
3. Complete AV block

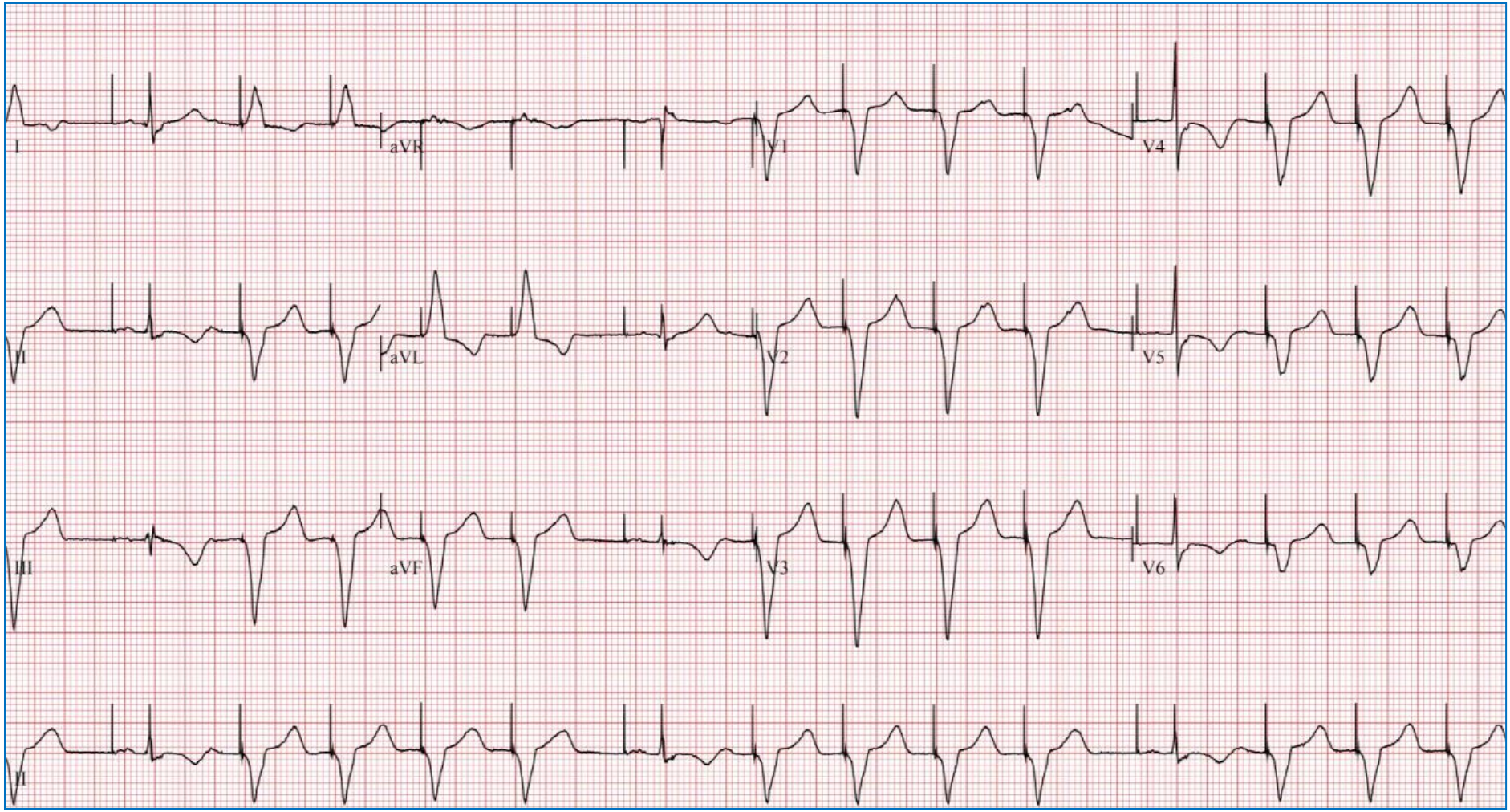
# PPM insertion : DDD type



# ECG after PPM



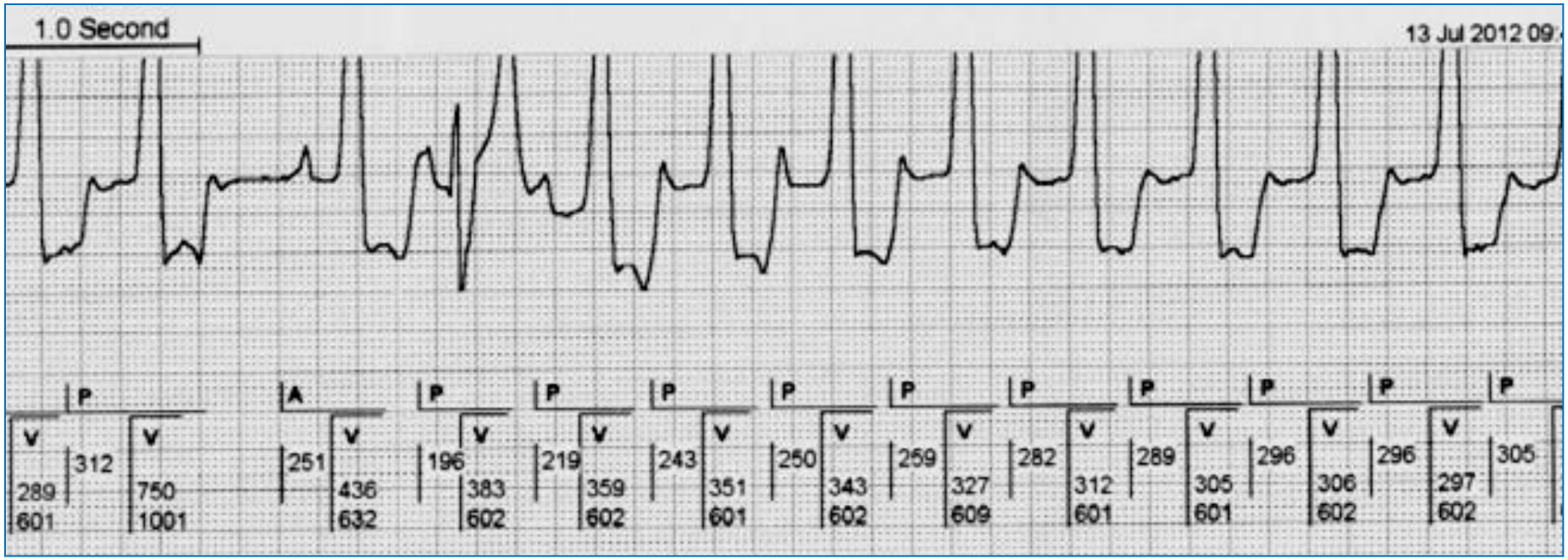
# Palpitation during OPD F/U



# What is the mechanism of tachycardia?

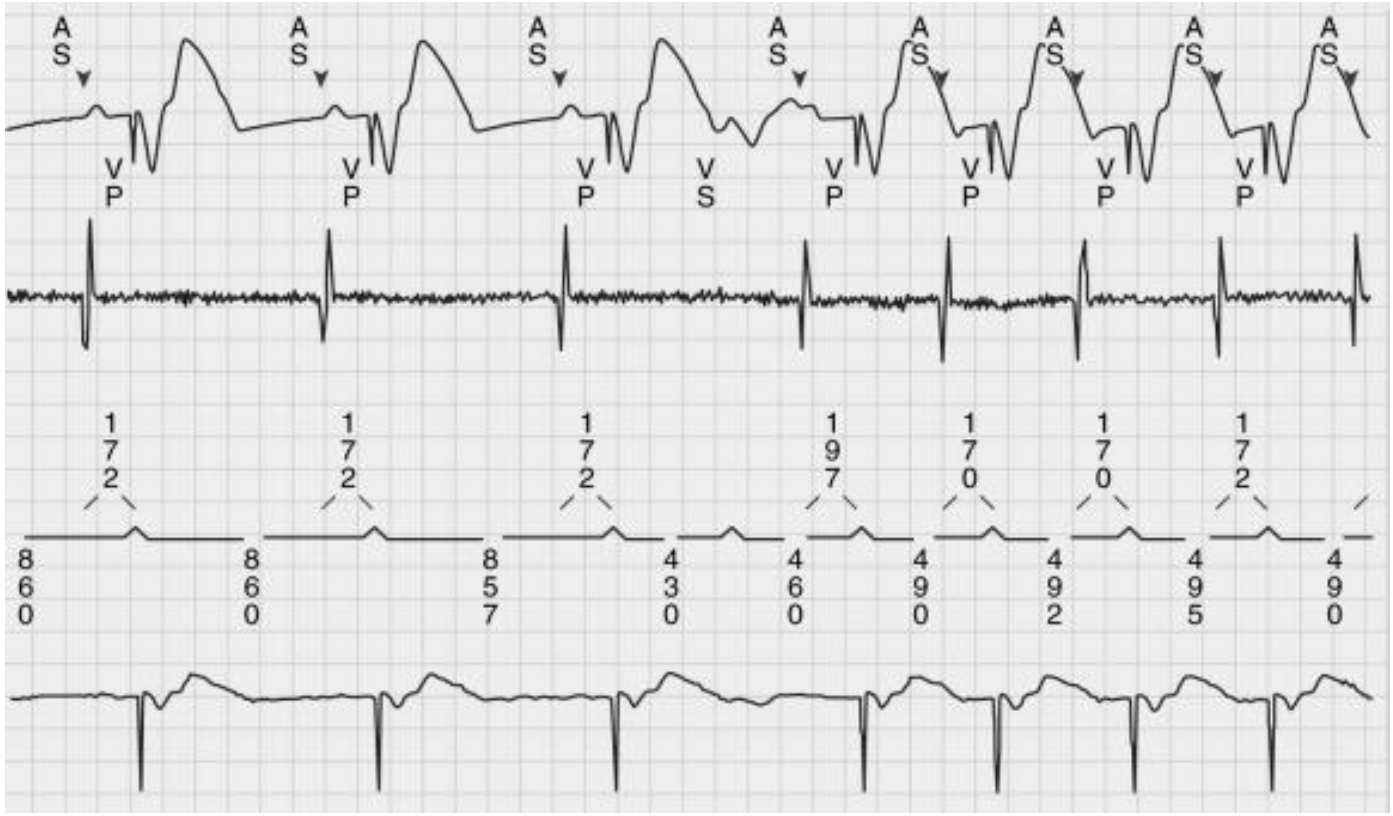
1. Atrial tachycardia
2. Atrial fibrillation
3. Pacemaker mediated tachycardia
4. Physiologic response

# PPM analysis



# Pacemaker mediated tachycardia

• Endless-loop tachycardia is used to refer to a form of a reentrant tachycardia due to restrograde VA conduction in dual chamber pacemaker

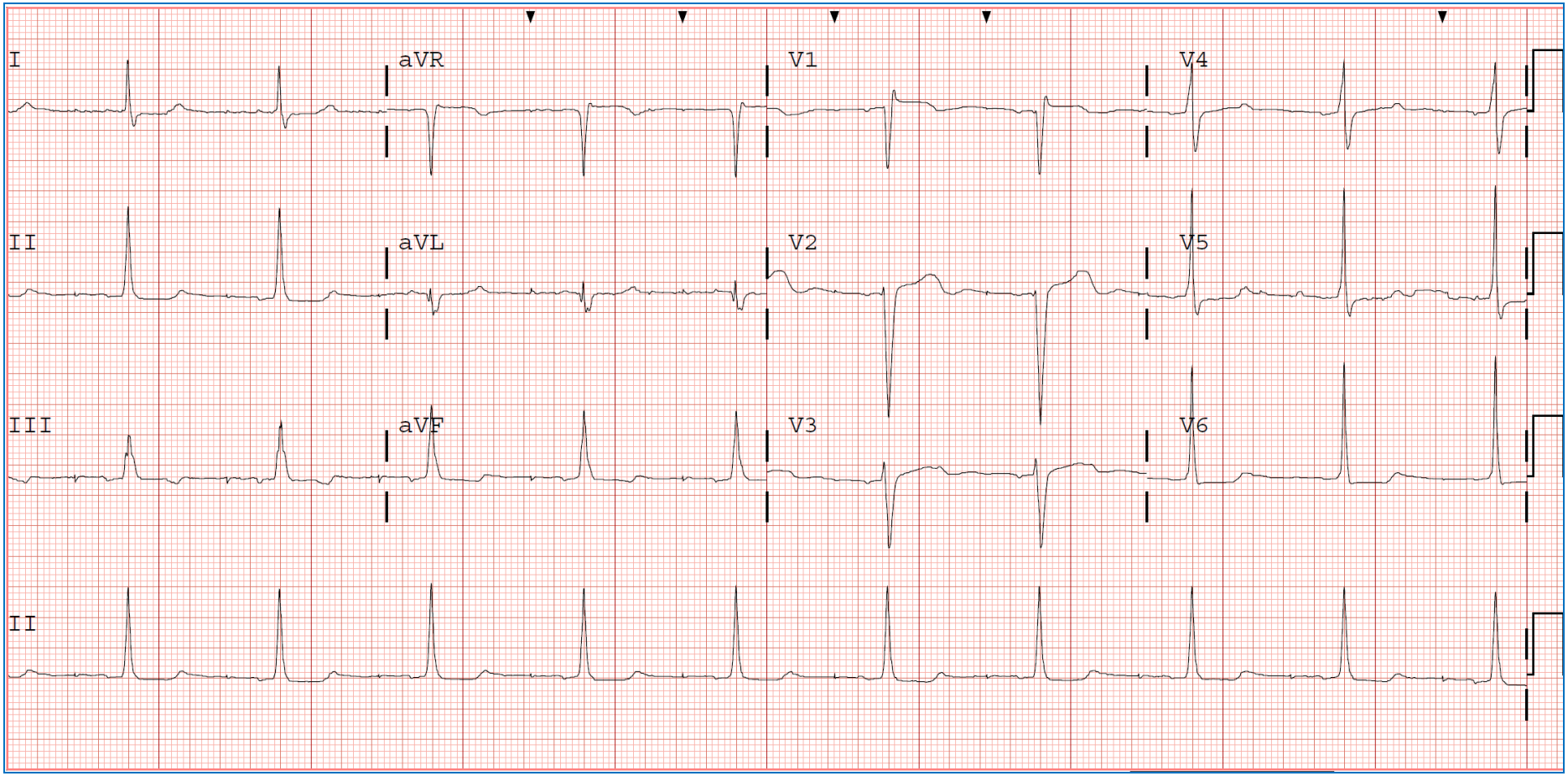


# Case 23.

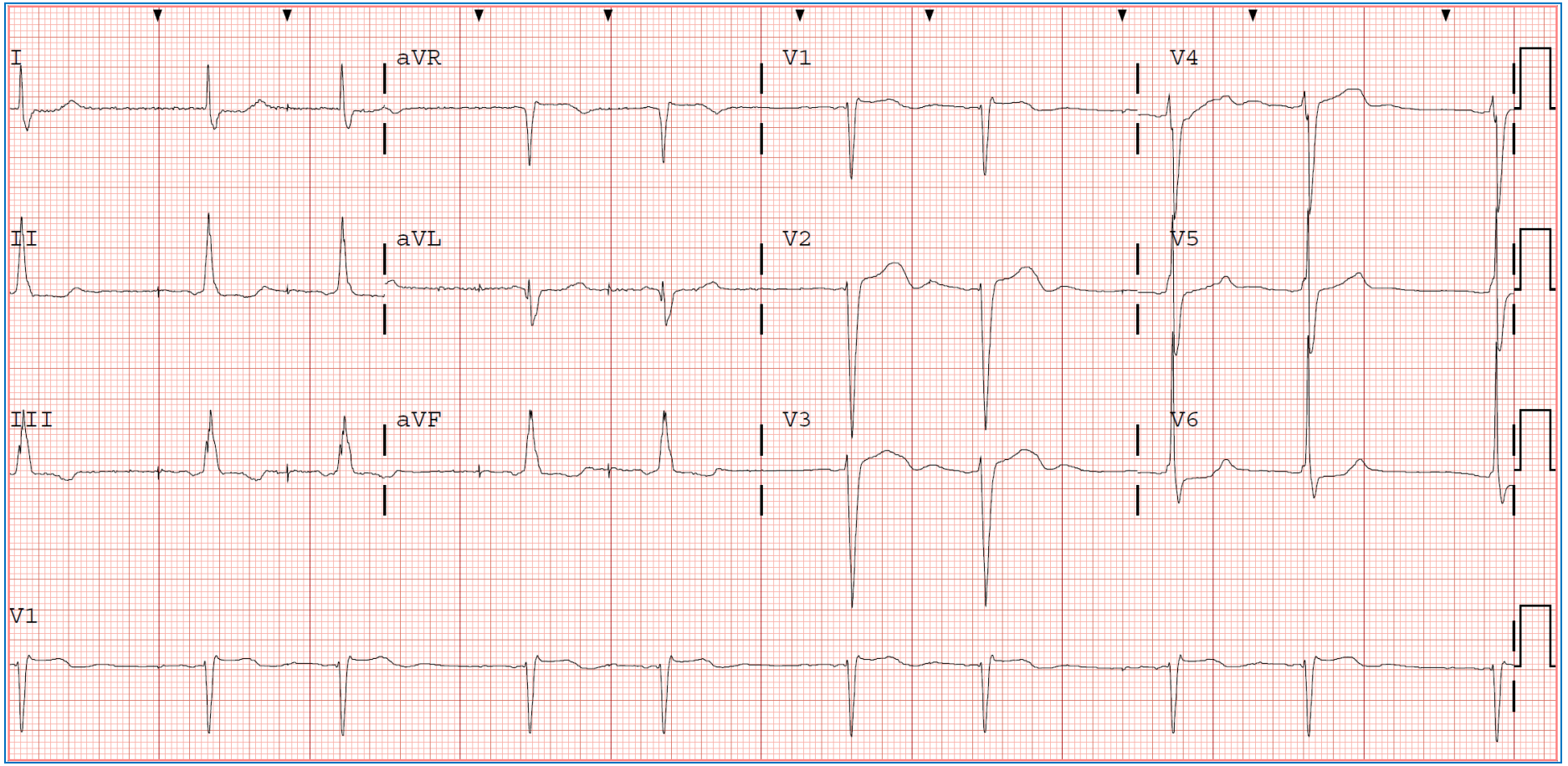
68/F, s/p DDD pacemaker for SSS and PAF (1997.12)
s/p DDDR pacemaker replacement d/t ERI (2010.8.12)

| | Atrium | Ventricle |
|---|---|---|
| P/R, mV | No P | 2.8 |
| Threshold, V@ 0.4 ms | 1.0 | 1.5 |
| Impedance, Ohm | 446 | 328 |

