



# SURGICAL INDICATIONS OF VHD

GUIDELINES

○ Cardiologist 가  
넘겨 주면 수술 한다.



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# GUIDELINES

- Guidelines on the management of valvular heart disease (version 2012)
  - The Joint Task Force on the Management of Valvular Heart Disease of the *European Society of Cardiology (ESC)* and the *European Association for Cardio-Thoracic Surgery (EACTS)*
- ACC/AHA 2006 Guidelines for the Management of Patients With Valvular Heart Disease
  - A Report of the *American College of Cardiology/American Heart Association*
  - Task Force on Practice Guidelines the American College of Cardiology/American Heart Association



## 결정 요소

- Valve related Symptoms
- LV function
- LV dimension
- Severity by Echocardiogram
- Pulmonary HTN
- Arrhythmia, Thrombus, Embolism
- Life expectancy



# SEVERITY OF VALVE DISEASE - ACC/AHA(2006)

A. Left-Sided Valve Disease			
Indicator	Aortic Stenosis		
	Mild	Moderate	Severe
Jet velocity (m per second)	Less than 3.0	3.0-4.0	Greater than 4.0
Mean gradient (mm Hg)*	Less than 25	25-40	Greater than 40
Valve area (cm <sup>2</sup> )	Greater than 1.5	1.0-1.5	Less than 1.0
Valve area index (cm <sup>2</sup> per m <sup>2</sup> )			Less than 0.6
	Mitral Stenosis		
	Mild	Moderate	Severe
Mean gradient (mm Hg)*	Less than 5	5-10	Greater than 10
Pulmonary artery systolic pressure (mm Hg)	Less than 30	30-50	Greater than 50
Valve area (cm <sup>2</sup> )	Greater than 1.5	1.0-1.5	Less than 1.0
	Aortic Regurgitation		
	Mild	Moderate	Severe
<b>Qualitative</b>			
Angiographic grade	1+	2+	3-4+
Color Doppler jet width	Central jet, width less than 25% of LVOT	Greater than mild but no signs of severe AR	Central jet, width greater than 65% LVOT
Doppler vena contracta width (cm)	Less than 0.3	0.3-0.6	Greater than 0.6
<b>Quantitative (cath or echo)</b>			
Regurgitant volume (ml per beat)	Less than 30	30-59	Greater than or equal to 60
Regurgitant fraction (%)	Less than 30	30-49	Greater than or equal to 50
Regurgitant orifice area (cm <sup>2</sup> )	Less than 0.10	0.10-0.29	Greater than or equal to 0.30
<b>Additional essential criteria</b>			Increased
Left ventricular size			
	Mitral Regurgitation		
	Mild	Moderate	Severe
<b>Qualitative</b>			
Angiographic grade	1+	2+	3-4+
Color Doppler jet area	Small, central jet (less than 4 cm <sup>2</sup> or less than 20% LA area)	Signs of MR greater than mild present but no criteria for severe MR	Vena contracta width greater than 0.7 cm with large central MR jet (area greater than 40% of LA area) or with a wall-impinging jet of any size, swirling in LA
Doppler vena contracta width (cm)	Less than 0.3	0.3-0.69	Greater than or equal to 0.70
<b>Quantitative (cath or echo)</b>			
Regurgitant volume (ml per beat)	Less than 30	30-59	Greater than or equal to 60
Regurgitant fraction (%)	Less than 30	30-49	Greater than or equal to 50
Regurgitant orifice area (cm <sup>2</sup> )	Less than 0.20	0.2-0.39	Greater than or equal to 0.40
<b>Additional essential criteria</b>			Enlarged
Left atrial size			Enlarged
Left ventricular size			
B. Right-Sided Valve Disease			
	Characteristic		
Severe tricuspid stenosis:	Valve area less than 1.0 cm <sup>2</sup>		
Severe tricuspid regurgitation:	Vena contracta width greater than 0.7 cm and systolic flow reversal in hepatic veins		
Severe pulmonary stenosis:	Jet velocity greater than 4 m per second or maximum gradient greater than 60 mm Hg		
Severe pulmonary regurgitation:	Color jet fills outflow tract Dense continuous wave Doppler signal with a steep deceleration slope		





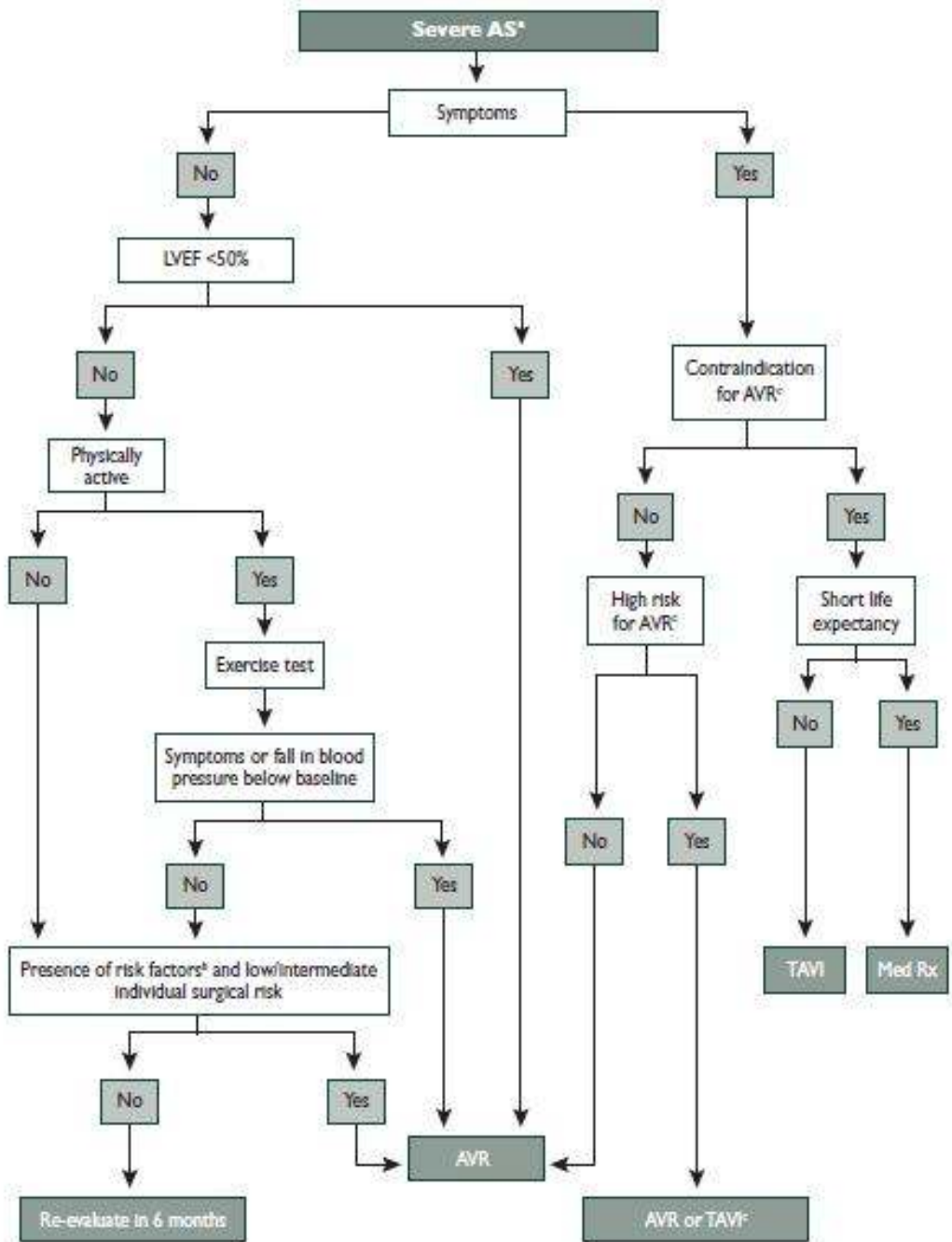
# AORTIC STENOSIS

## ESC & EACTS(2012)

- Symptomatic AS
- CABG, AA, another valve 수술이 동반된 경우
- Asymptomatic severe AS
  - LV dysfunction(LVEF<50%)
  - Abnormal exercise test
    - Valve related Sx
    - Fall in BP
    - Increased PG >20mmHg
  - Peak transvalvular velocity >5.5m/s
  - Severe calcification
  - Excessive LV hypertrophy in the absence of HTN



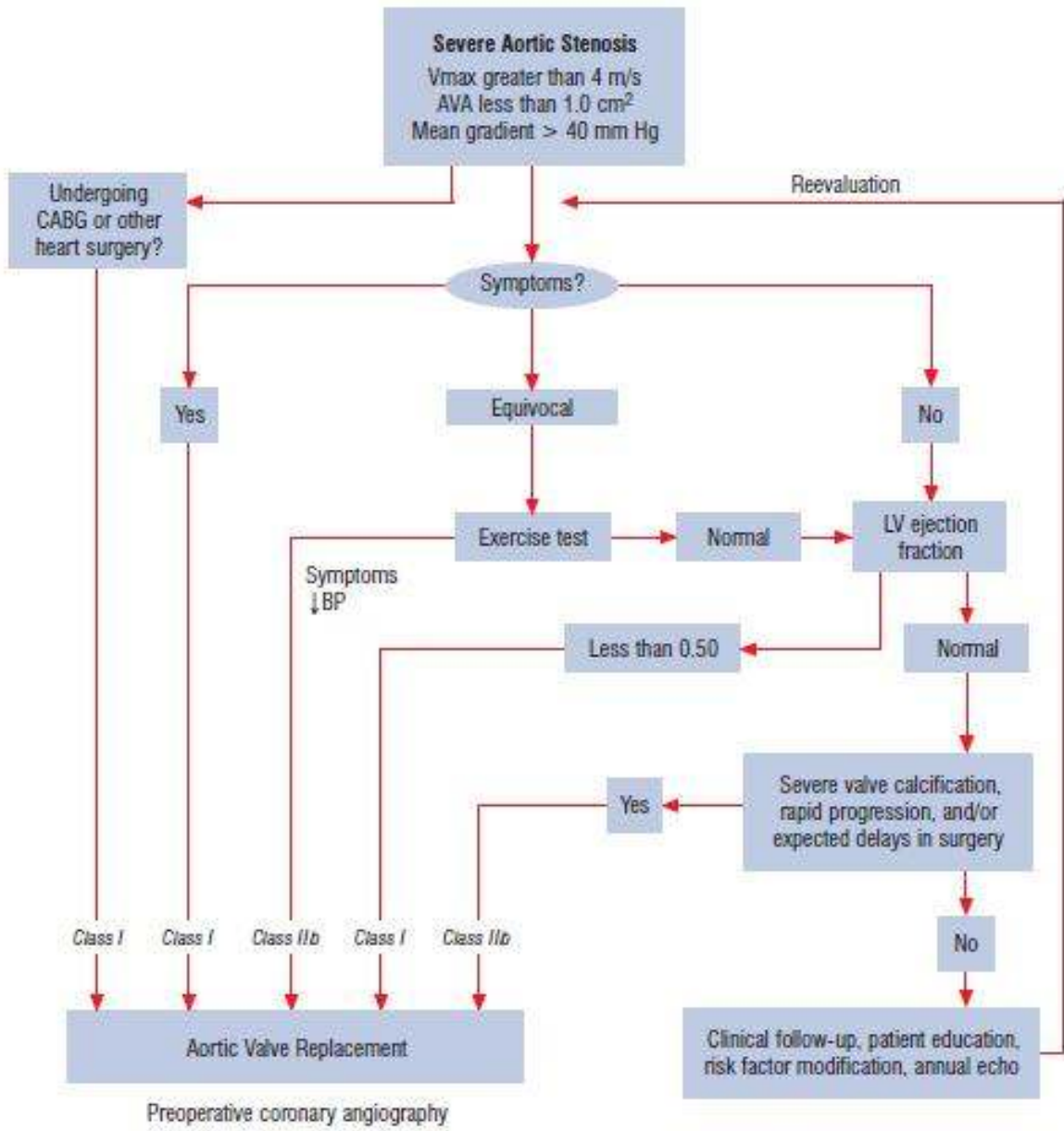




ESC & EACTS(2012)