# 2009-10-11



# AAI lower rate 60 bpm
# 2 yrs after replacement



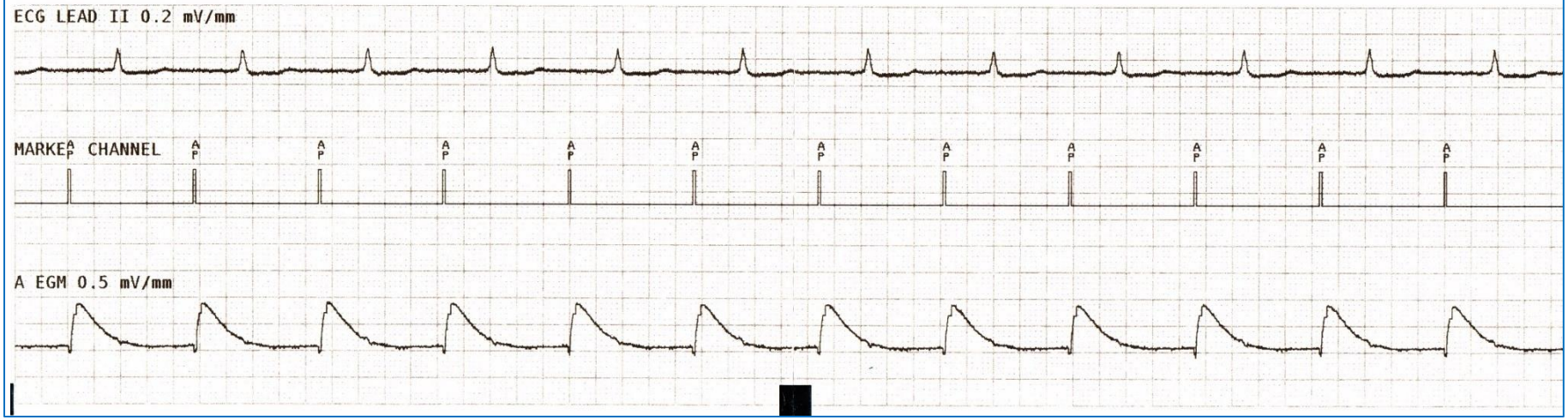
# What is your diagnosis?

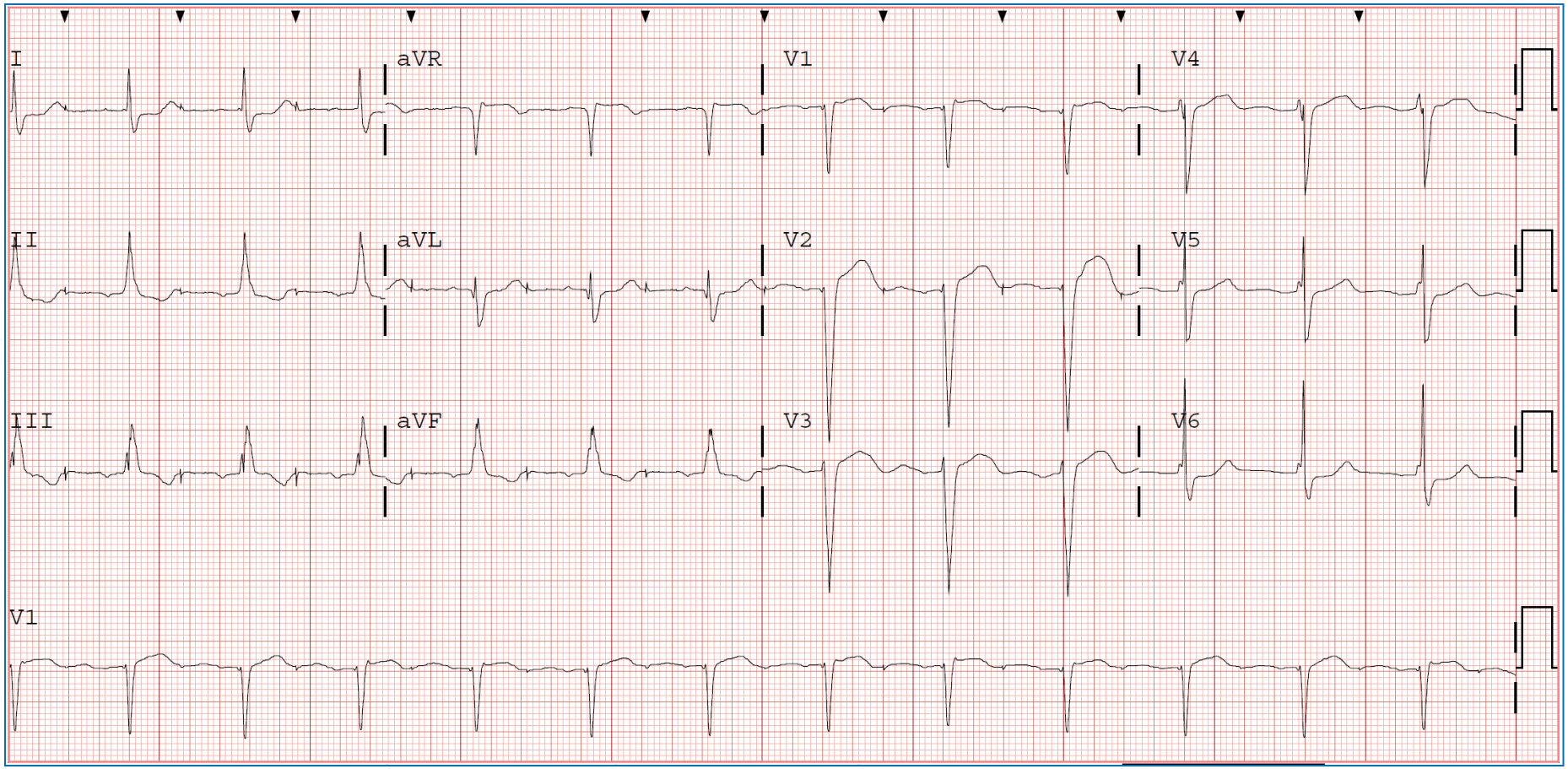
1. Atrial undersensing
2. Atrial oversensing
3. Ventricular undersensing
4. Ventricular oversensing

Atrial sensitivity =0.1 mV


CHART SPEED 25.0 mm/s

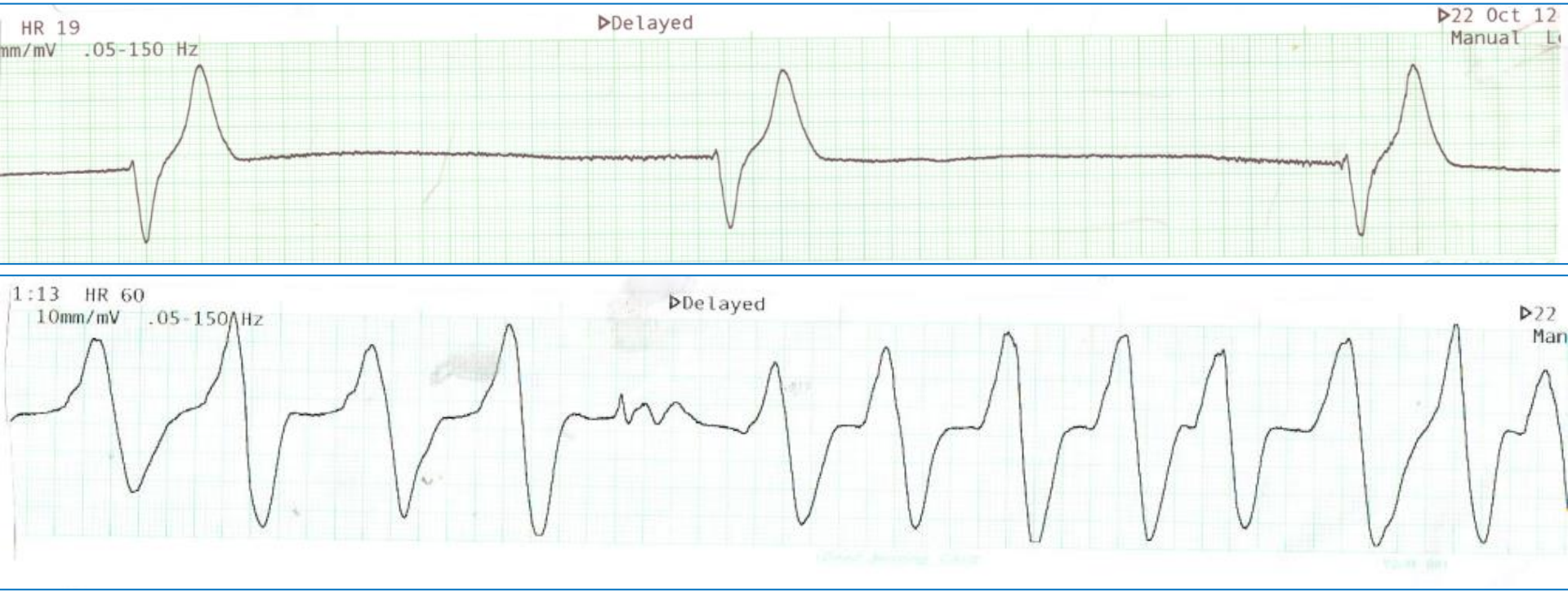
Atrial sensitivity=0.35 mV



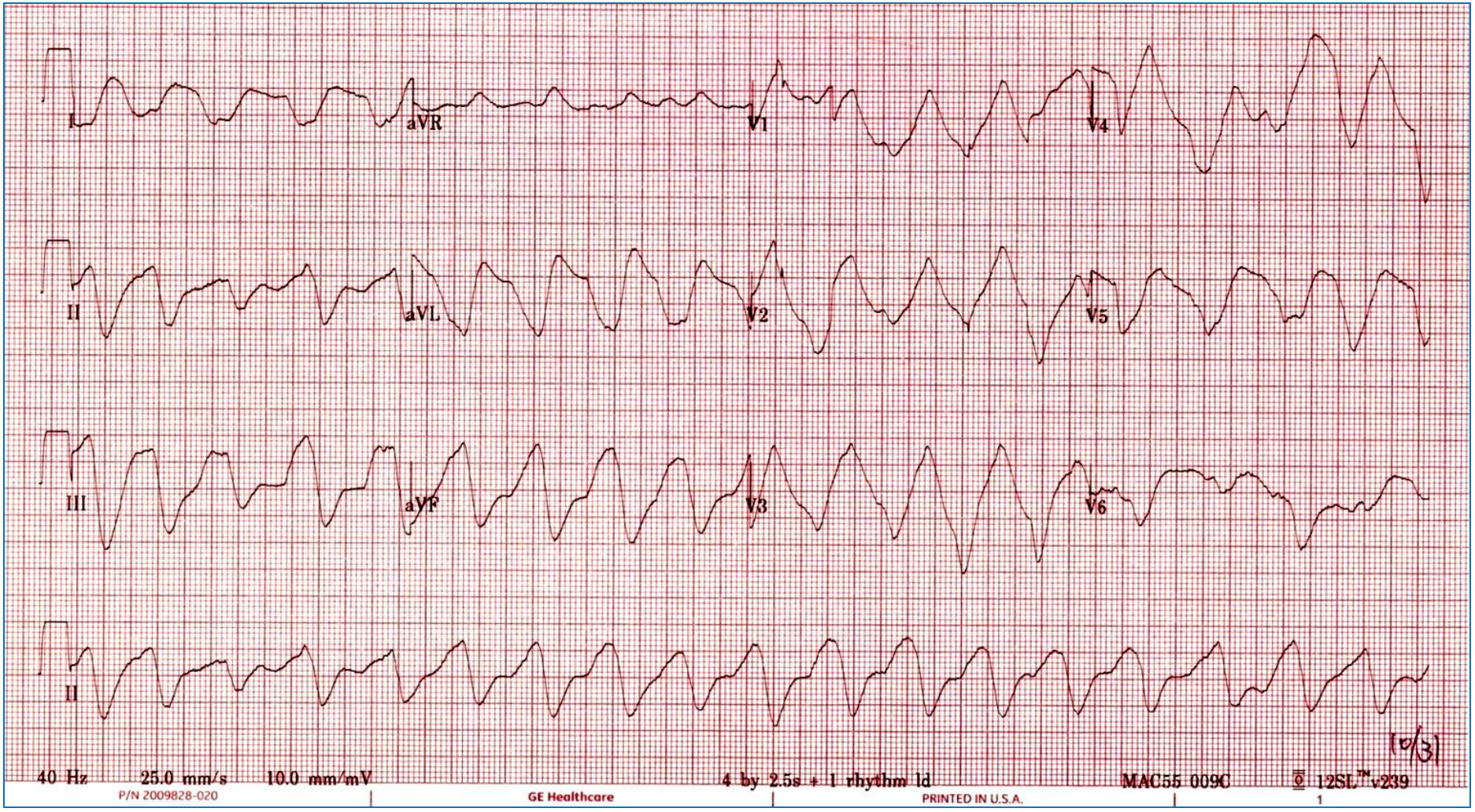

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

# Case 24.

**69/M, ESRD**
**Syncope**



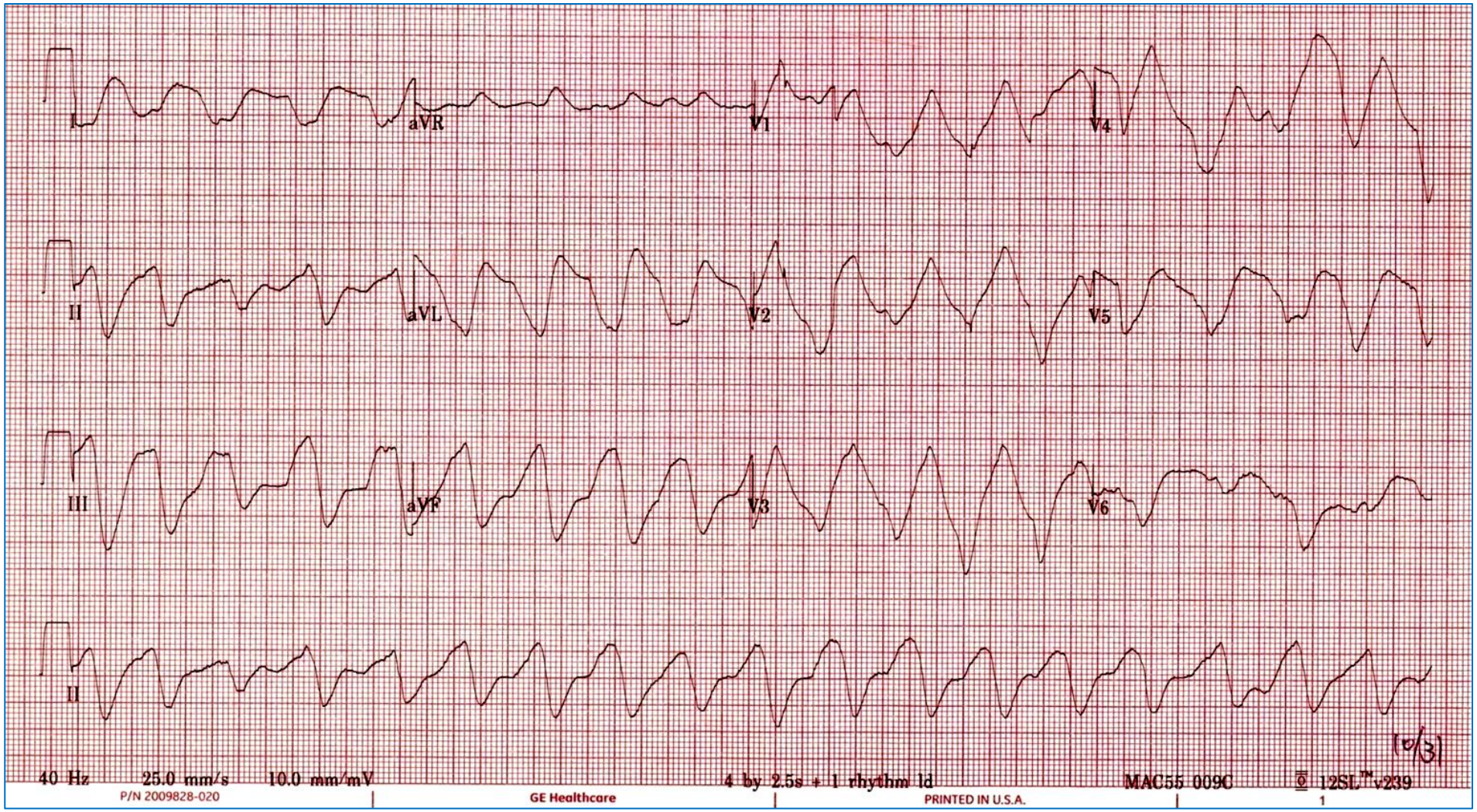
# ECG


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
40 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 1 rhythm ld
MAC55 009C
12SL™ v239
P/N 2009828-020
GE Healthcare
PRINTED IN U.S.A.
1

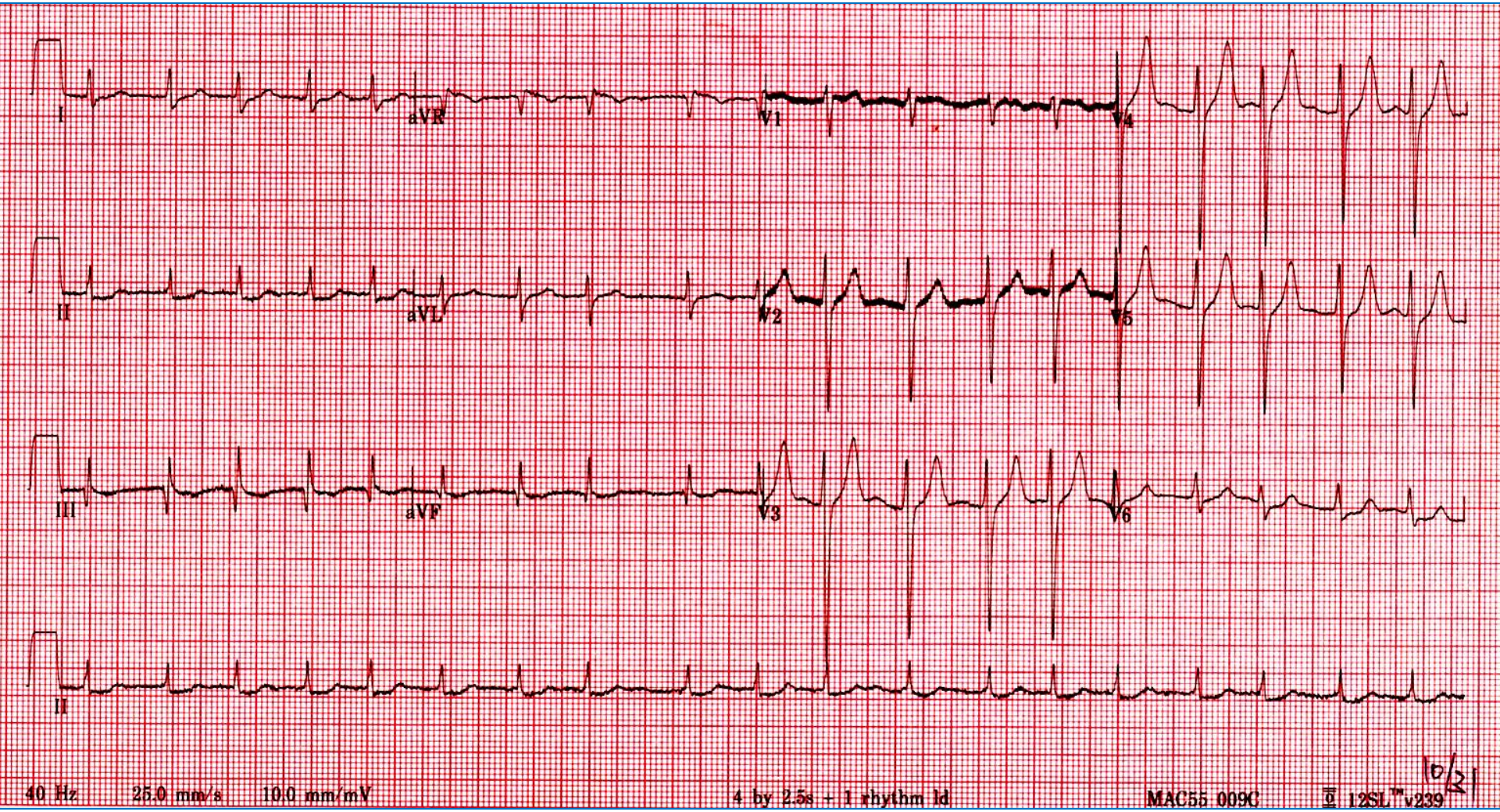
# What is your diagnosis?