ACC/AHA(2006)





# AORTIC REGURGITATION

# ESC & EACTS(2012)

	Class <sup>a</sup>	Level <sup>b</sup>	Ref <sup>c</sup>
<b>A. Indications for surgery in severe aortic regurgitation</b>			
Surgery is indicated in symptomatic patients.	I	B	59
Surgery is indicated in asymptomatic patients with resting LVEF ≤50%.	I	B	71
Surgery is indicated in patients undergoing CABG or surgery of ascending aorta, or on another valve.	I	C	
Surgery should be considered in asymptomatic patients with resting EF >50% with severe LV dilatation: LVEDD >70 mm, or LVESD >50 mm or LVESD >25 mm/m <sup>2</sup> BSA. <sup>d</sup>	IIa	C	
<b>B. Indications for surgery in aortic root disease (whatever the severity of AR)</b>			
Surgery is indicated in patients who have aortic root disease with maximal ascending aortic diameter <sup>e</sup> ≥50 mm for patients with Marfan syndrome.	I	C	
Surgery should be considered in patients who have aortic root disease with maximal ascending aortic diameter: ≥45 mm for patients with Marfan syndrome with risk factors <sup>f</sup> ≥50 mm for patients with bicuspid valve with risk factors <sup>g</sup> ≥55 mm for other patients	IIa	C	

AR = aortic regurgitation; BSA = body surface area; CABG = coronary artery bypass grafting; EF = ejection fraction; LV = left ventricular; LVEDD = left ventricular end-diastolic diameter; LVESD = left ventricular end-systolic diameter.

<sup>a</sup>Class of recommendation.

<sup>b</sup>Level of evidence.

<sup>c</sup>Reference(s) supporting class I (A + B) and IIa + IIb (A + B) recommendations.

<sup>d</sup>Changes in sequential measurements should be taken into account.

<sup>e</sup>Decision should also take into account the shape of the different parts of the aorta. Lower thresholds can be used for combining surgery on the ascending aorta for patients who have an indication for surgery on the aortic valve.

<sup>f</sup>Family history of aortic dissection and/or aortic size increase >2 mm/year (on repeated measurements using the same imaging technique, measured at the same aorta level with side-by-side comparison and confirmed by another technique), severe AR or mitral regurgitation, desire of pregnancy.

<sup>g</sup>Coarctation of the aorta, systemic hypertension, family history of dissection or increase in aortic diameter >2 mm/year (on repeated measurements using the same imaging technique, measured at the same aorta level with side-by-side comparison and confirmed by another technique).

# ESC & EACTS(2012)

## A. Indications for surgery in severe aortic regurgitation

Surgery is indicated in symptomatic patients.

Surgery is indicated in asymptomatic patients with resting LVEF  $\leq 50\%$ .

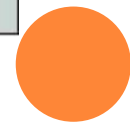
Surgery is indicated in patients undergoing CABG or surgery of ascending aorta, or on another valve.

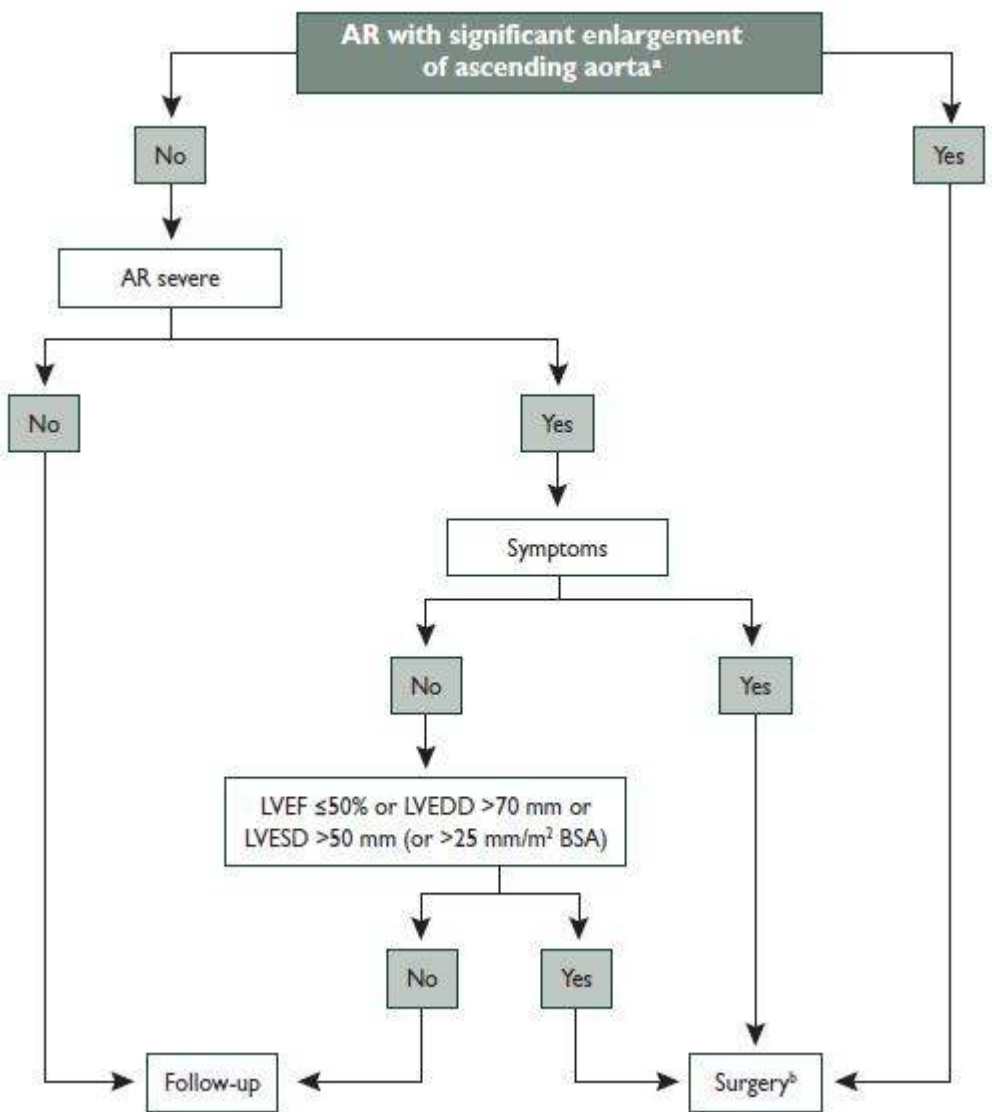
Surgery should be considered in asymptomatic patients with resting EF  $> 50\%$  with severe LV dilatation: LVEDD  $> 70$  mm, or LVESD  $> 50$  mm or LVESD  $> 25$  mm/m<sup>2</sup> BSA.<sup>d</sup>

## B. Indications for surgery in aortic root disease (whatever the severity of AR)

Surgery is indicated in patients who have aortic root disease with maximal ascending aortic diameter<sup>e</sup>  $\geq 50$  mm for patients with Marfan syndrome.

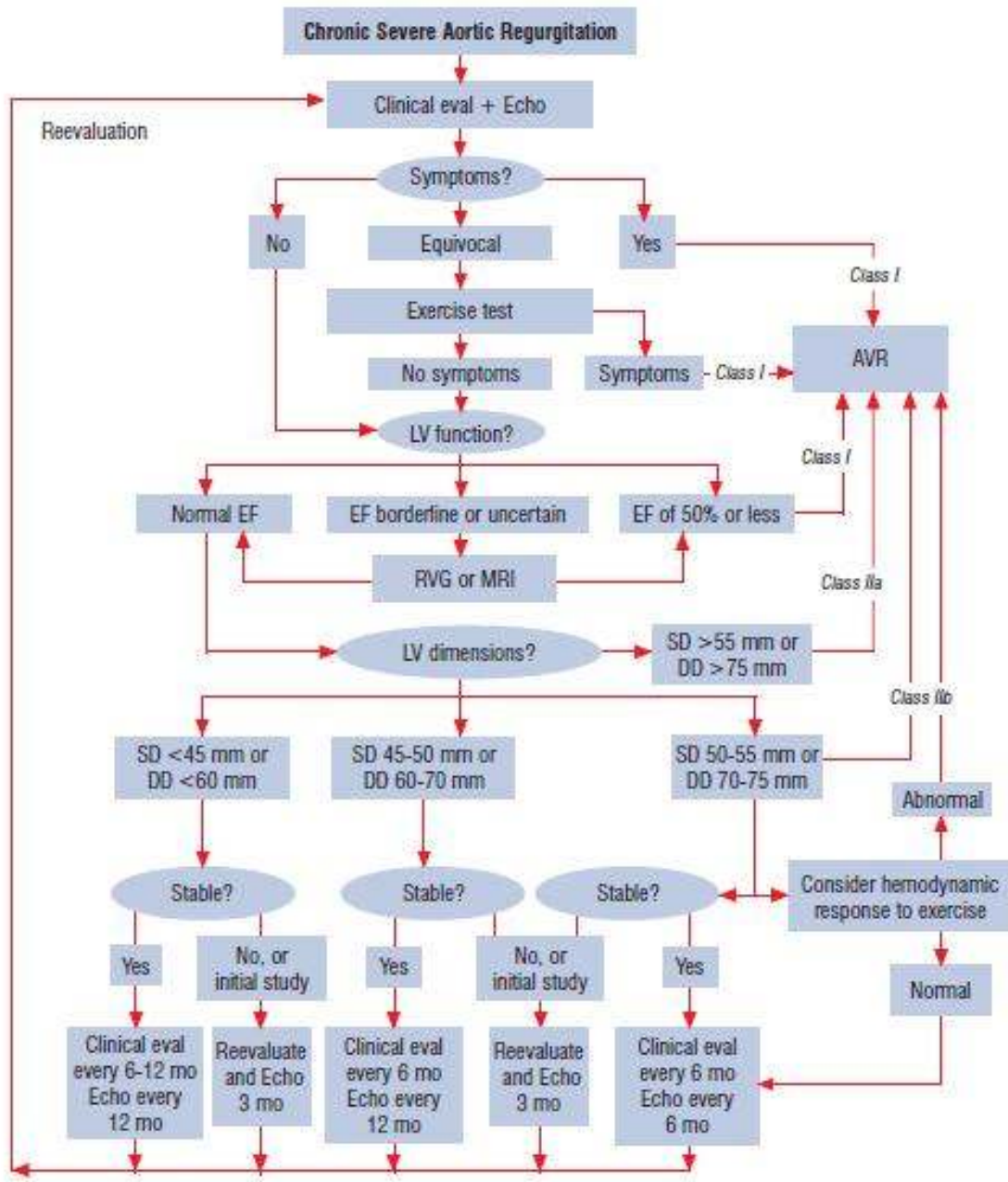
Surgery should be considered in patients who have aortic root disease with maximal ascending aortic diameter:  
 $\geq 45$  mm for patients with Marfan syndrome with risk factors<sup>f</sup>  
 $\geq 50$  mm for patients with bicuspid valve with risk factors<sup>g</sup>  
 $\geq 55$  mm for other patients