1. Hypokalemia
2. Hyperkalemia
3. Hypocalcemia
4. Hypecalcemia
5. Hypomagnesemia

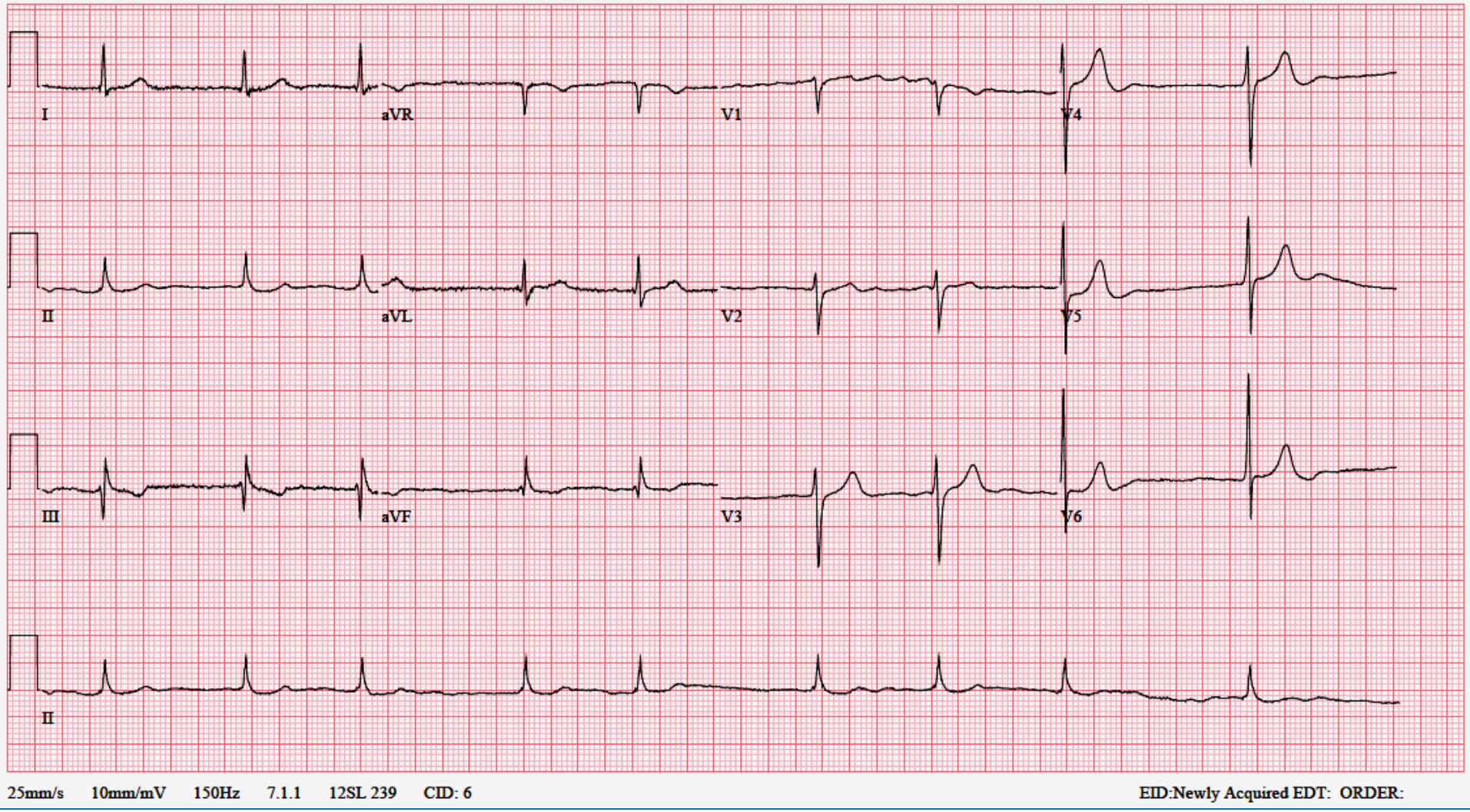
# Serum $K^+$=9.0 mEq/L



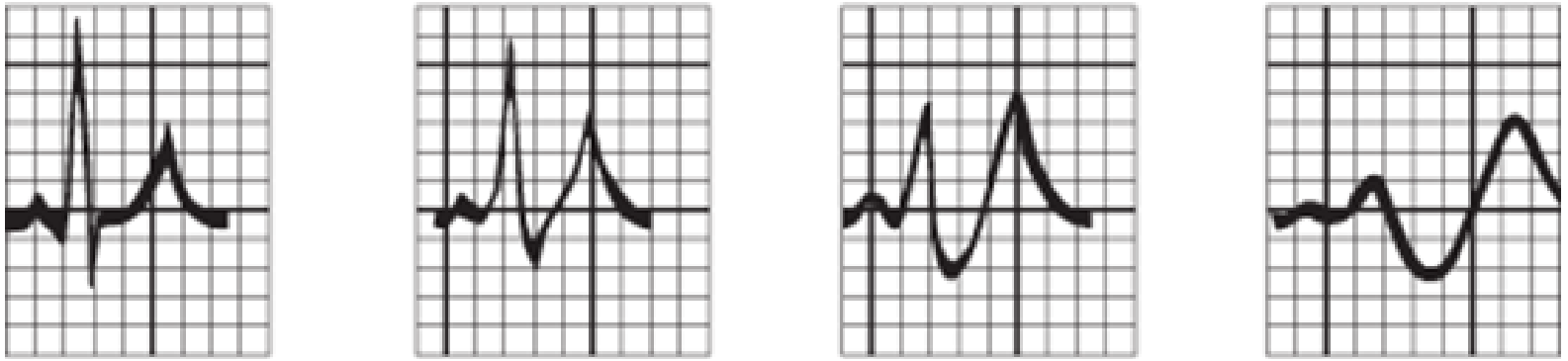
# Serum $K^+$=7.5 mEq/L



# Serum $K^+$=4.1 mEq/L



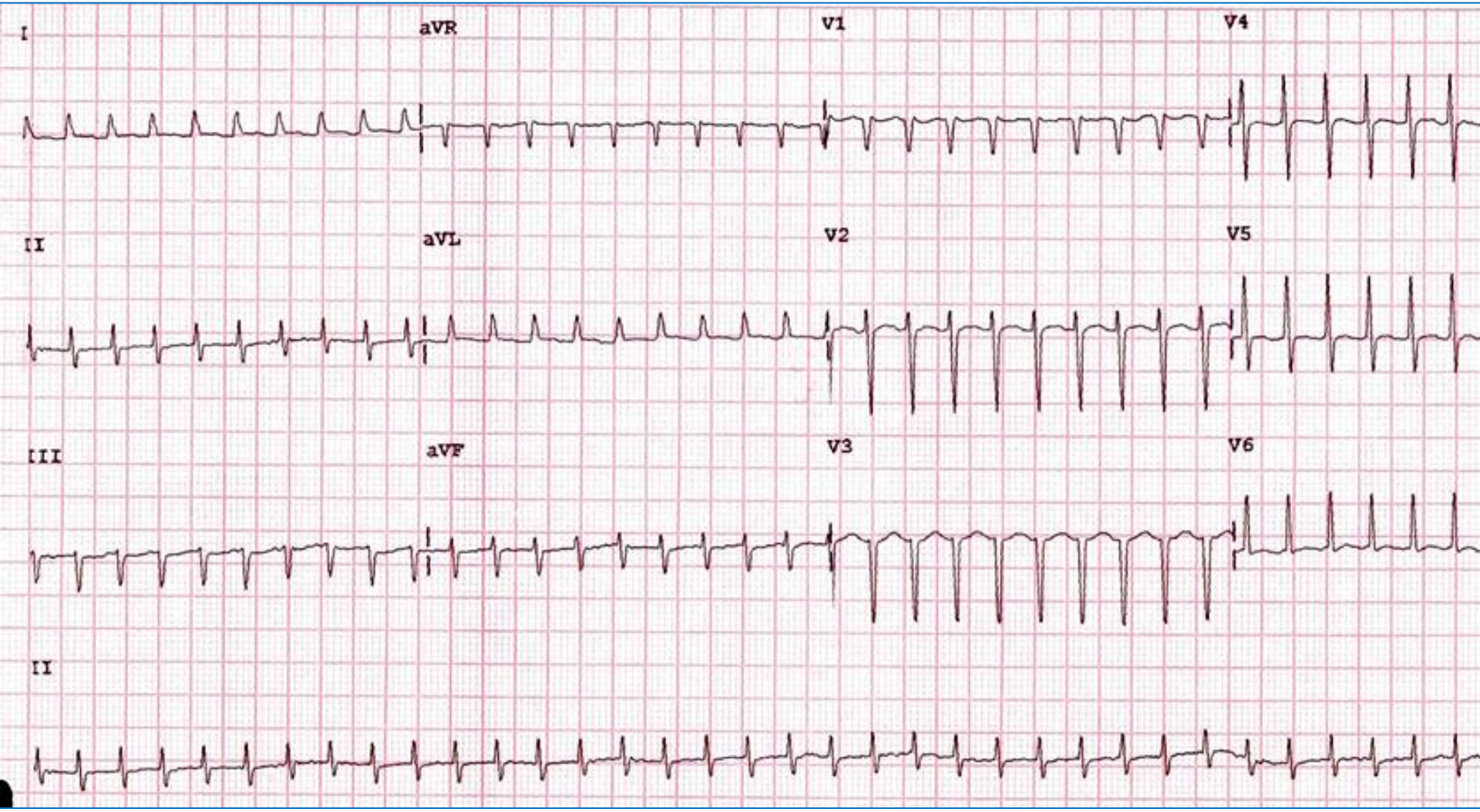
# Hyperkalemia ECG



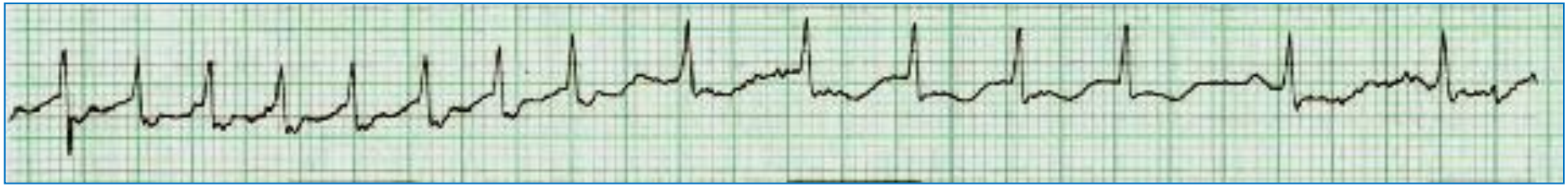

Hyperkalemia

# Case 25.

**53/F, Leukemia on chemo therapy**
**Consultation for management of tachcyardia**

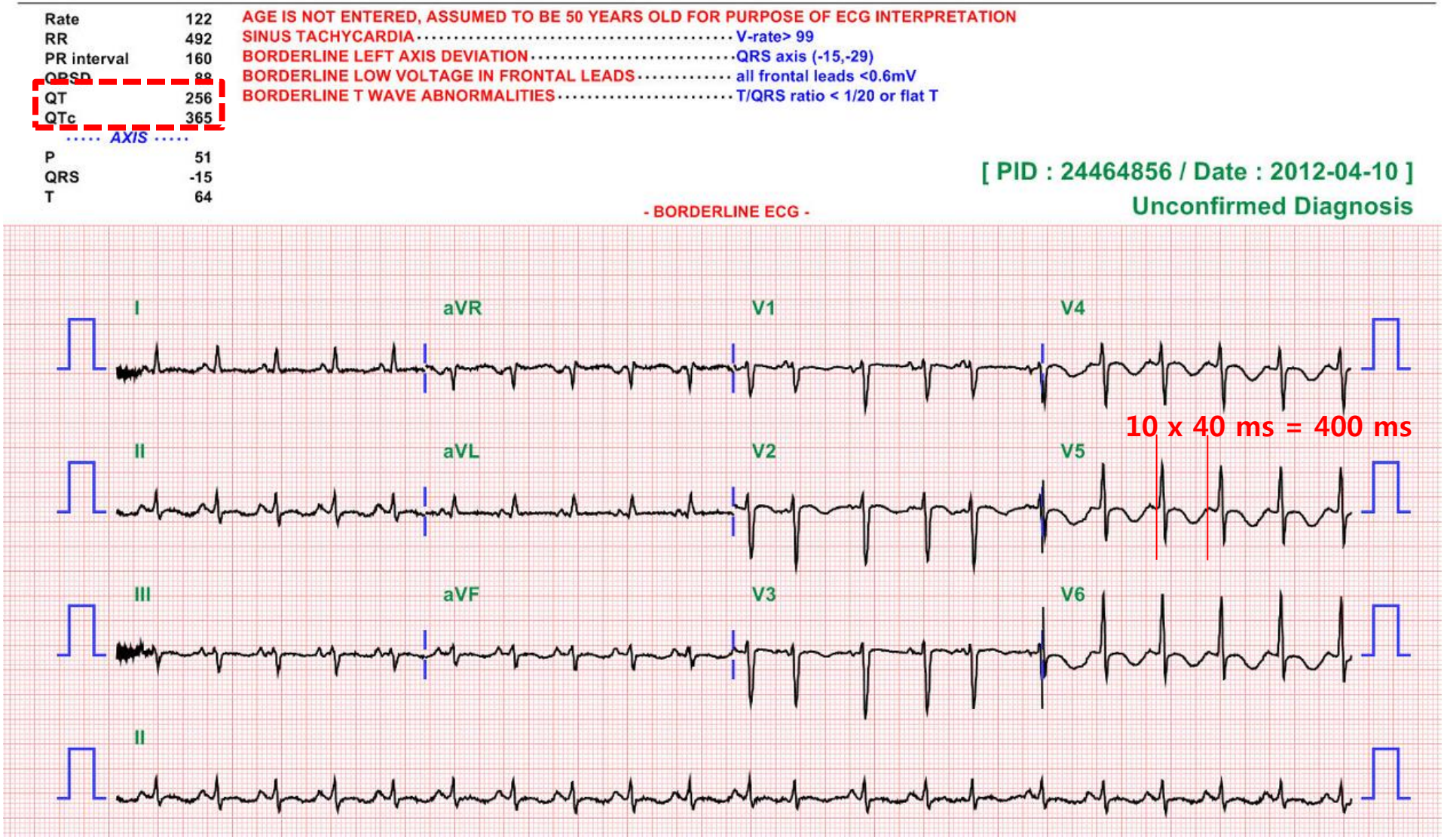


# Transition zone may be clue



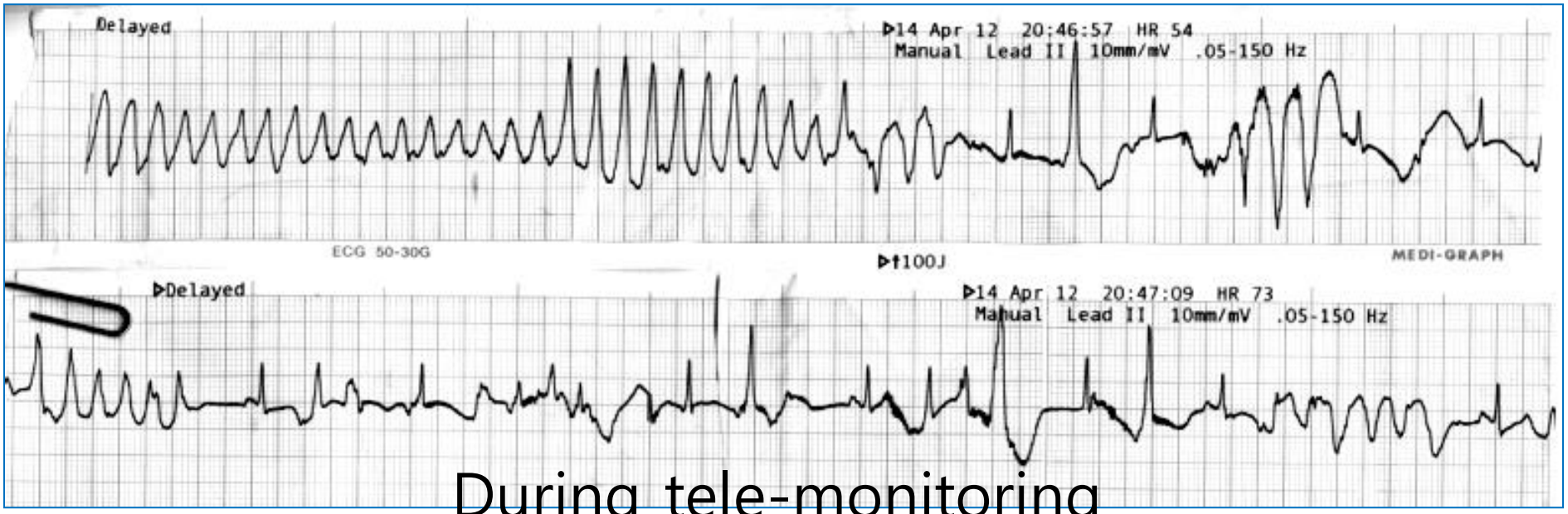
明若觀火

# 聲東擊西


Rate 122
RR 492
PR interval 160
QRSD 88
QT 256
QTc 365
AXIS
P 51
QRS -15
T 64
AGE IS NOT ENTERED, ASSUMED TO BE 50 YEARS OLD FOR PURPOSE OF ECG INTERPRETATION
SINUS TACHYCARDIA
V-rate> 99
BORDERLINE LEFT AXIS DEVIATION
QRS axis (-15,-29)
BORDERLINE LOW VOLTAGE IN FRONTAL LEADS
all frontal leads <0.6mV
BORDERLINE T WAVE ABNORMALITIES
T/QRS ratio < 1/20 or flat T
[ PID : 24464856 / Date : 2012-04-10 ]
Unconfirmed Diagnosis
- BORDERLINE ECG -
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
II
10 x 40 ms = 400 ms

| 검사항목 | 검체명 | 참고치 | 2-04-15 :12:17 | 2012-04-15 04:27:11 | 2012-04-15 02:58:37 | 2012-04-15 01:06:45 | 2012-04-14 22:51:59 |
|---|---|---|---|---|---|---|---|
| Potassium | Serum | 3.5 ~ 5.1 | | 4.0 | 3.5 | 3.2 | 2.8 |

| 2012-04-14 20:16:34 | 2012-04-14 05:02:00 | 2012-04-13 03:58:17 | 2012-04-12 04:27:12 | 2012-04-11 13:06:52 | 2012-04-11 04:27:11 | 2012-04-10 09:01:19 |
|---|---|---|---|---|---|---|
| 3.1 | 3.6 | 3.1 | 3.2 | 2.6 | 2.6 | 2.8 |



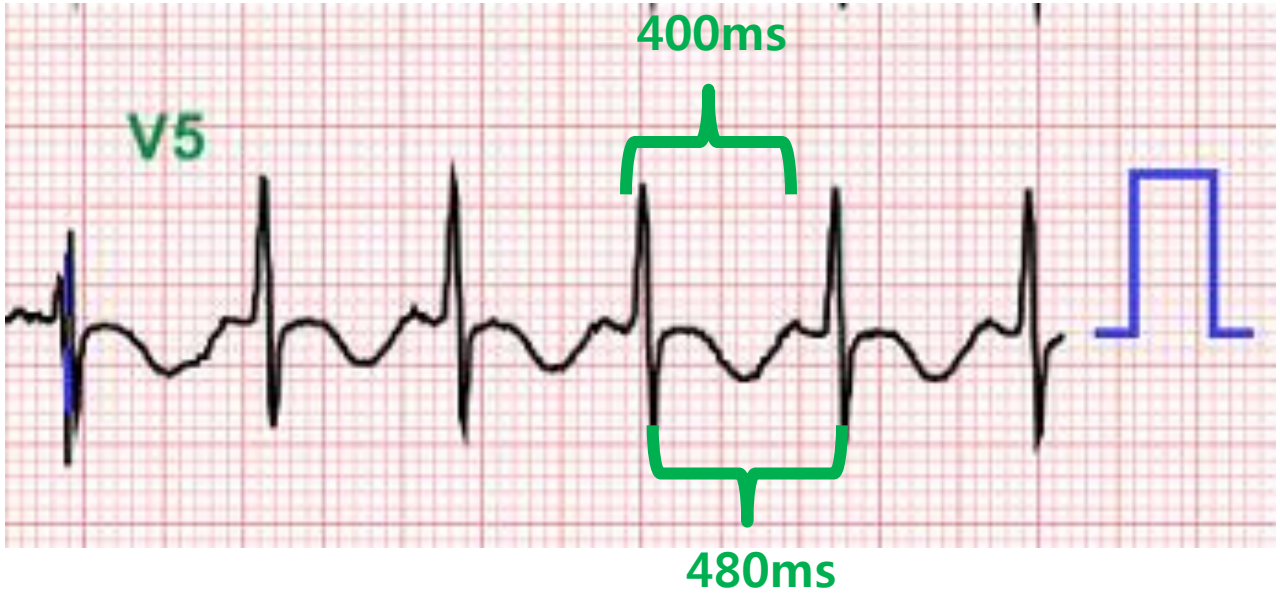

During tele-monitoring

# QT interval 측정 (1)


$$QTc = \frac{QT}{\sqrt{RR}}$$

- QT = 40ms x 10 = 400ms
- QT 는 HR 이 빨라지면 짧아진다!
- QTc = 400 / √0.48 = 571ms

# QT interval 측정 (2)




**QT > RR / 2**

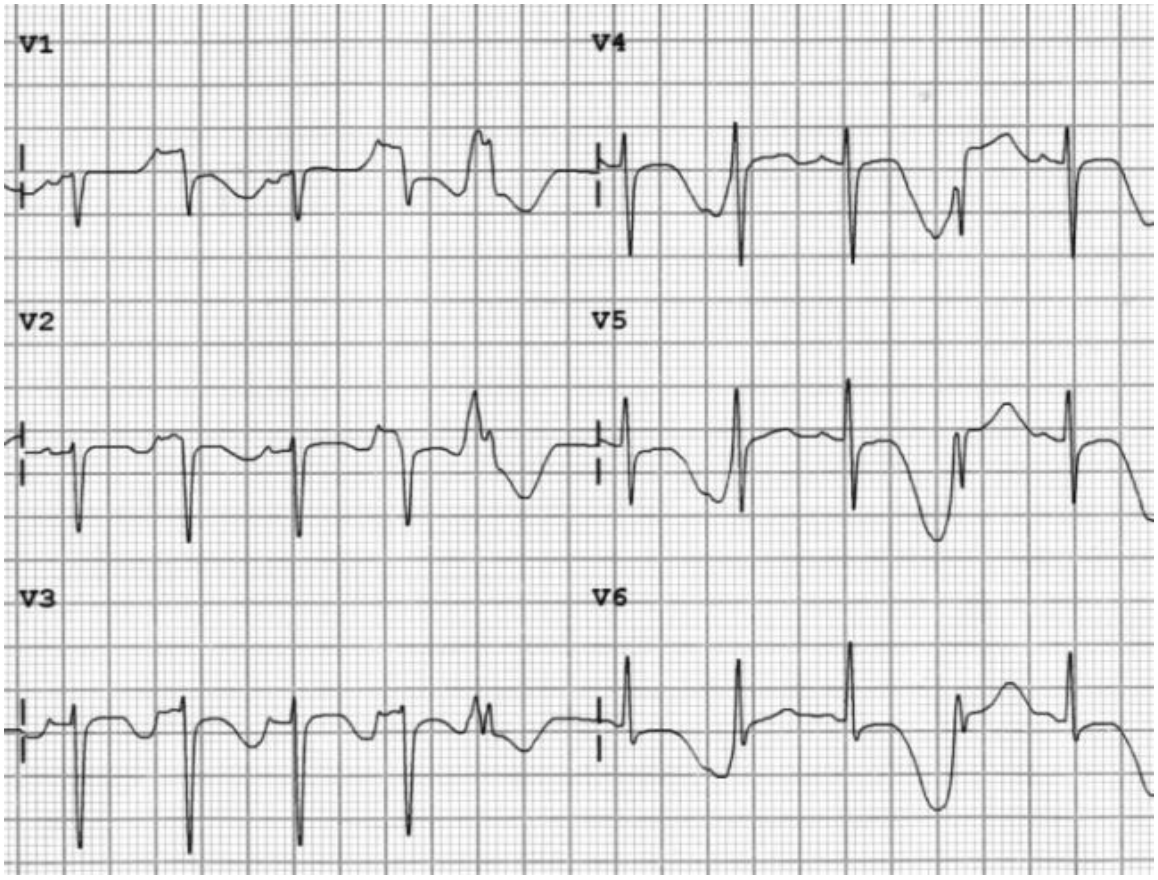
# QT interval 측정 (3)


| | |
|---|---|
| Rate | 122 |
| RR | 492 |
| PR interval | 160 |
| QRSD | 88 |
| QT | 256 |
| QTc | 365 |

- **400 x 365/256 = 570ms**

**≈ 400 + 110 = 520ms**

# After amiodarone iv

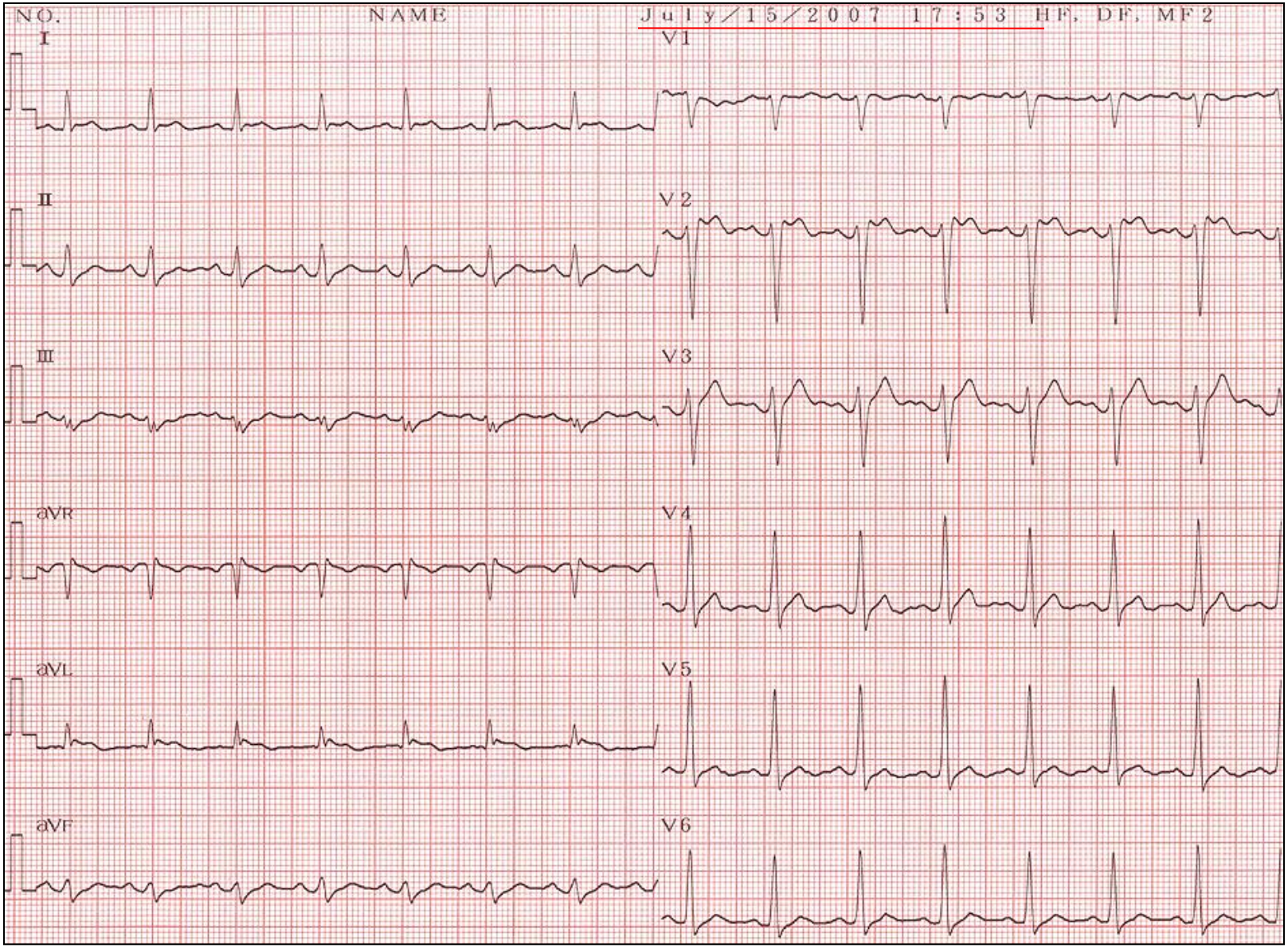



# Torsades de pointes

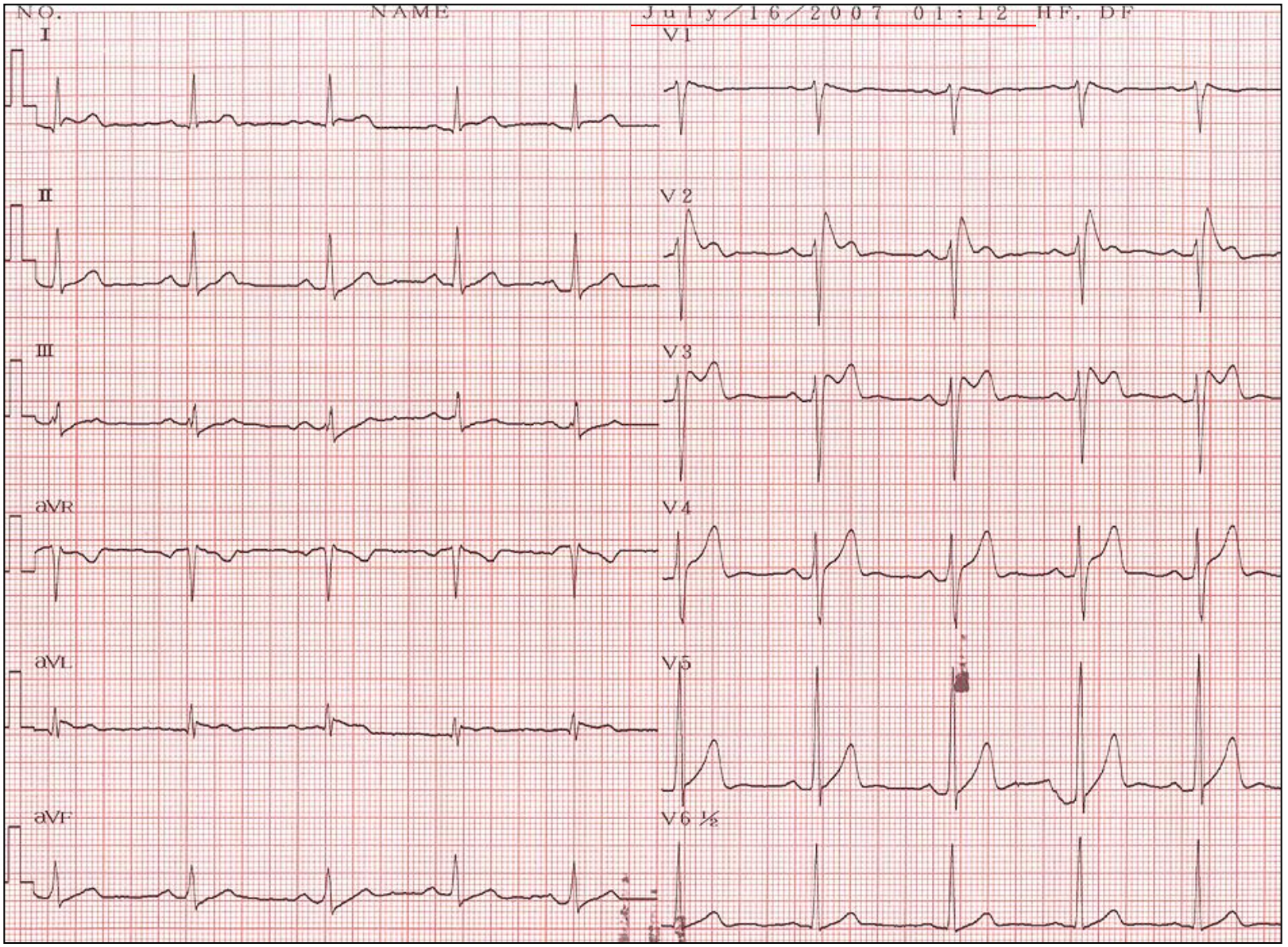
- Not unusual in post-operation setting
  - poor diet, hypokalemia, numerous drug, amiodarone…
- **Hypokalemia**
  => QT prolongation
- Treatment
  - $K^+$ correction, iv magnesium (6~10g/day) regardless of level
  - Isoproterenol or temporary pacing
- The only (short-term) contraindication of **amiodarone** !