ESC & EACTS(2012)





ACC/AHA(2006)





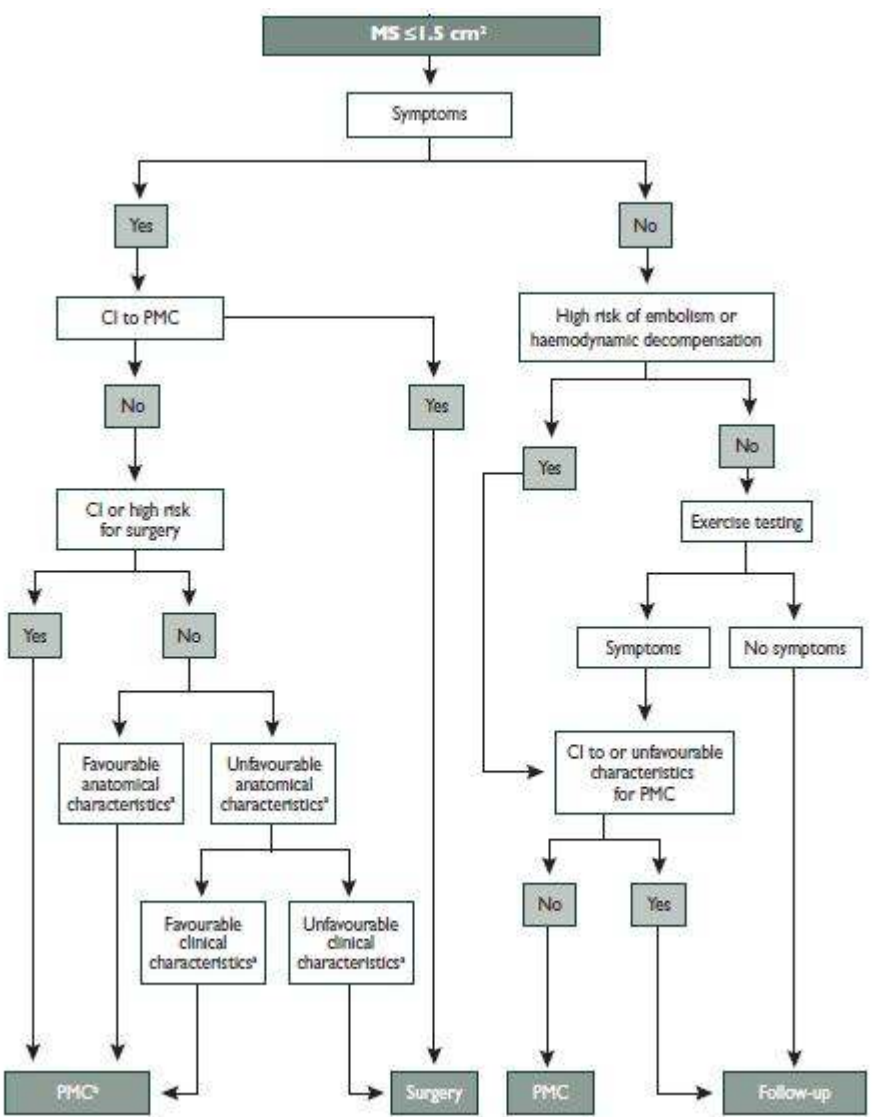
# MITRAL STENOSIS



## ESC & EACTS(2012)

- Clinically significant MS ( $MVA < 1.5 \text{cm}^2$ )
- Symptomatic Pt.





ESC & EACTS(2012)

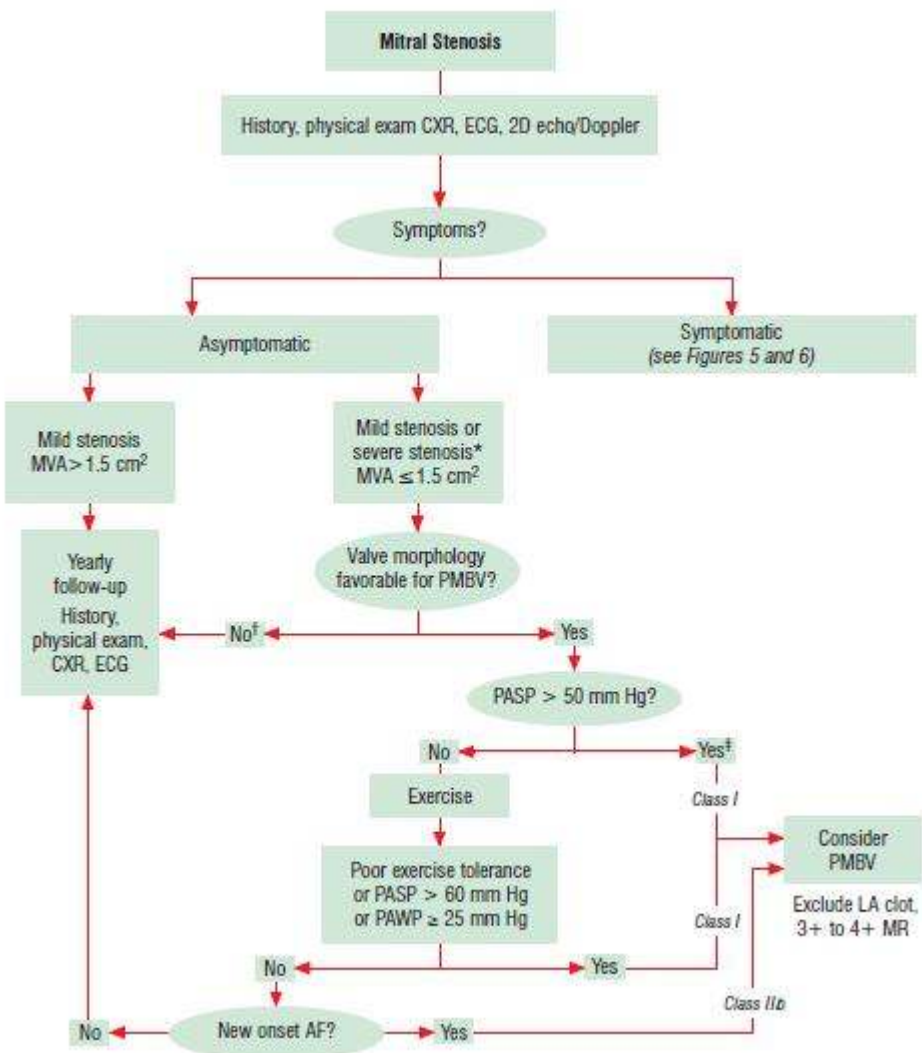


## ACC/AHA(2006)

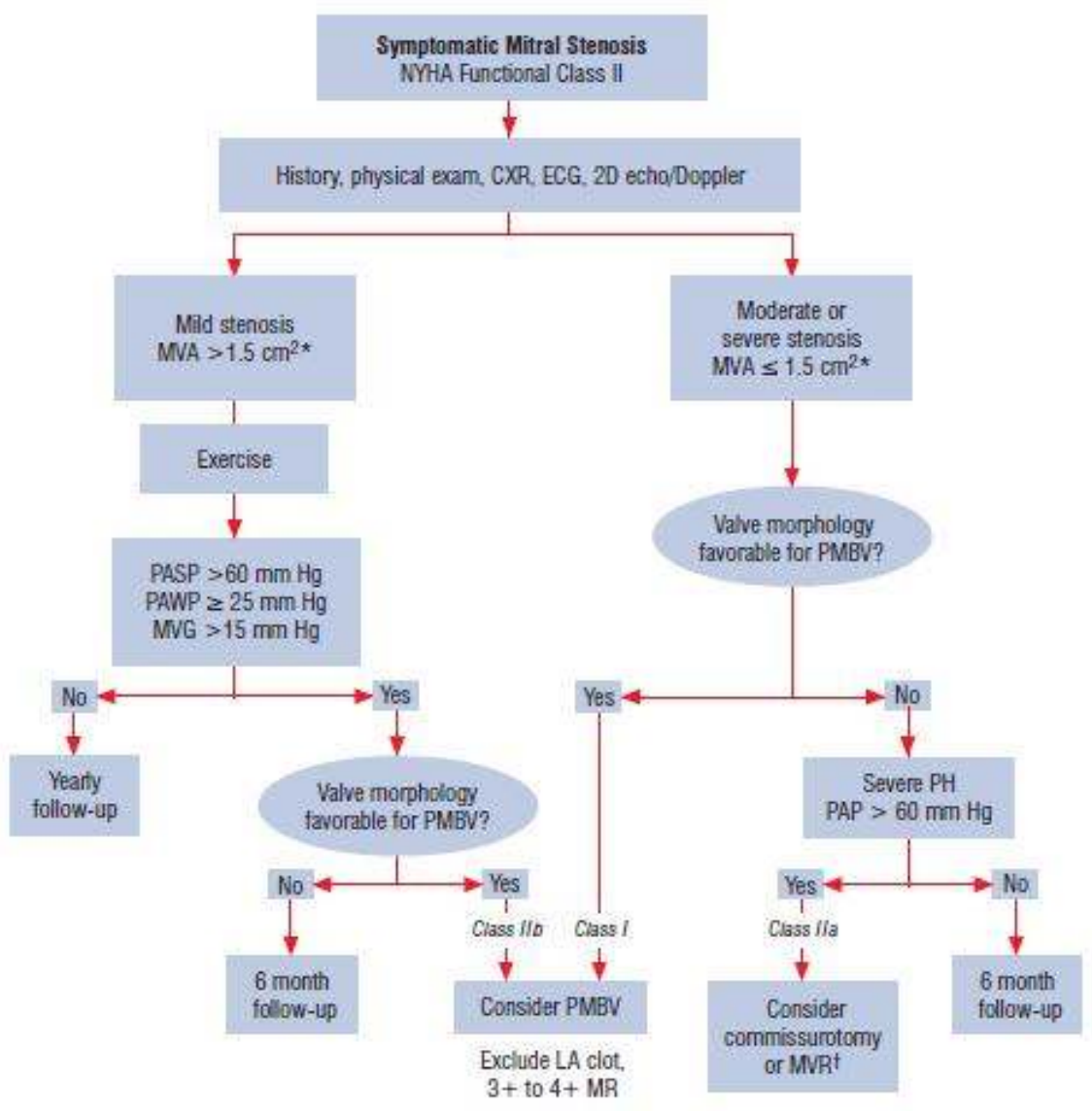
- Symptomatic (NYHA III-IV) moderate to severe MS
- Symptomatic moderate to severe MS with MR
- Severe MS and Pul HBP (PASP >60)
- Embolic event



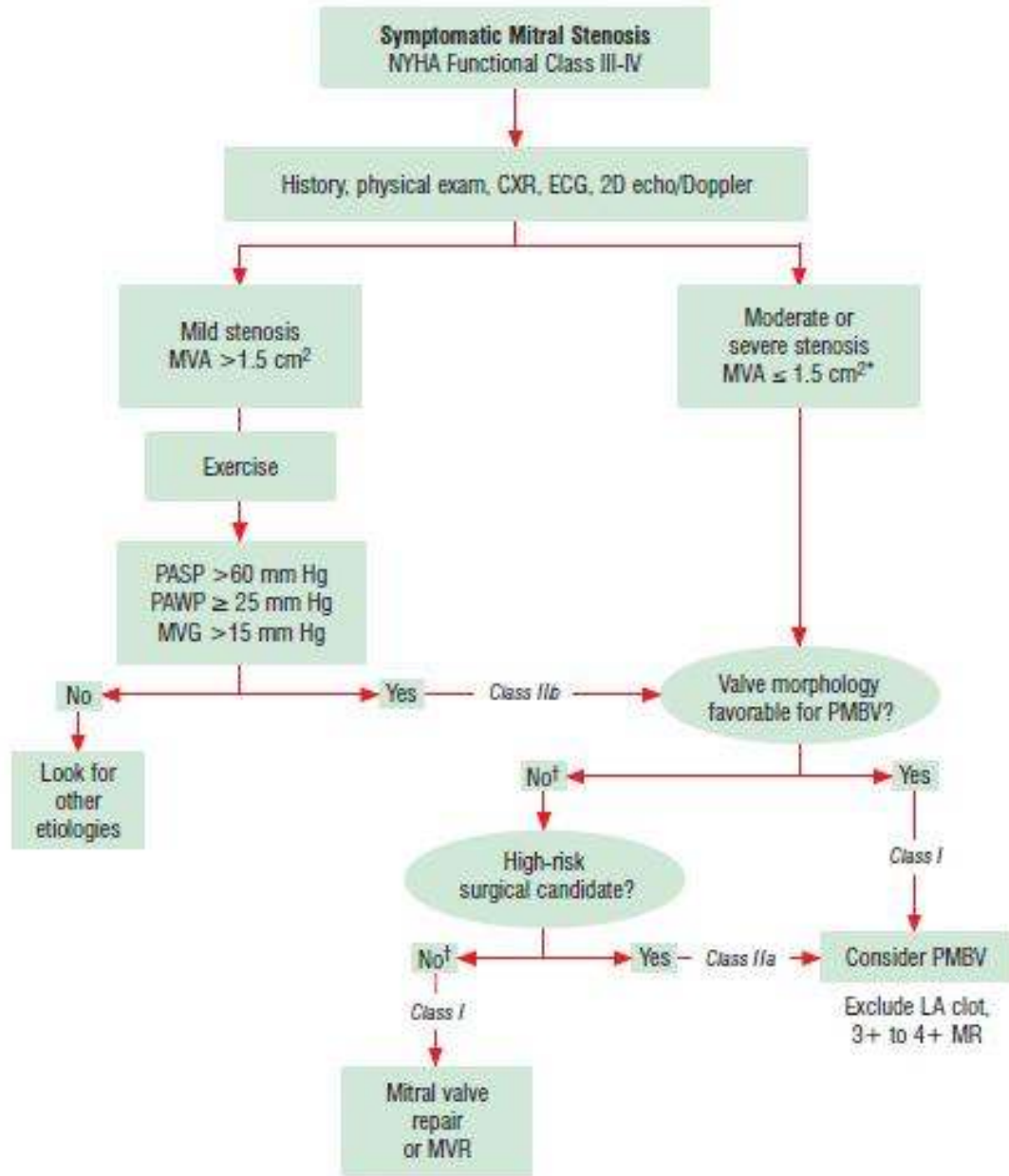
ACC/AHA(2006)



ACC/AHA(2006)



# ACC/AHA(2006)





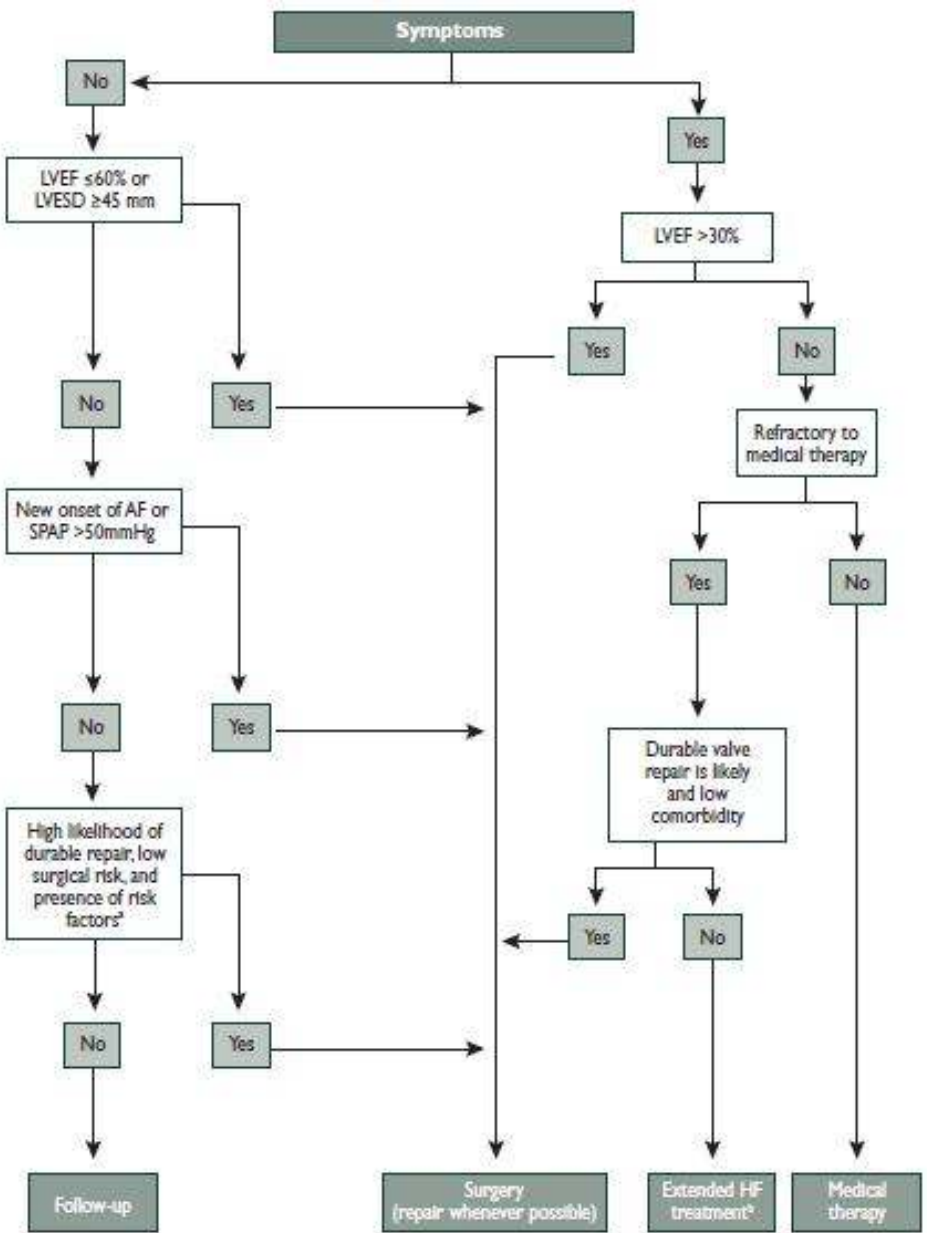
# MITRAL REGURGITATION

## ESC & EACTS(2012)

- Acute severe MR
- Symptomatic Pt. (EF>30%, LVESD<55)
- Asymptomatic Pt.
  - LV dysfunction (LVEF<60% or LVESD>45)
  - New onset atrial fibrillation w/ normal LV function
  - Pul HBP(SPAP>50) w/ normal LV function
  - Pul. HBP on exercise (SPAP>60)
  - Flail leaflet and LVESD>40mm(LVESDI>22)
  - LA dilatation (LAVI >60ml/m<sup>2</sup>)