# Case 26.

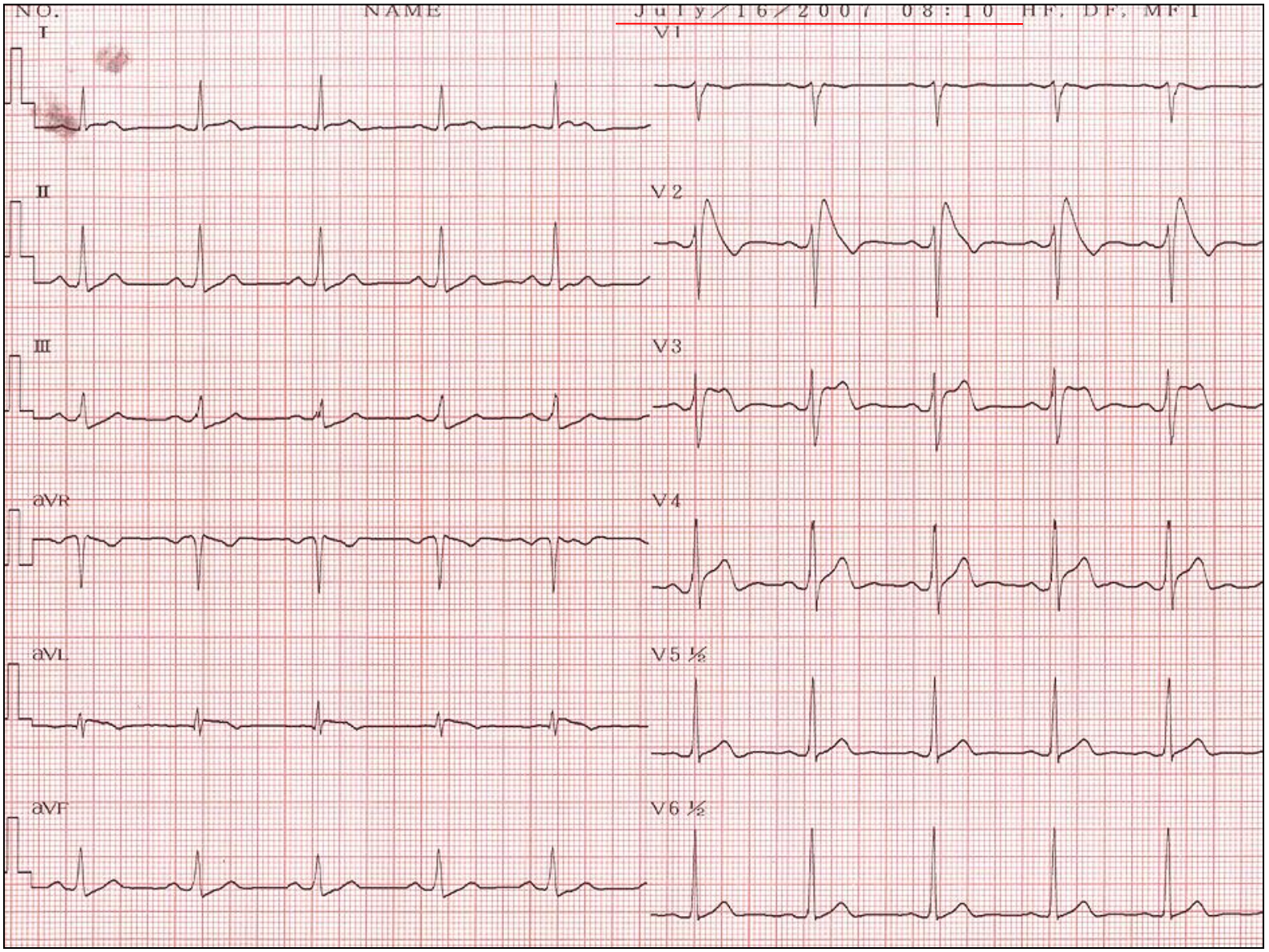
M/35, syncope



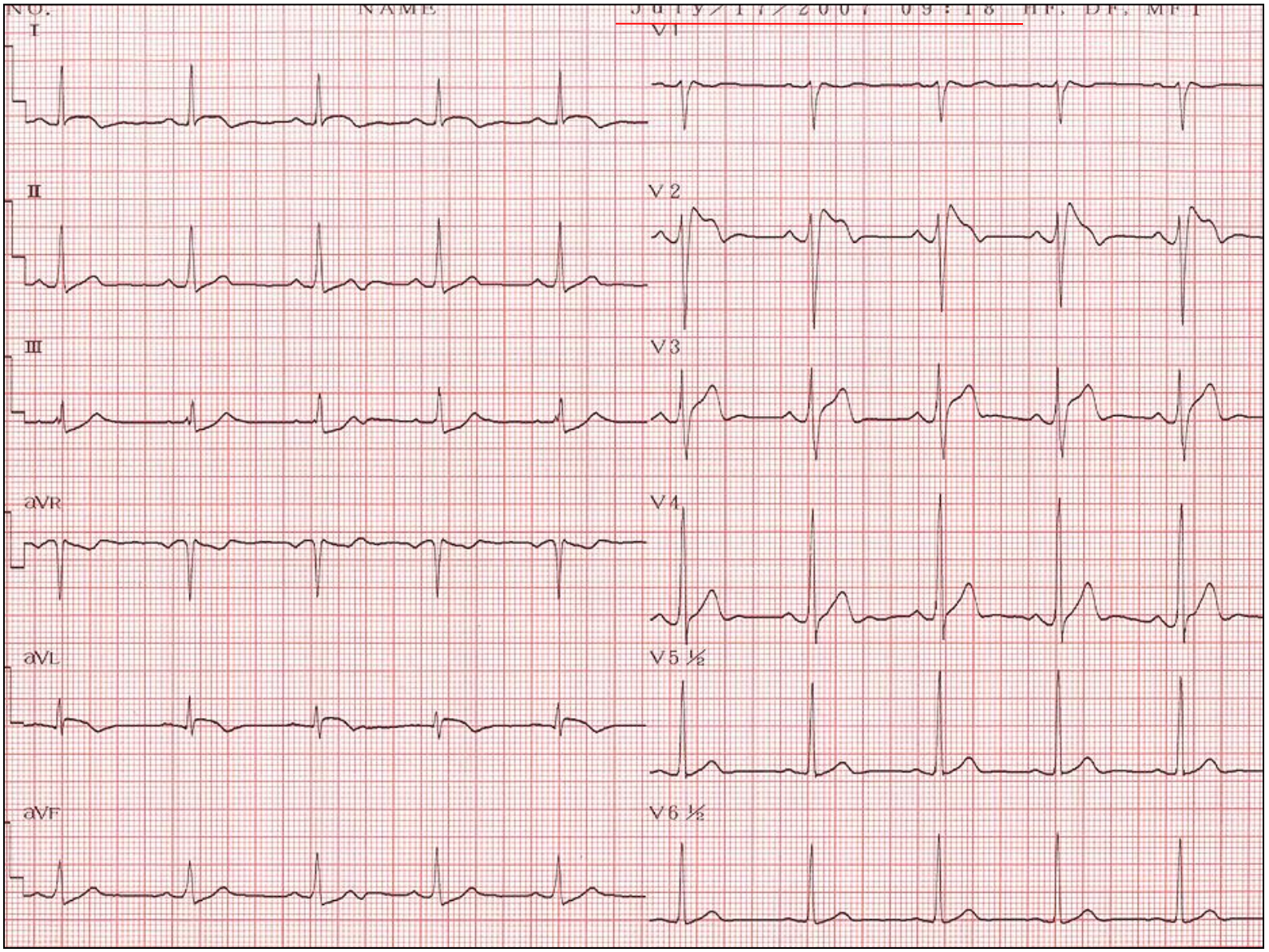
# F/U ECG after 5 hr



# F/U ECG after 7 hr



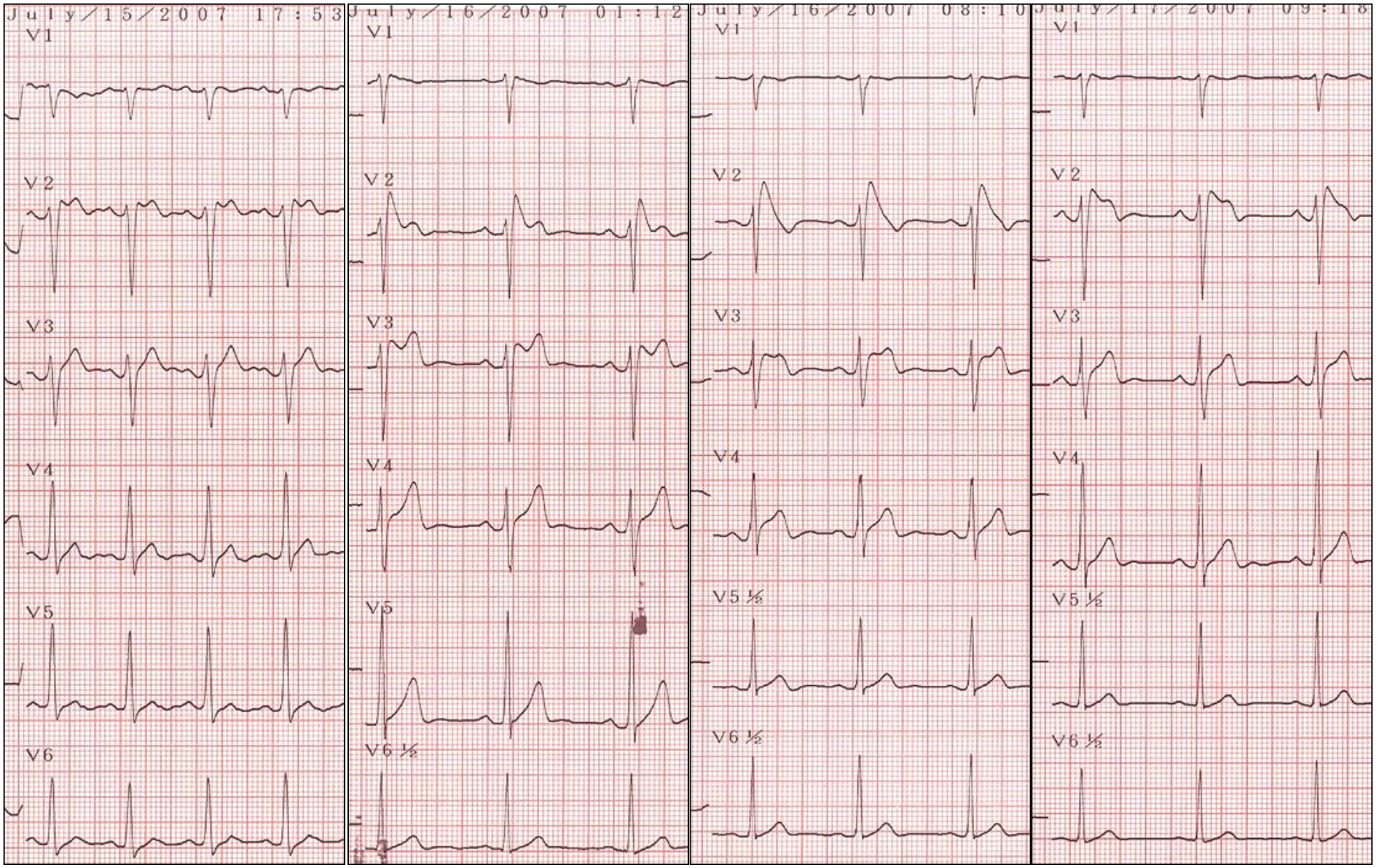
# F/U ECG after 1 day



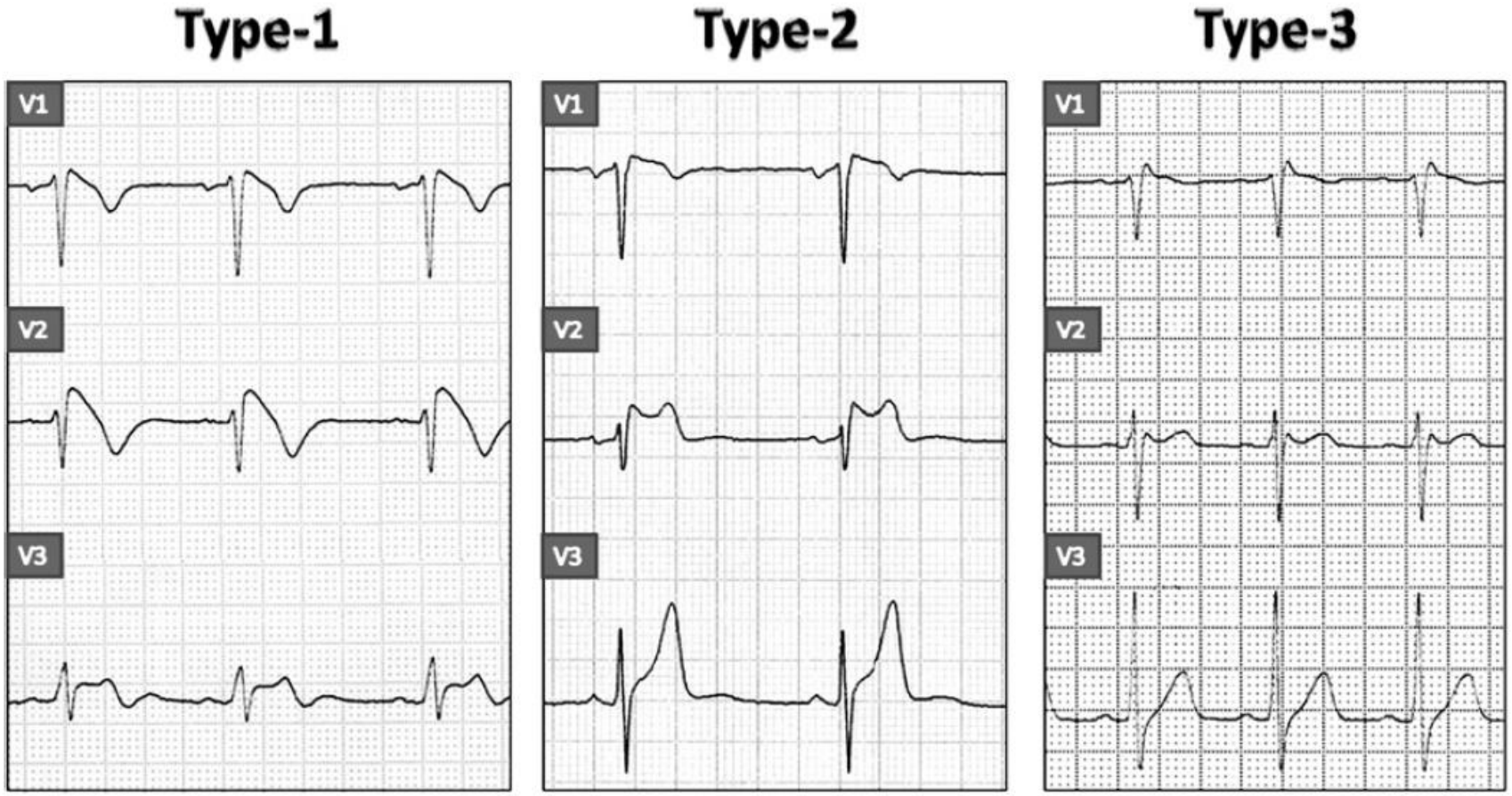
# 진단은 ?

1. RBBB
2. ST elevation MI
3. Brugada syndrome
4. Short QT syndrome

# Serial ECG at right precordial lead



# Three different ECG patterns in Brugada syndrome




coved-type pattern

saddle-back pattern

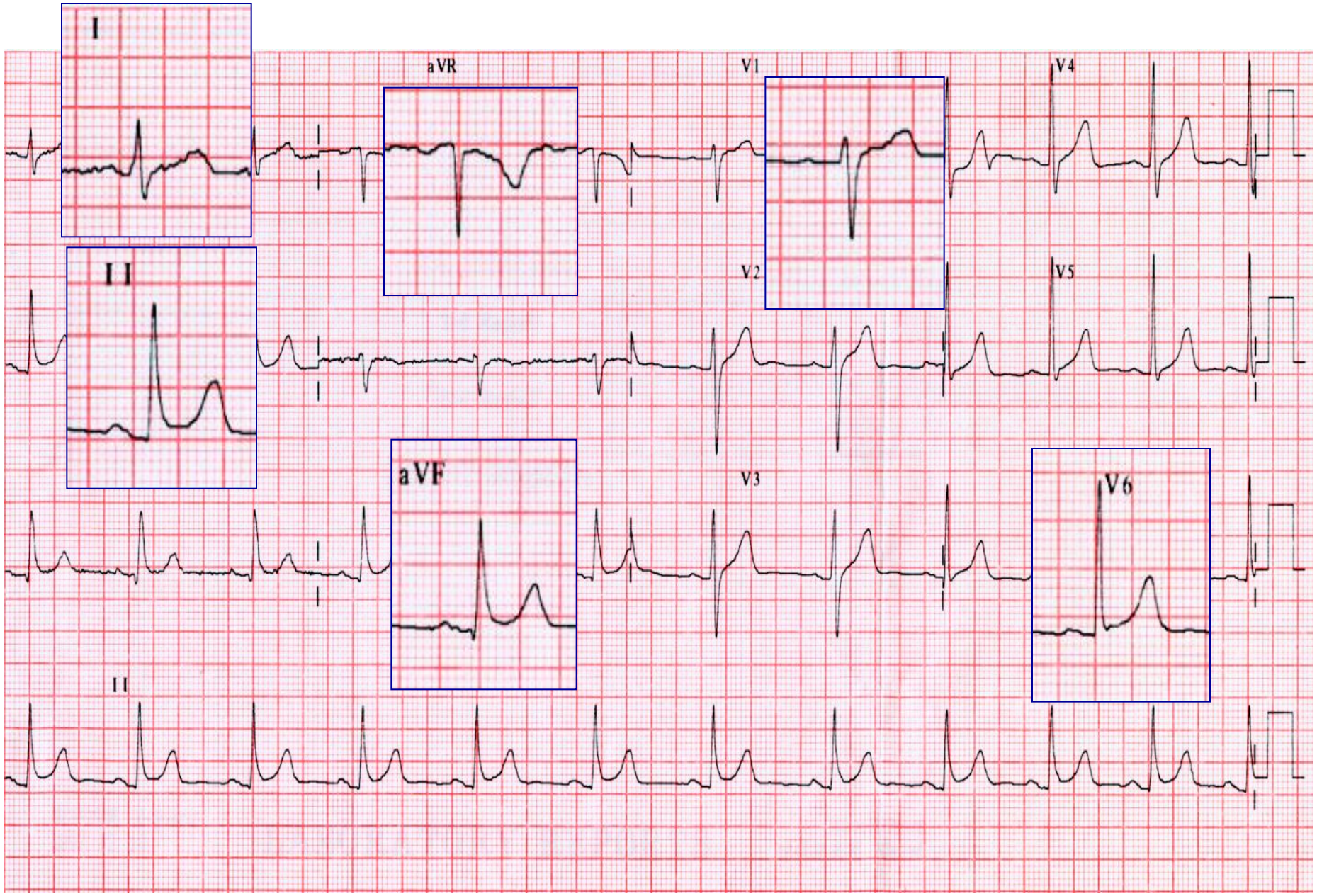
# 예비문제-4 case

# Case 27.

## What is your diagnosis and the solution?

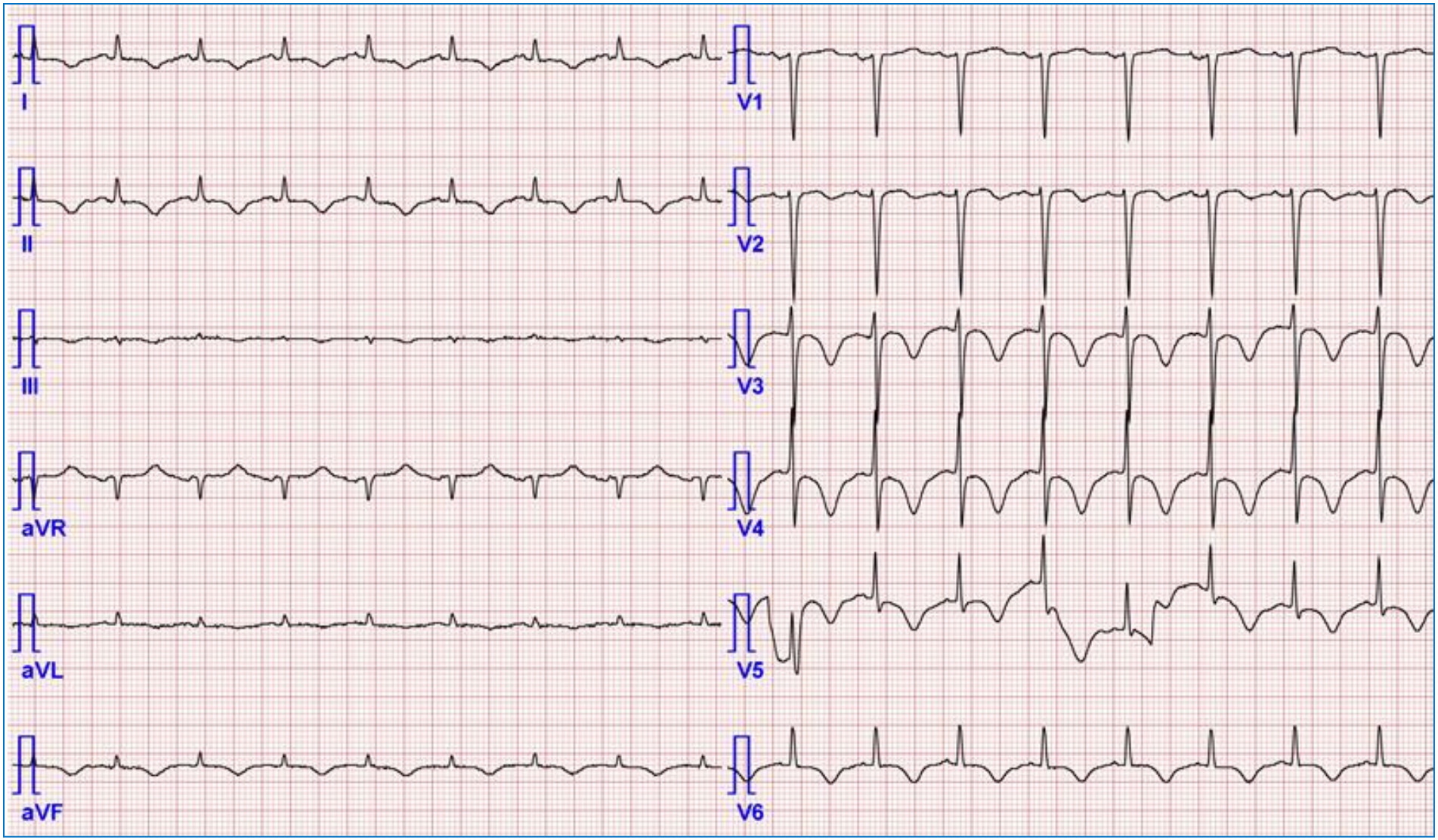
**What is your diagnosis and the solution?**

1. Inferior wall MI --- Emergent CAG
2. Dextrocardia --- Check x-ray
3. Arm leads reversal --- Call intern
4. Left fascicular block --- observation

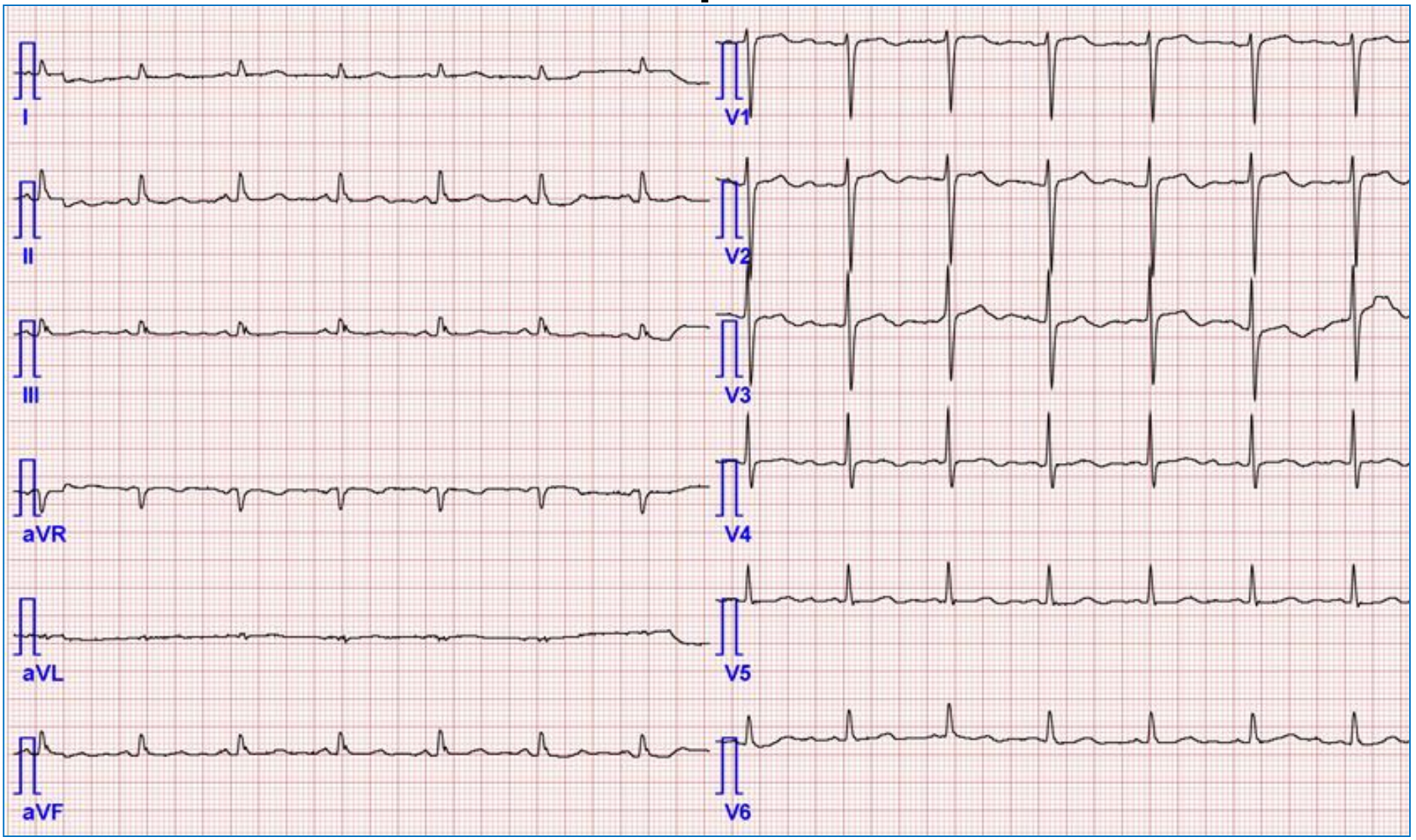

I
aVR
V1
V4
II
V2
V5
aVF
V3
V6
II

# Case 28.

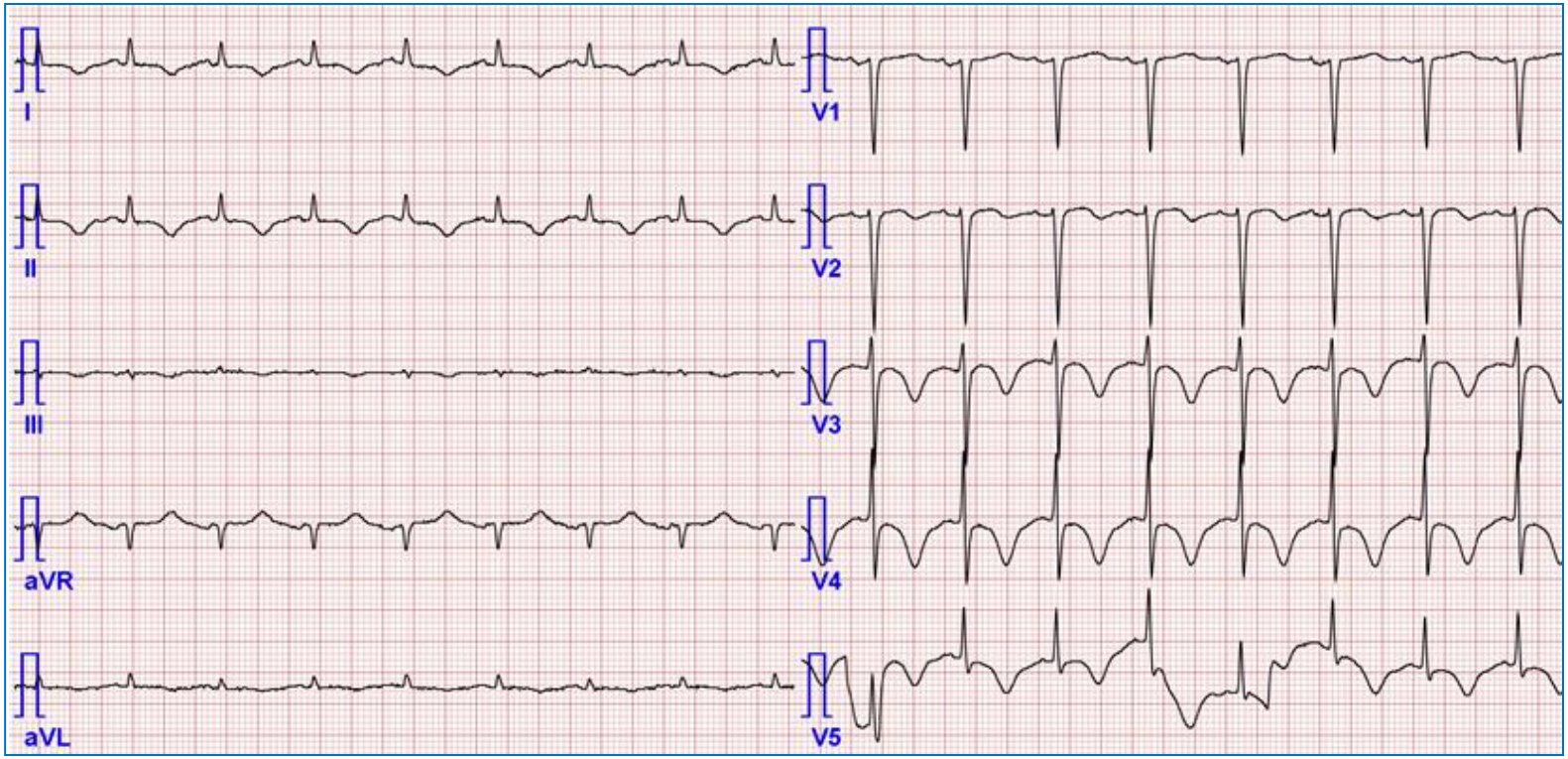
**78/F, s/p open reduction d/t femur dislocation after fall down**
**Dyspnea, Post OP 4 day**



# Pre-op ECG



# What is ECG diagnosis?




1. (Sinus) tachycardia
2. Low voltage in limb leads
3. T wave inversion
4. QT prolongation
5. Above all

# Normal CAG

# Stress-induced cardiomyopathy

- ECG finding
  - Any finding
  - sinus dysfunction, AV block, Q wave, QRS widening, QT prolongation, ST elevation, T inversion, low voltage
- Precipitating event
  - Any event