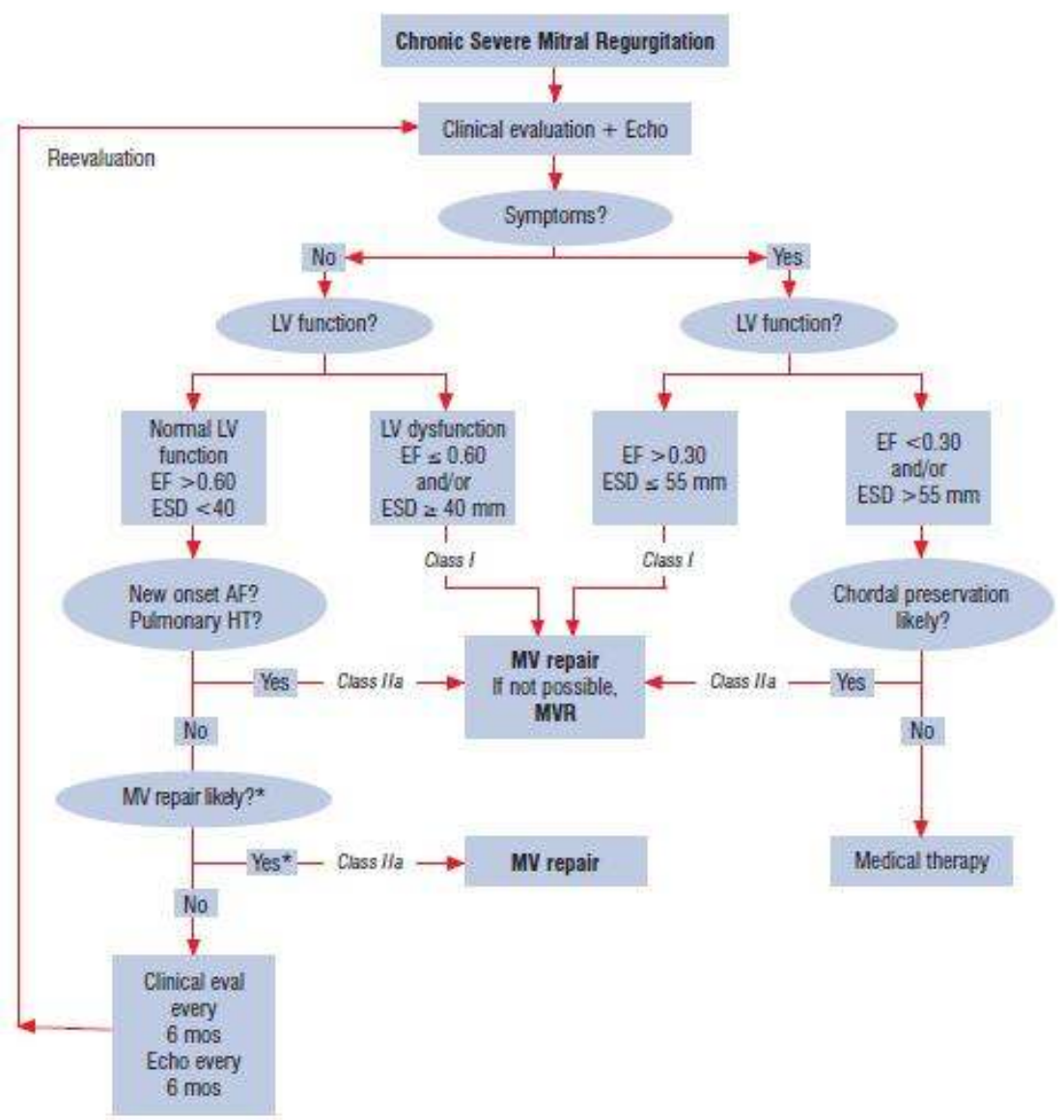




ESC & EACTS(2012)



ACC/AHA(2006)



The image features a dark blue background with decorative elements on the left side. There are three vertical stripes: a thin orange line, a wider textured orange line, and another thin orange line. To the right of these stripes are five orange circles of varying sizes. The word "SUMMARY" is written in a bold, yellow, sans-serif font, positioned to the right of the circles.

# SUMMARY

- Symptomatic Patients
- LV systolic dysfunction
- LV Dilatation
- Exercise Test
- Associated condition
  - Arrhythmia
  - Thromboembolism
  - Pul. HTN
- Acute Episode
- Op Ix에 해당하는 환자는 2개월내에 수술해야 outcome이 좋다.
- Guideline에 따라 3~12개월마다 Echo F/up 필요



# Postoperative Management of VHD

가톨릭대학 성빈센트병원  
조민섭

# Postop Mx of Cardiac Surgery

- ❑ *Cardiovascular Mx*
- ❑ *Mediastinal bleeding*
- ❑ *Antithrombotic Tx*
- ❑ Respiratory Care
- ❑ Fluid Mx
- ❑ Renal, Metabolic, Endocrine Mx
- ❑ Neurologic Mx
- ❑ Gastro-intestinal Mx

# Post-op Routines

## - Op day & POD #1

- ❑ Wean from vasoactive medication
- ❑ Wean from ventilator and extube
- ❑ Remove S-G cath & A-line
- ❑ Get Pt. Out of bed in a chair
- ❑ Start clear liquid diet

# Post-op Routines

## - POD # 2

- ❑ Transfer to floor
- ❑ Remove foley cath
- ❑ Remove chest tube
- ❑ Stop antibiotics
- ❑ Get out of bed & ambulate
- ❑ Advance diet



# Post-op Routines

-POD #3 ~ 5

- ❑ Continue diuresis to pre-op weight
- ❑ Advance diet to achieve satisfactory nutrition
- ❑ Increase activity level
- ❑ Plan for home services of rehabilitation
- ❑ Remove pacing wires
- ❑ Obtain pre-discharge Lab datas
- ❑ Perform discharge teaching

# Post-op Routines

-POD #5 ~ 7

- ❑ Remove the skin sutures
- ❑ Discharge

# ICU admission setting

- ❑ Pressure lines. Ventilator, breathing sound, E-tube 위치, EKG
- ❑ Scan HR, Rhythm, BP
- ❑ Swan-Ganz position, check CO
- ❑ Check Bleeding, U/O, tissue perfusion
- ❑ Sampling
- ❑ Routine monitoring
  - BT, Ventilation, ABP, NIBP, CVP, PAP, SaO<sub>2</sub>, CO, SvO<sub>2</sub>, NG-tube, U/O, Bleeding, Labs



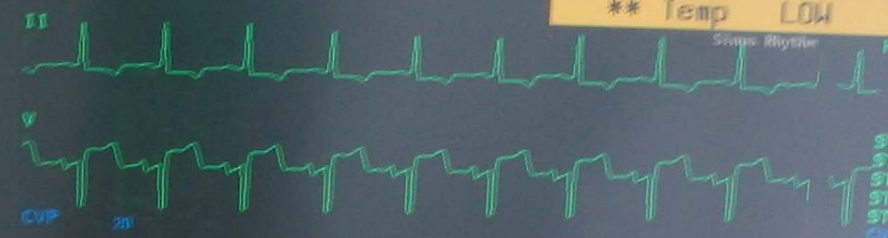
# Patient Monitoring

# Monitoring

- BP
- EKG
- Temperature
- Respiration
- $SaO_2$
- $ETCO_2$
- CVP
- PAP & PCWP
- $CO$  & CI
- SVR & SVRI
- $MvO_2$
- Urine Output
- Ventilator
- IABP
- ECMO
- Pacemaker

Not Admitted Adult 25 May 17:48 0 Profiles Screen A

**\*\* Temp LOW**



HR **77** Pulse  **76**  
 ST-I -0.1 ST-aVF 0.7 PVC 0  
 ST-II -0.7 ST-V 0.7 etCO<sub>2</sub> 27  
 ST-III -0.8 ST-MCL 0.6 imCO<sub>2</sub> 0  
 ST-aVR 0.4  
 ST-aVL 0.2  
 CVP (11)



SpO<sub>2</sub> **98** sRRR **12**



RR  **14**



Temp **35.9**

Audio OFF | Pause | Start/Stop | Stop All | Zero Press | Red Line Record | Delayed Record | Function Standby | Data Setup | Main Screen

13

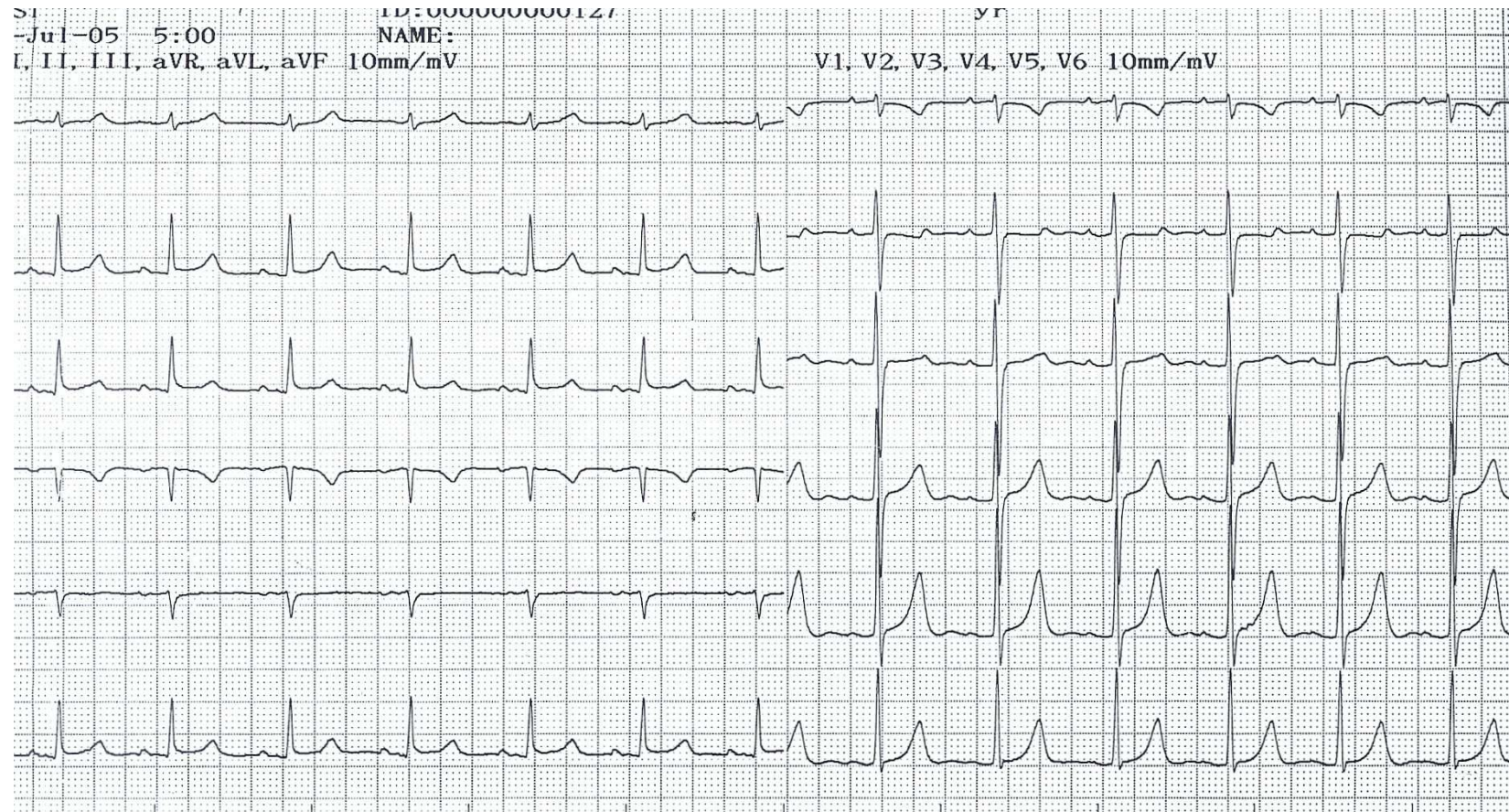
# EKG & AEG

## □ EKG

- Rhythm
- Wave form

## □ AEG

- Precordial lead 중 하나를 Atrial pacing wire 와 연결하여 기록
- Atrial contraction 여부 관찰  
(P-wave의 유무 관찰)