Syed et al. *Europace* 2011

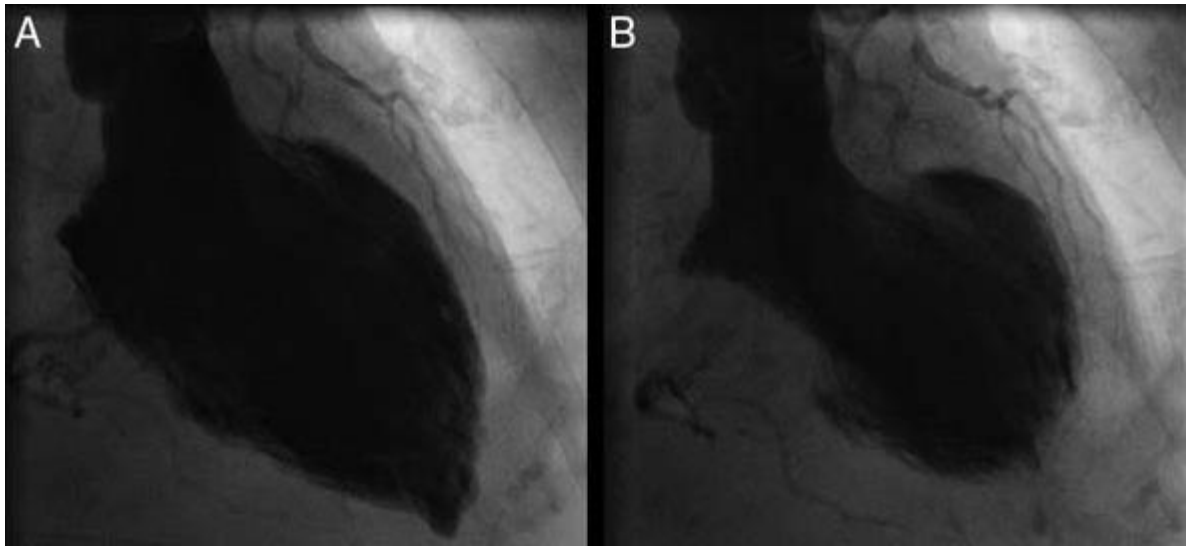
Sharkey et al. *JACC* 2010

# Synonyms

= **Takotsubo cardiomyopathy**

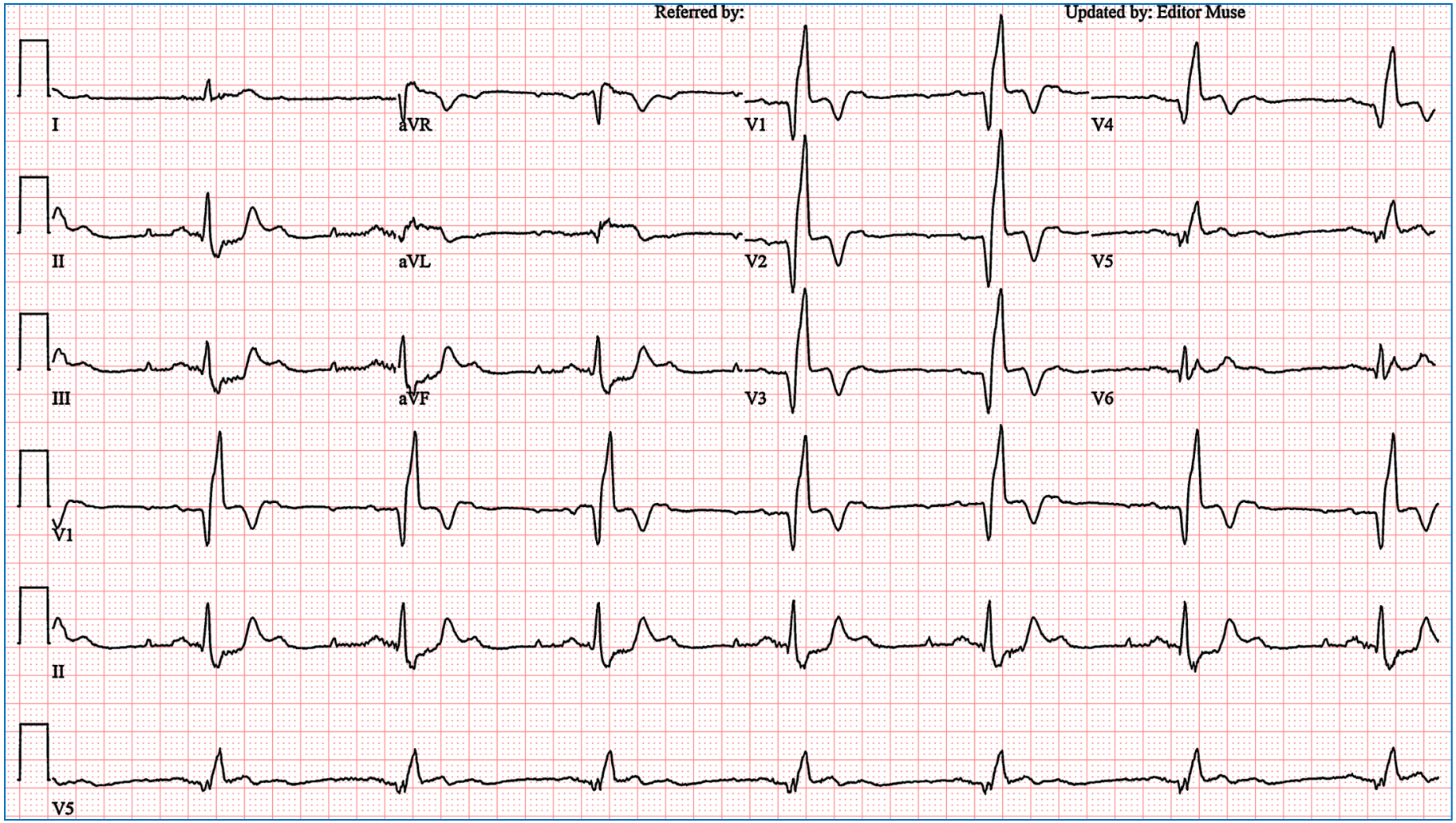
= Apical ballooning syndrome

cf.) reverse (inverted) takotsubo cardiomyopathy




# Case 29.

## 56/F, Hypertension
## Chest pain and syncope



# The location of myocardial infarction?

1. Inferior NSTEMI
2. Lateral STEMI
3. Anterior STEMI Proximal to 1st septal and diagonal branch
4. Anterior STEMI between 1st septal and diagonal branch
5. Anterior STEMI distal to 1st septal and diagonal branch

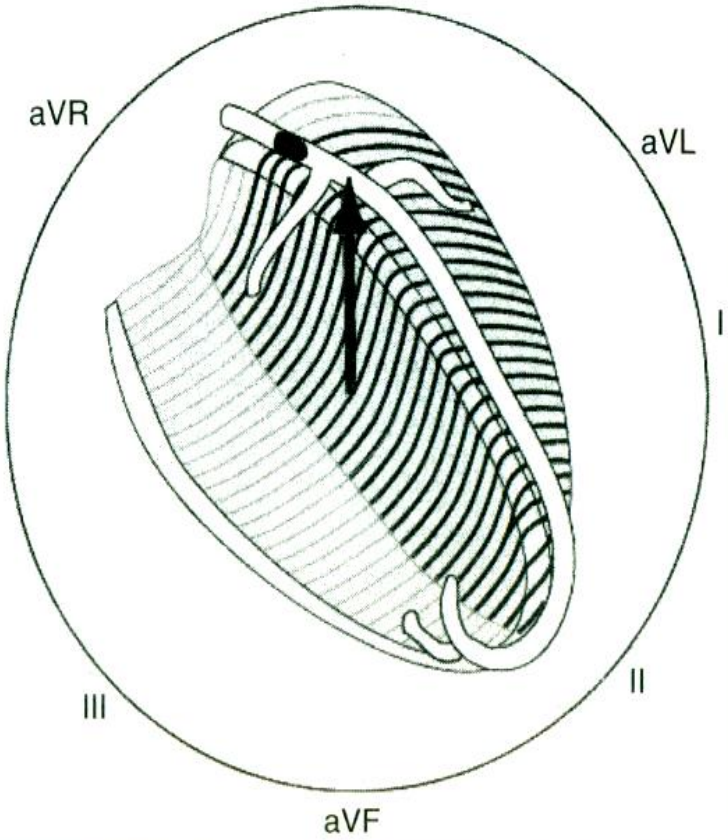
# Anterior wall MI

## The ECG in Anterior Wall MI

### LAD OCCLUSION PROXIMAL TO FIRST SEPTAL AND FIRST DIAGONAL BRANCH

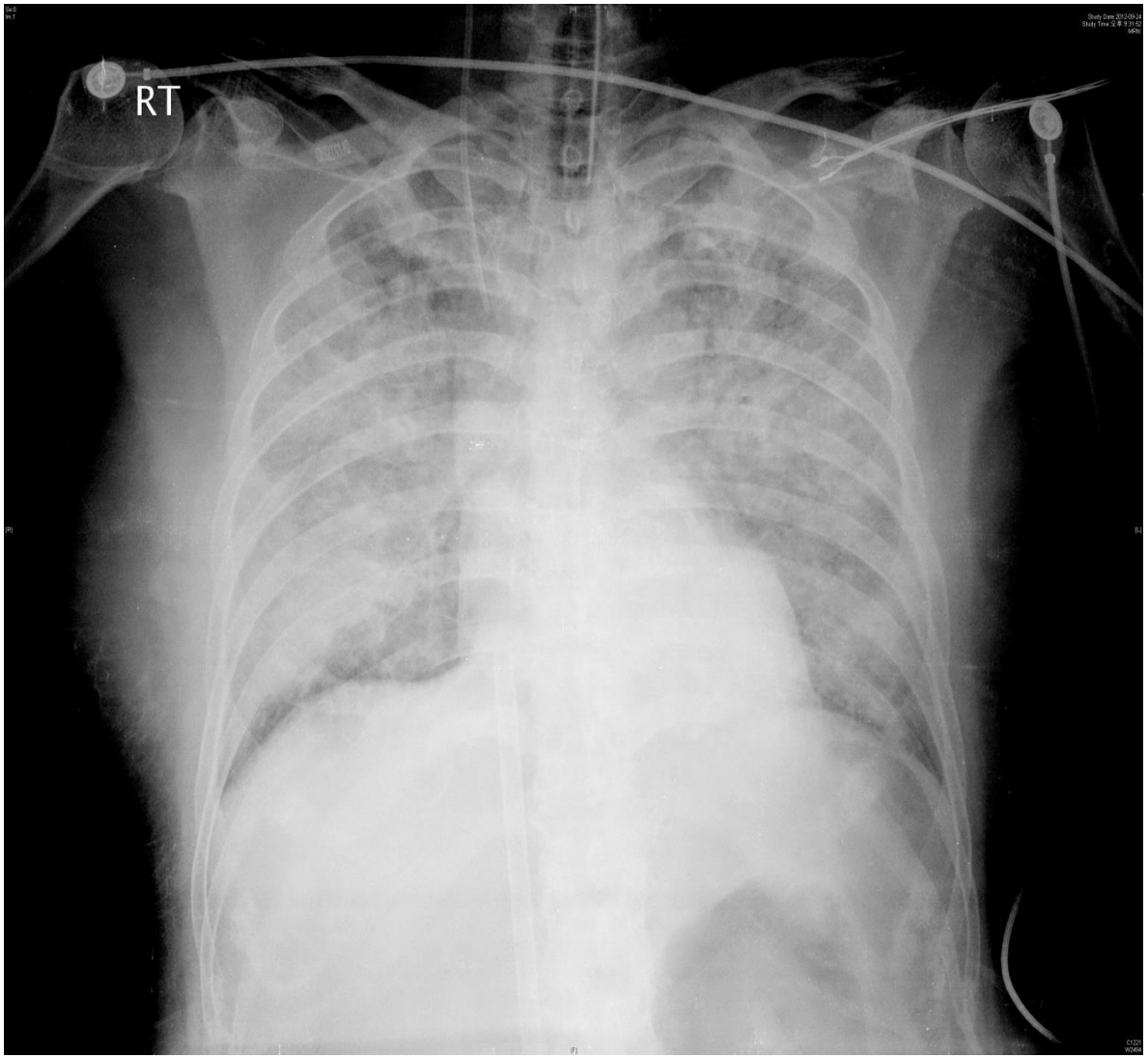
Apart from ST elevation in the precordial leads $V_1$ to $V_4$, the frontal ST vector points toward the base of the heart.

- ST elevation in aVR, aVL, and $V_1$
- ST depression in II, III, aVF, $V_5$, and $V_6$
- Acquired right bundle branch block (qR in lead $V_1$) with or without hemiblock indicates a proximal LAD occlusion.

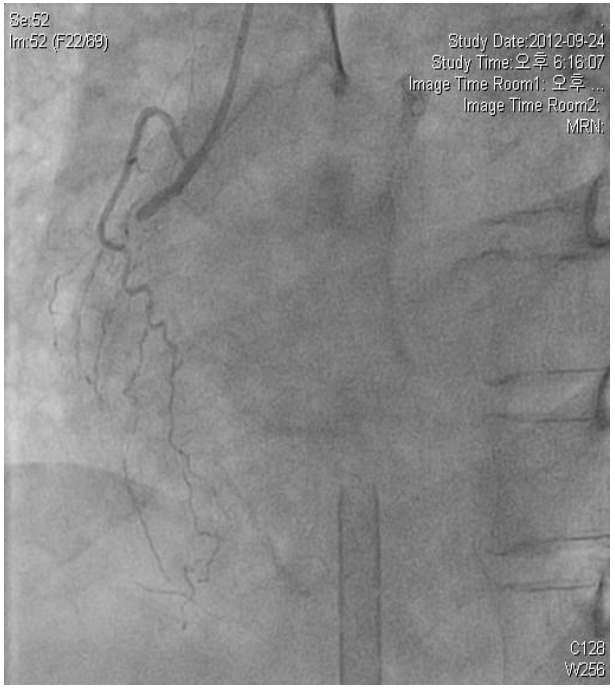


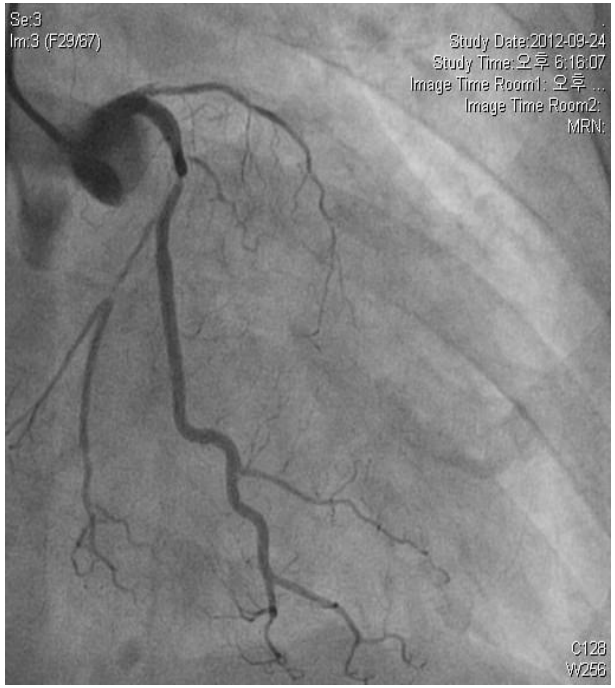

Hein J.J Wellens The ECG in emergency decision makin

# Chest AP



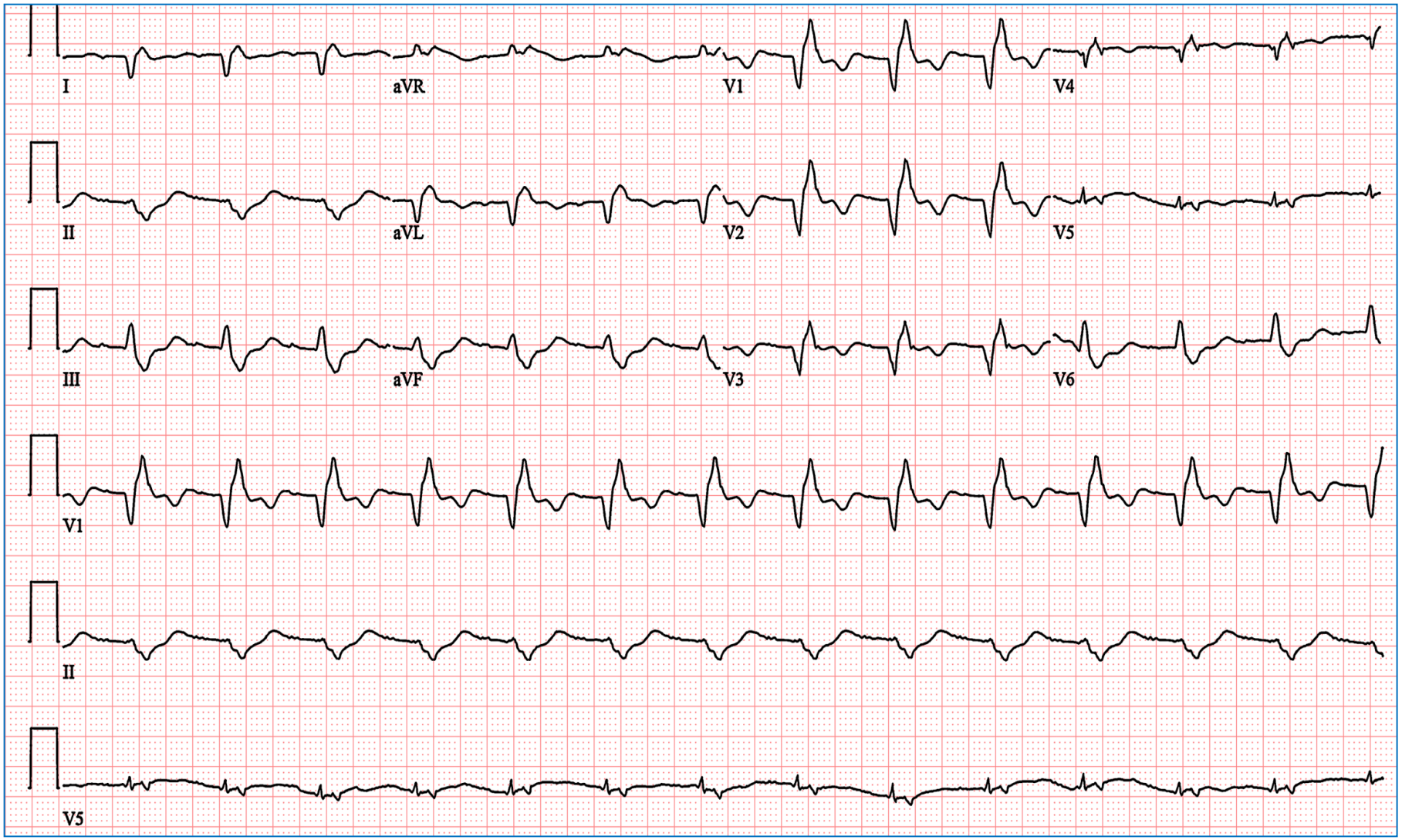
# C-angio


Se:52
Im:52 (F22/89)
Study Date:2012-09-24
Study Time:오후 6:16:07
Image Time Room1: 오후 ...
Image Time Room2:
MRN:
C128
W256