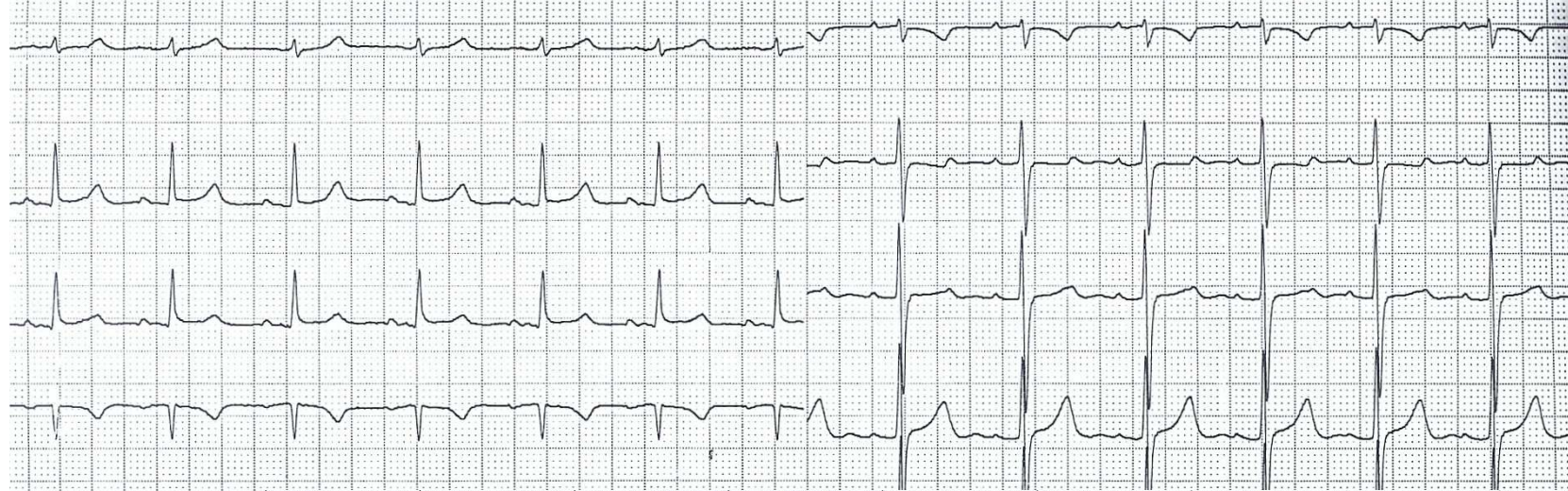


SI ID:00000000127 yr

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I, II, III, aVR, aVL, aVF 10mm/mV

V1, V2, V3, V4, V5, V6 10mm/mV



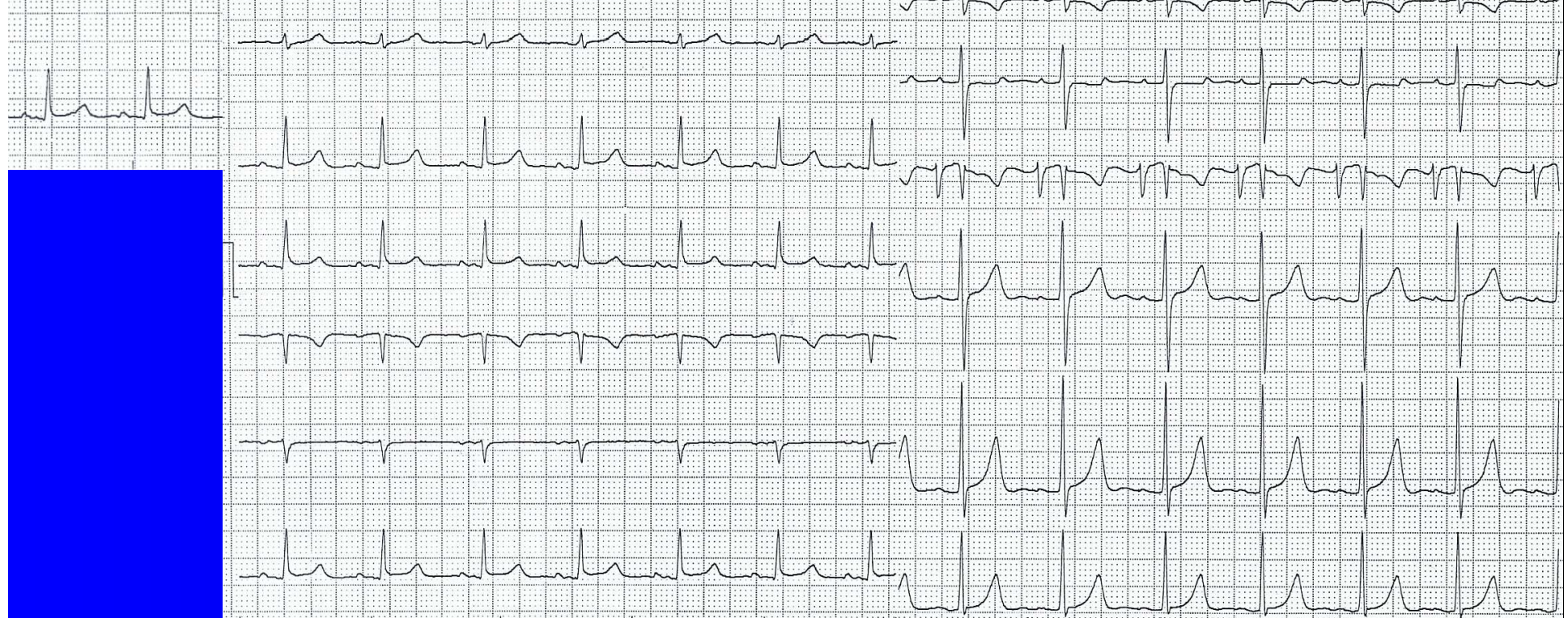
REST

ID:00000000128 yr

26-Jul-05 5:01 NAME:

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V1, V2, V3, V4, V5, V6 10mm/mV



REST

16-Jul-05 5:33

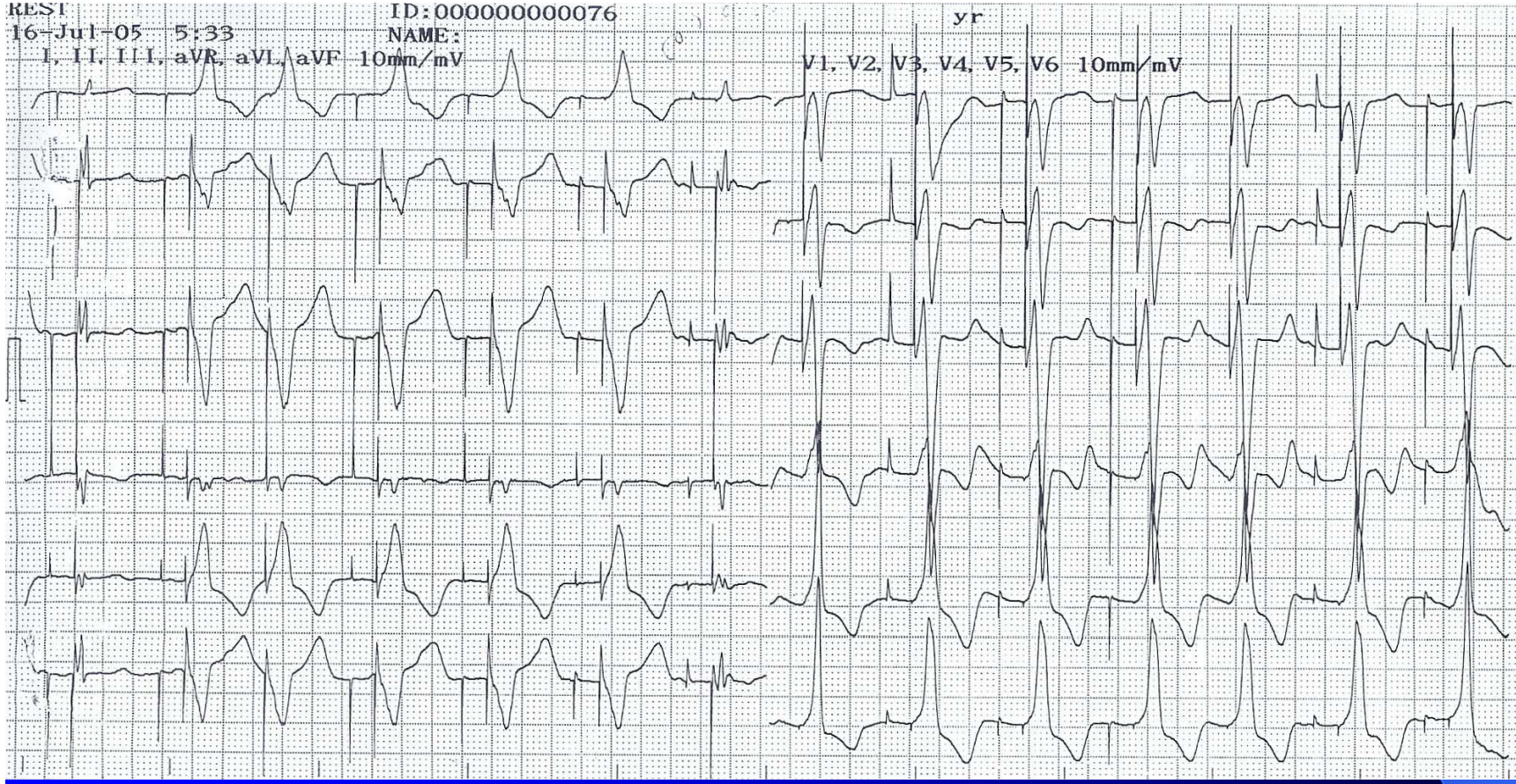
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yr

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I, II, III, aVR, aVL, aVF 10mm/mV