Se:3
Im:3 (F29/67)
Study Date:2012-09-24
Study Time:오후 6:16:07
Image Time Room1: 오후 ...
Image Time Room2:
MRN:
C128
W256

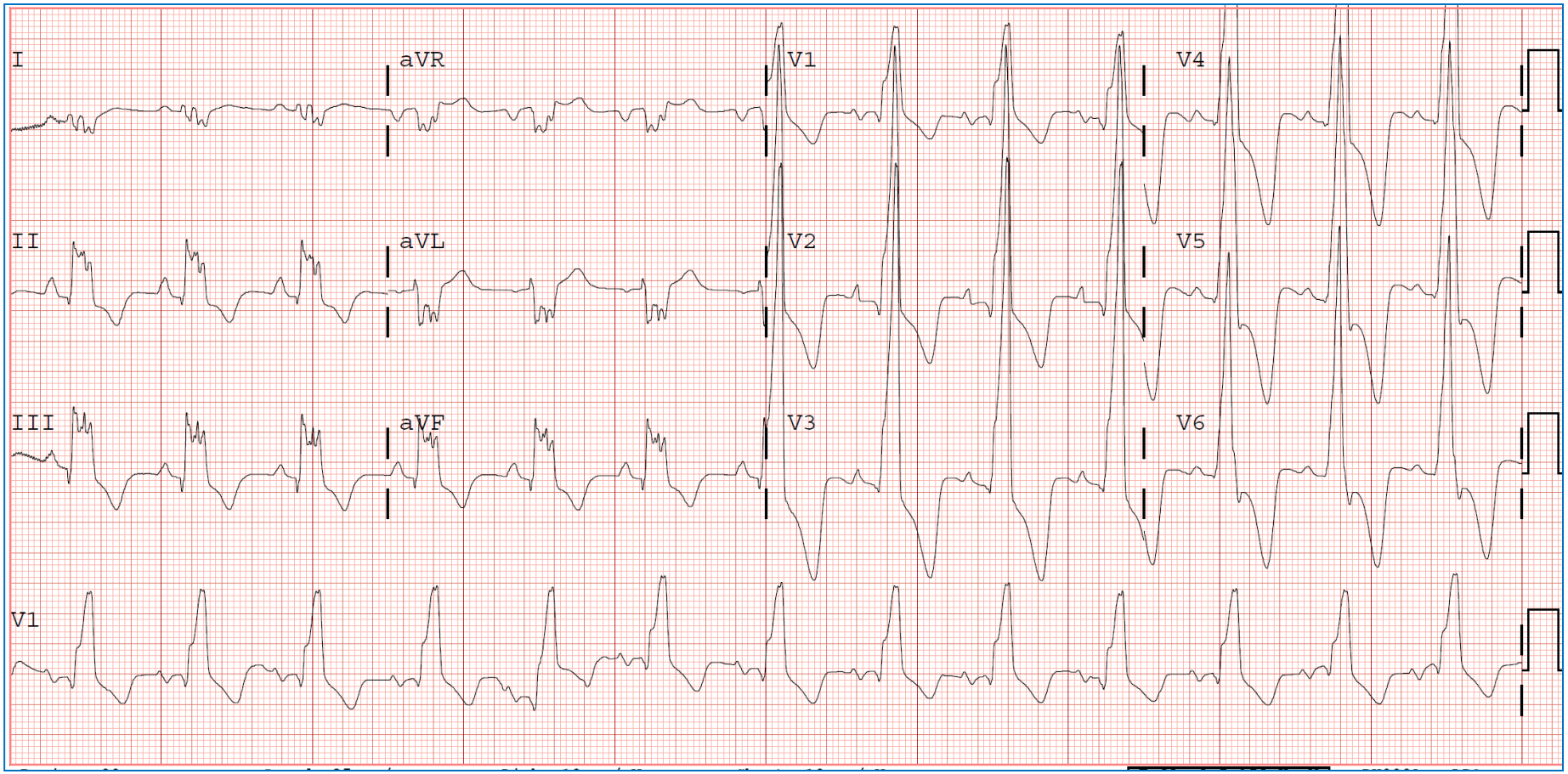

Se:5
Im:5 (F17/49)
Study Date:2012-09-24
Study Time:오후 6:16:07
Image Time Room1: 오후 ...
Image Time Room2:
MRN:
C128
W256

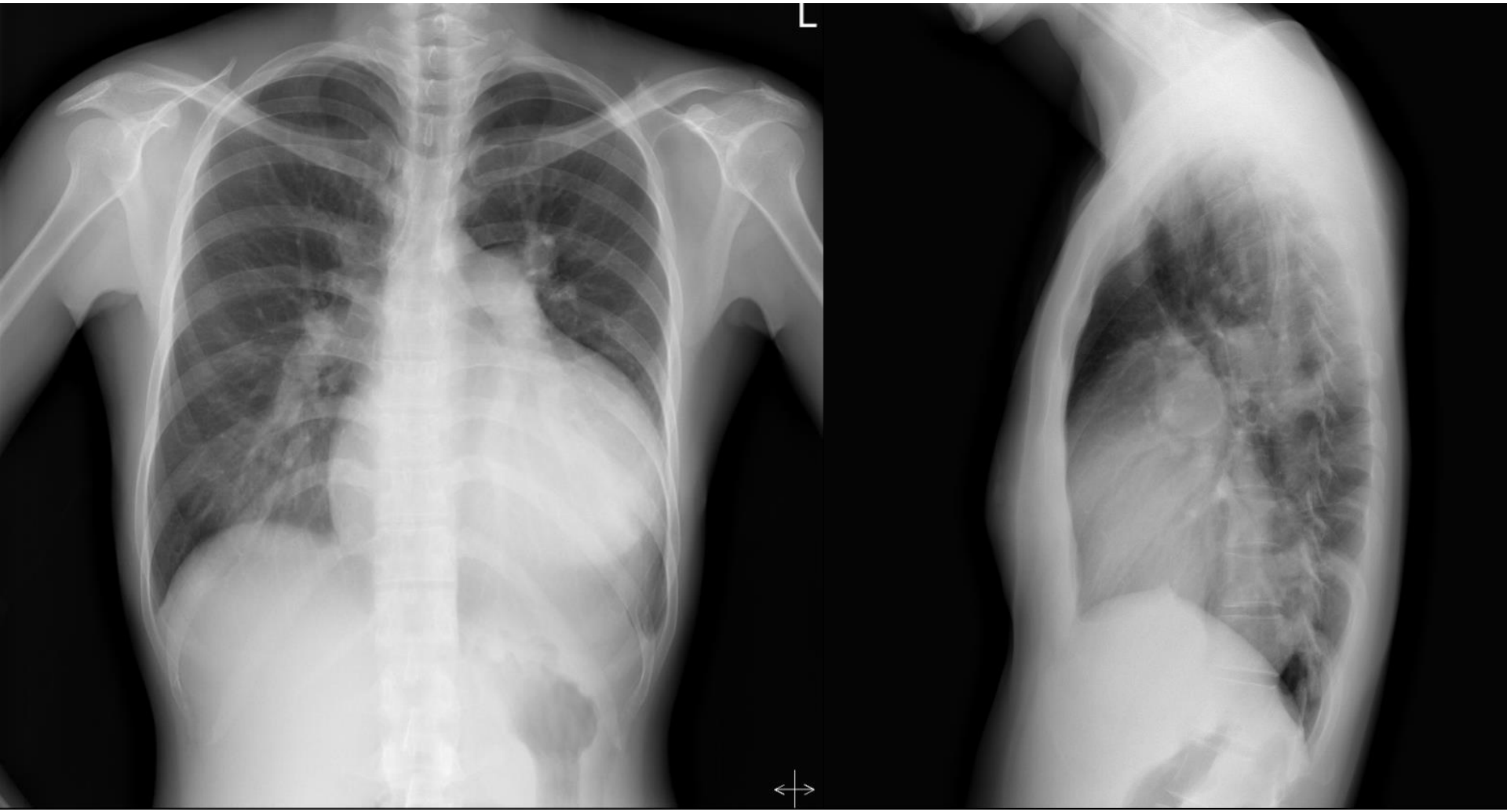
# ECG after PCI



# Case 30.

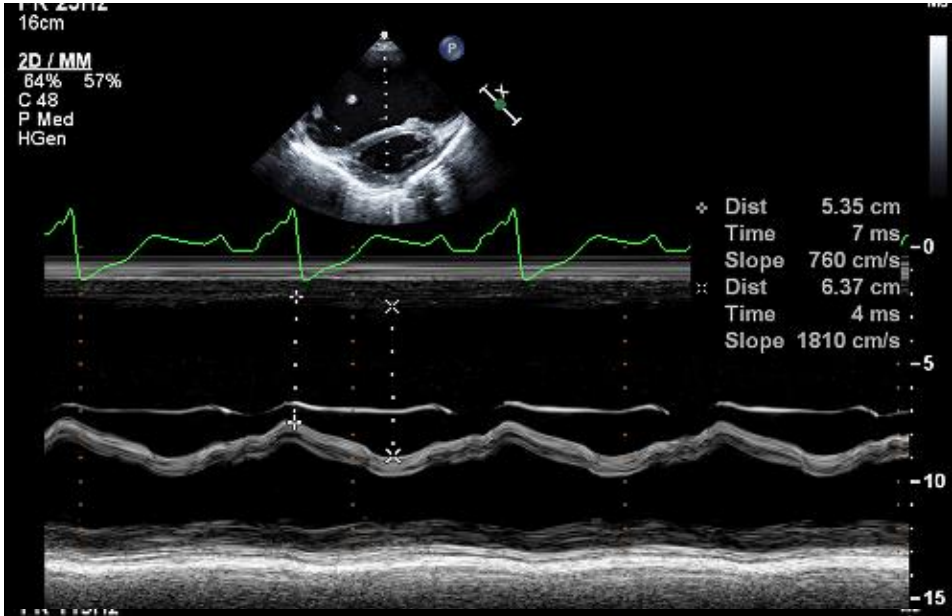
**37/F**
**Cardiomegaly**

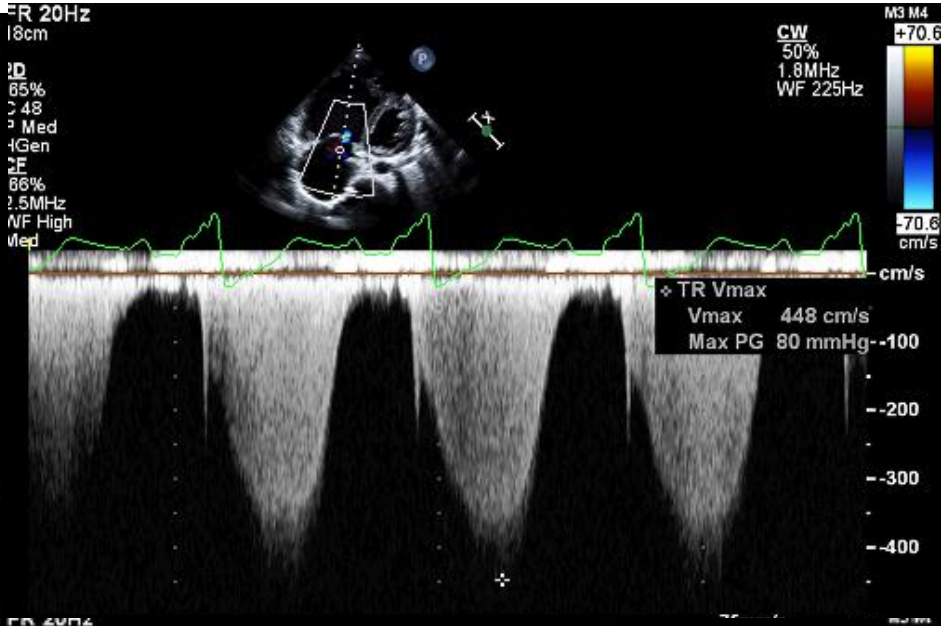


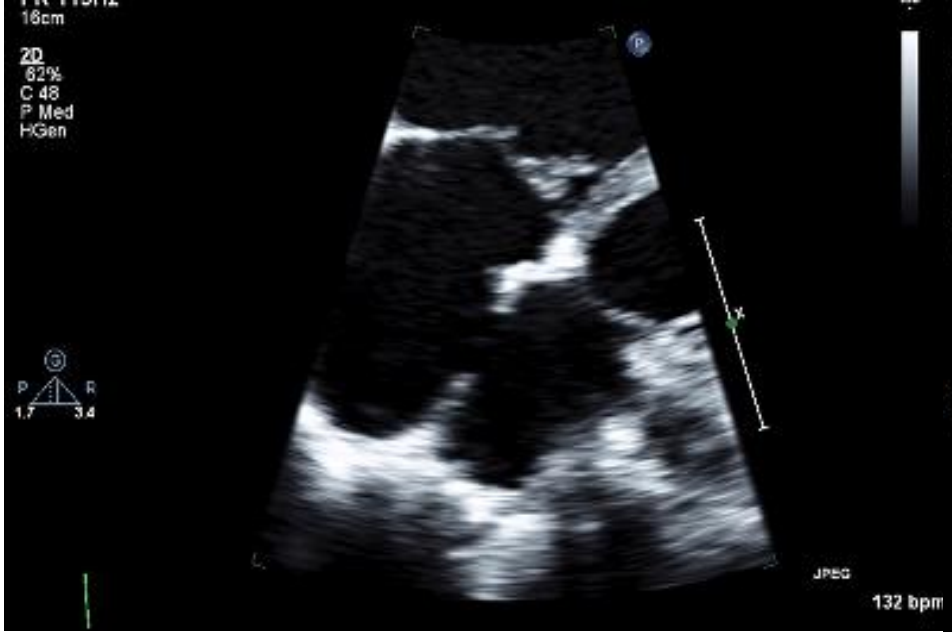

L

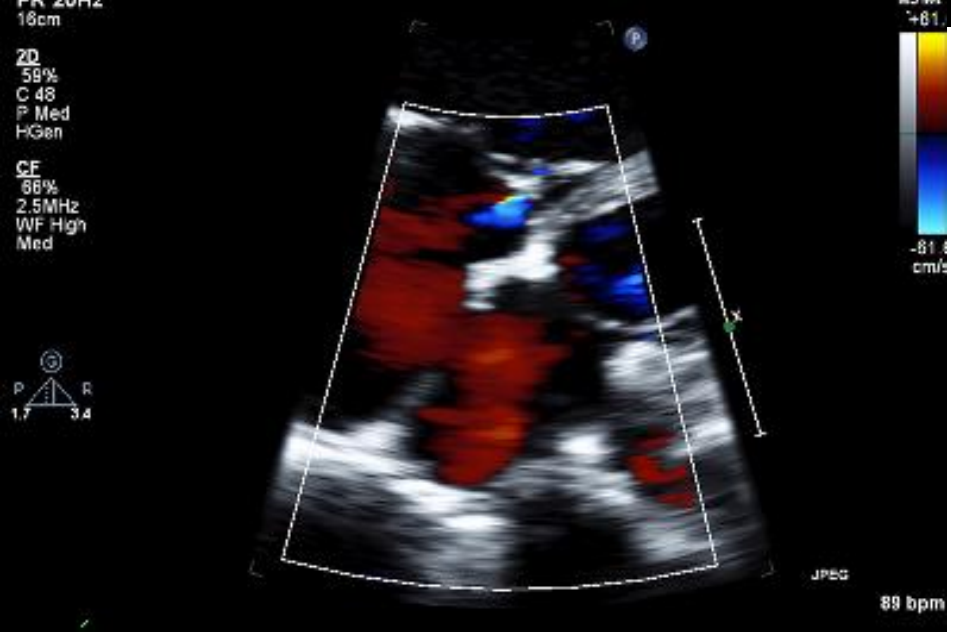
# What is your diagnosis?

1. Atrial septal defect
2. Cardiac sarcoidosis
3. Dilated cardiomyopathy
4. Hypertrophic cardiomyopathy
5. Prior myocardial infarction


16cm
2D / MM
64% 57%
C 48
P Med
HGen
Dist 5.35 cm
Time 7 ms
Slope 760 cm/s
Dist 6.37 cm
Time 4 ms
Slope 1810 cm/s
-0
-5
-10
-15


8cm
CW
50%
1.8MHz
WF 225Hz
M3 M4
+70.6
-70.6
cm/s
TR Vmax
Vmax 448 cm/s
Max PG 80 mmHg
-100
-200
-300
-400


16cm
2D
62%
C 48
P Med
HGen
JPEG
132 bpm


16cm
2D
59%
C 48
P Med
HGen
CF
66%
2.5MHz
WF High
Med
JPEG
89 bpm