V1, V2, V3, V4, V5, V6 10mm/mV



REST ID: 000000000076

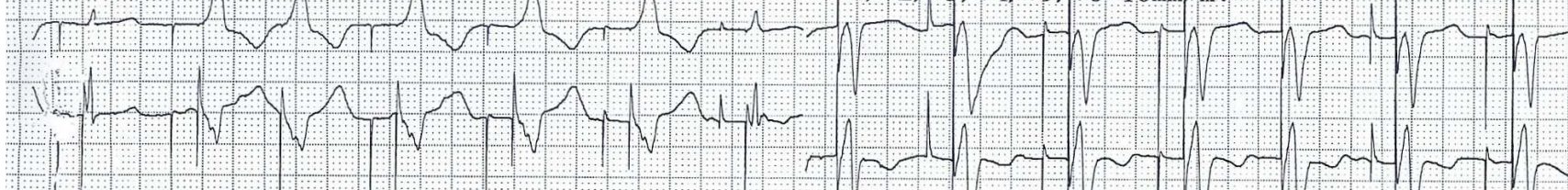
16-Jul-05 5:33

NAME:

yr

I, II, III, aVR, aVL, aVF 10mm/mV

V1, V2, V3, V4, V5, V6 10mm/mV



ESI

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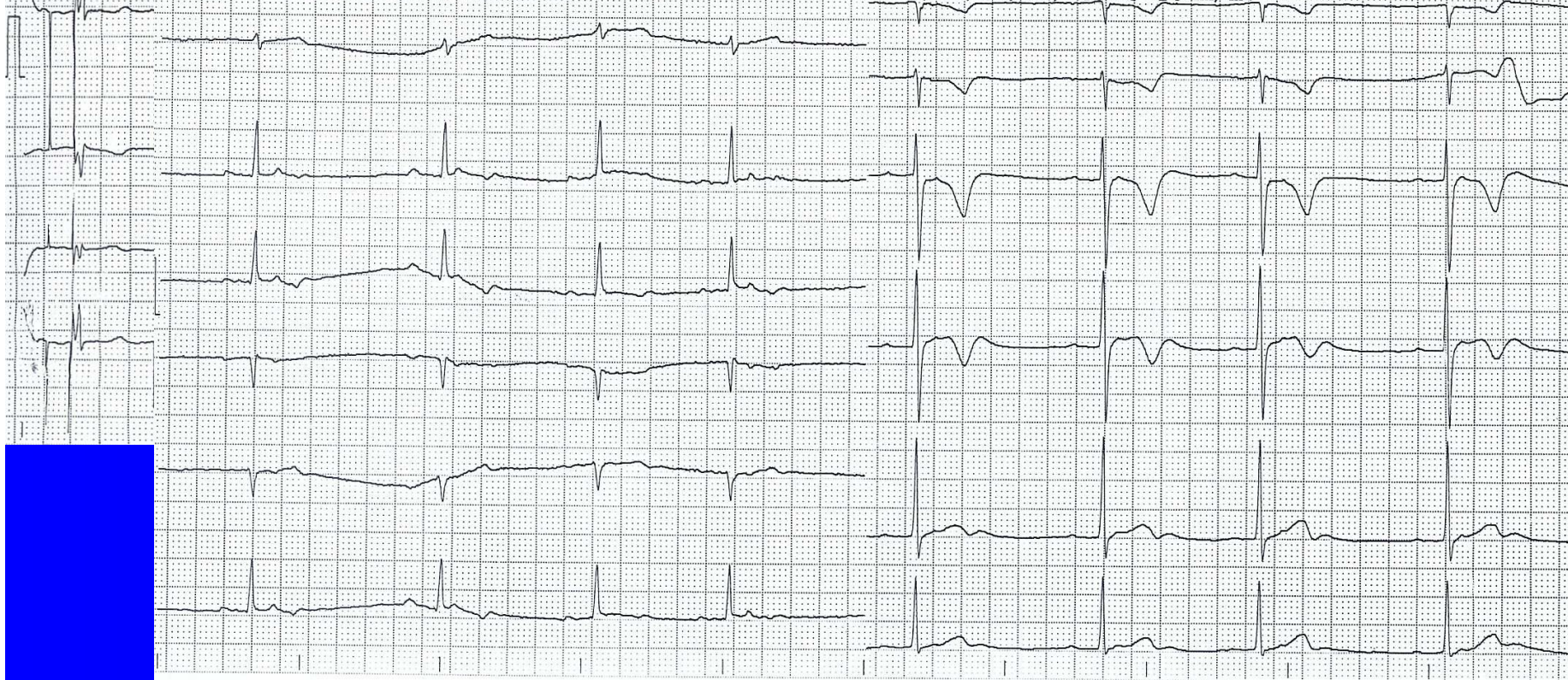
yr

6-Jul-05 5:33

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V1, V2, V3, V4, V5, V6 10mm/mV



REST ID: 000000000076

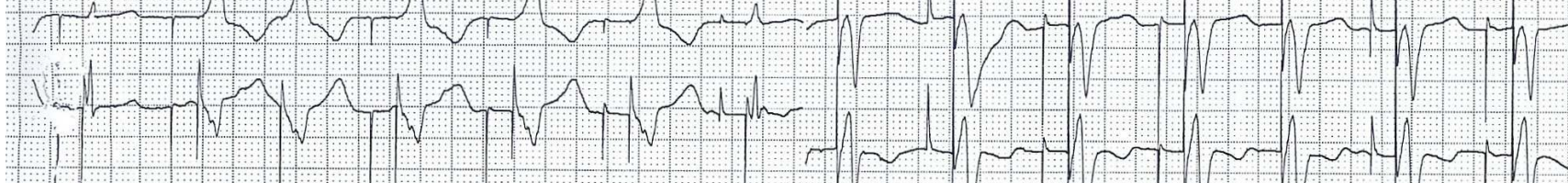
16-Jul-05 5:33

NAME:

yr

I, II, III, aVR, aVL, aVF 10mm/mV

V1, V2, V3, V4, V5, V6 10mm/mV



ESI

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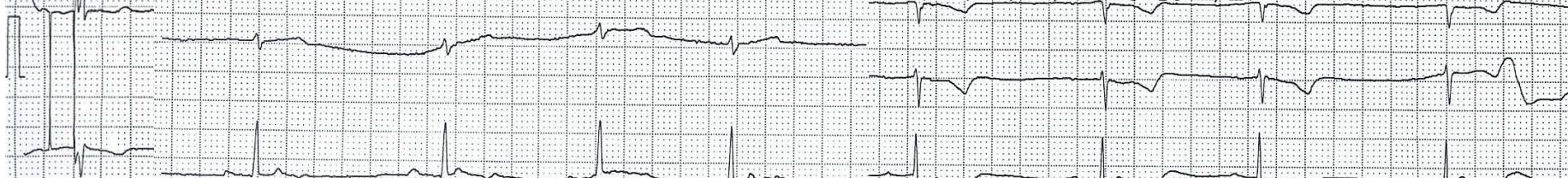
yr

6-Jul-05 5:33

NAME:

I, II, III, aVR, aVL, aVF 10mm/mV

V1, V2, V3, V4, V5, V6 10mm/mV



ST

ID: 000000000080

EAG

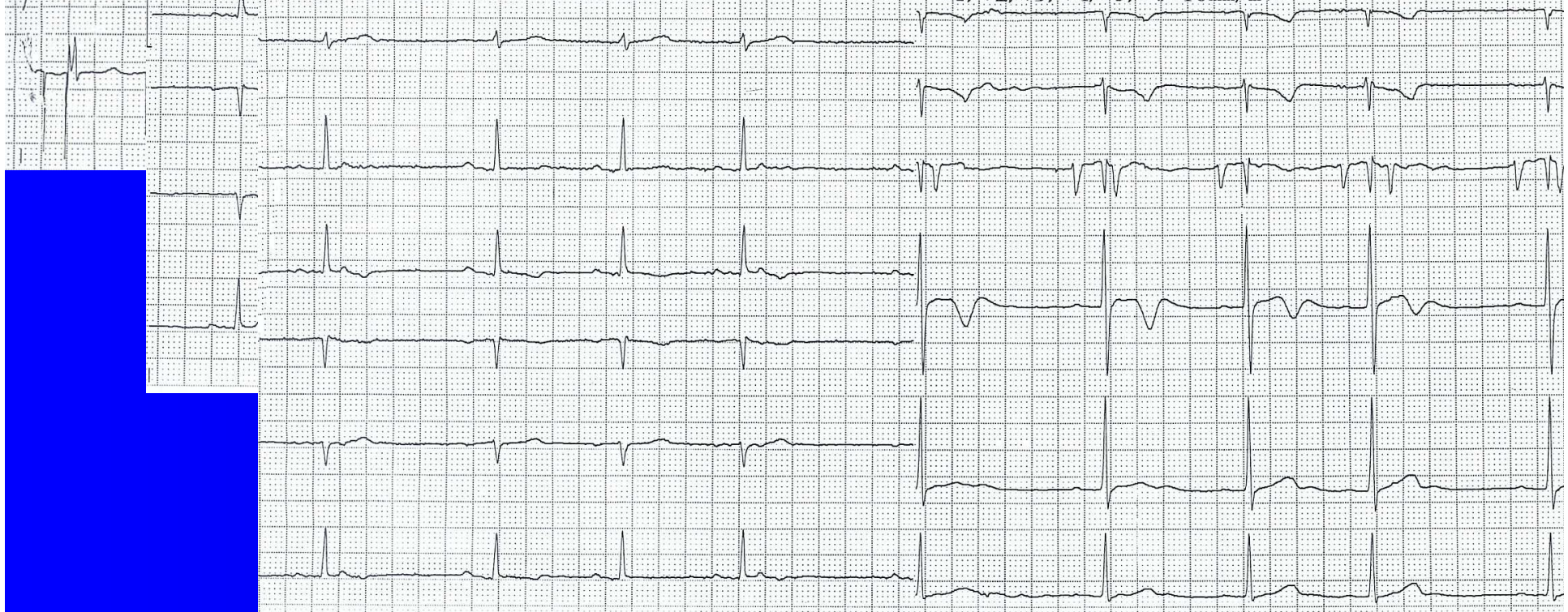
yr

17-Jul-05 5:40

NAME:

I, II, III, aVR, aVL, aVF 10mm/mV

V1, V2, V3, V4, V5, V6 10mm/mV



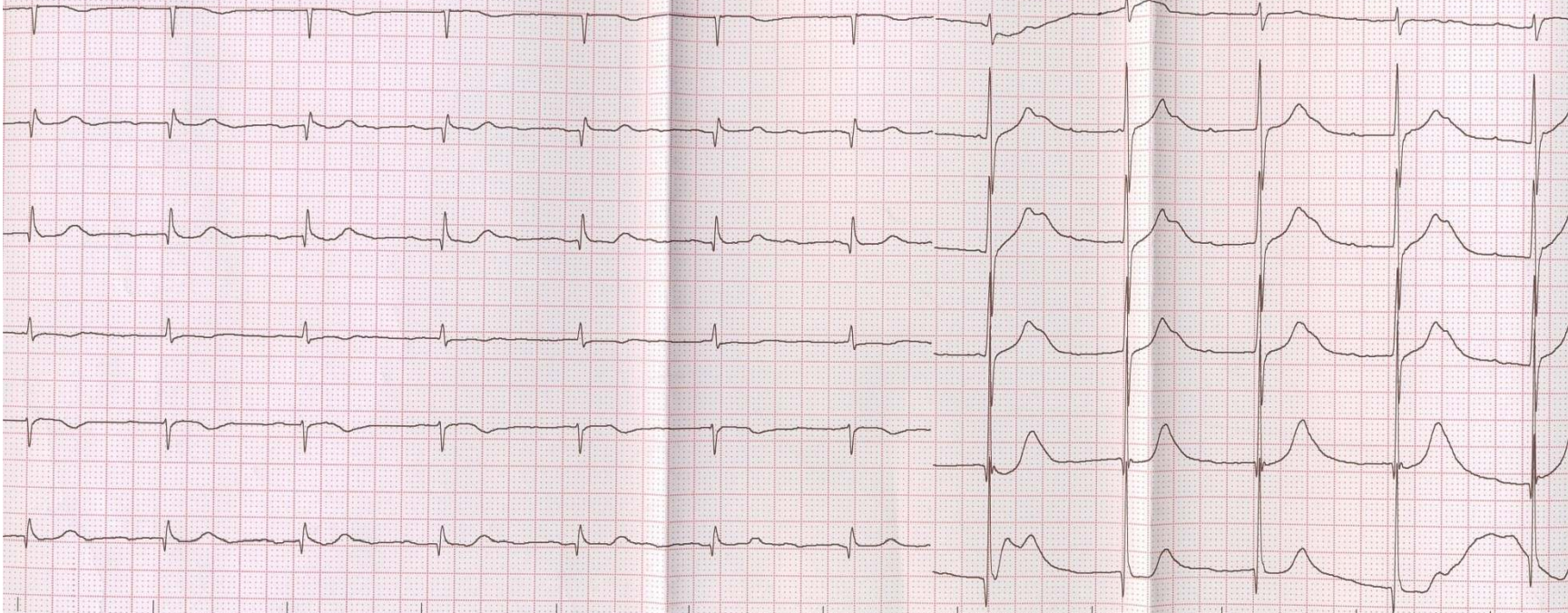
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yr

NAME:

aVF 10mm/mV

V1, V2, V3, V4, V5, V6 10mm/mV



DF

FX-3010 V01-02

MEDI-GRAPH

ECG 1-145-30R

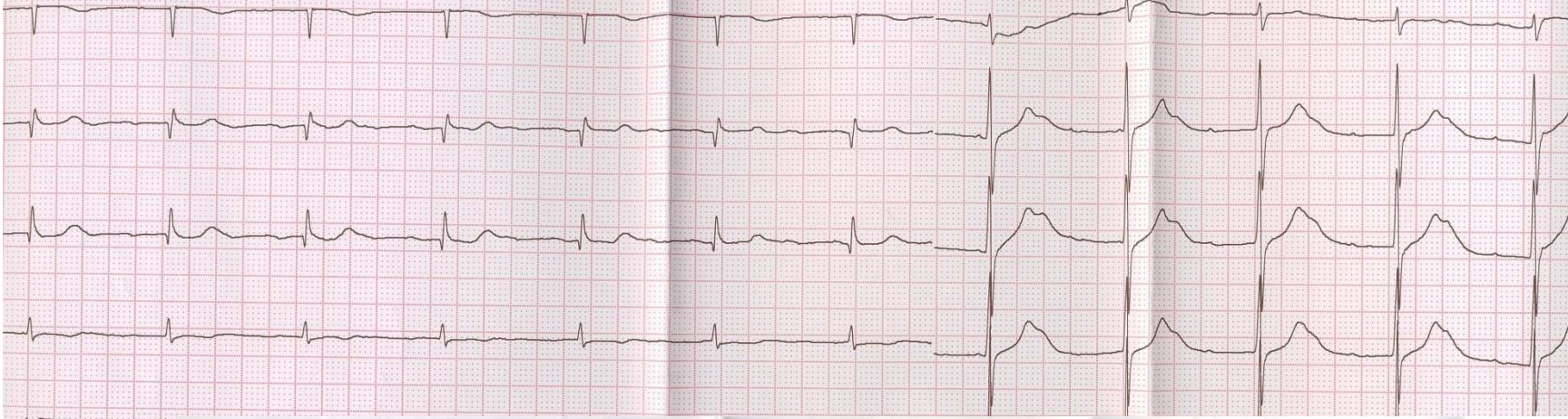
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yr

NAME:

aVF 10mm/mV

V1, V2, V3, V4, V5, V6 10mm/mV



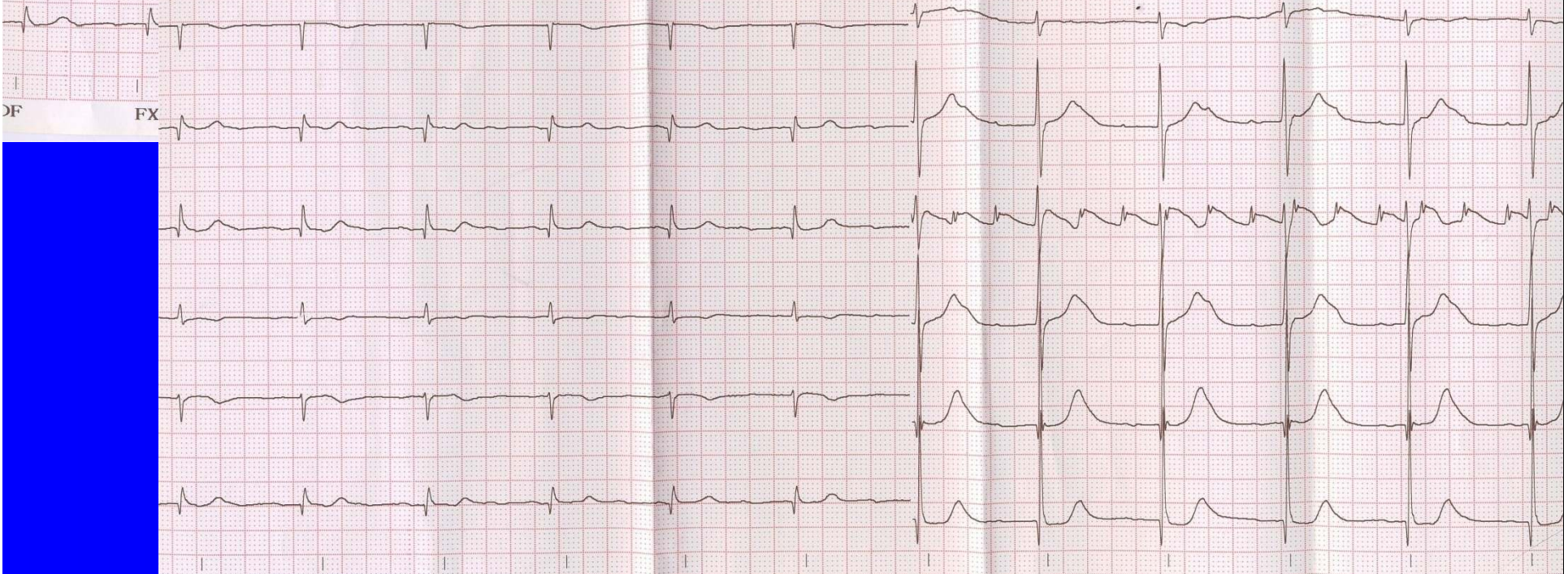
D:000000000004 HR: 59

yr

AME:

m/mV

V1, V2, V3, V4, V5, V6 10mm/mV



# Pathophysiology of AS

- ↑ LV systolic pr
  - LV wall stress
  - LV 탄성감소
  - LVH
  - LV failure
- Hypertrophied, Noncompliant LV
- Stiff unable to fill
  - Reduce stroke volume
  - LCO

# Post-op Mx of AS

- AV synchronocny
  - Pacing, Cardioversion, Med
  - Maintain atrial contraction
- Adequate preload
  - Ensure adequate LV filling pressure
  - PCWP >20
- Hypertension
  - Myocardial O<sub>2</sub> demand 감소
  - Bleeding risk 감소



# Pathophysiology fo AR

- LV volume overload
  - ↑ LV diastolic filling pressure
    - ↑ LVEDV
    - ↑ LV diastolic wall stress
    - LVH, Subendocardial fibrosis
    - LV failure
- Dilated, Hypertrophied LV
- LVEDP, LVEDV 감소
- Post-op vasodilated state

# Post-op Mx of AR

- ❑ Large amount of fluid therapy
- ❑ Maintain sinus rhythm

# Pathophysiology of MS

- ❑ Chronic elevation in LAP (>10~12mmHg)
- ❑ ↓ Flow into LV
- ❑ ↓ Cardiac output ;Cardiac cachexia
- ❑ LAH, A. fib
- ❑ Mural thrombi, Systemic emboli
- ❑ Pulmonary congestion (LAP>30mmHg)
- ❑ Pul. Vasoconstriction → ↑ PVR → Pul. HTN
- ❑ Intact LV function
- ❑ Small LV

# Post-op Mx of MS

- ❑ Small LV cavity with preserved function
- ❑ LV filling pressure ; >20mmHg
  - Ensure adequate cardiac output
  - Large quantity of fluid
- ❑ Maintain sinus rhythm
- ❑ Hemodynamic support for RV failure is required
- ❑ Post-op ventilatory failure

# Pathophysiology of MR

- ↑ LAP
  - Intermittent, less thrombogenic, less Pul. HTN
- ↓ Systemic blood flow
- LVH, LVE, LAE, RVE
- Rapid downhill course after Sx. begin

# Post-op Mx of MR

- LV dysfunction
  - Greater systolic wall stress required to achieve forward ejection
- Inotropics

# Paravalvular leak

- ❑ Urine color
- ❑ Auscultation
- ❑ Labs ; Heptoglobin, Bilirubin, LDH
- ❑ TTE, TEE
- ❑ Hemodynamic parameters, Kidney function, Anemia, Endocarditis
- ❑ Iron, Erythropoietin,  $\beta$ -blocker

# Arrhythmia

The background of the slide is a gradient of blue, transitioning from a dark blue at the top to a lighter blue at the bottom. A curved line, resembling a stylized wave or a path, starts from the left side and curves downwards and to the right, ending near the bottom right corner. The word "Arrhythmia" is written in a light yellow, serif font, centered in the upper half of the slide.



# Classification (Rate)

- ❑ Bradycardia
- ❑ Premature complexes
- ❑ Tachycardia

# Bradyarrhythmia

- ❑ Sinus bradycardia
- ❑ AV block
  - 1<sup>st</sup> degree AV block
  - 2<sup>nd</sup> degree AV block
    - Mobitz type I (Wenckebach phenomenon)
    - Mobitz type II
    - High grade AV block
  - 3<sup>rd</sup> degree AV block (Complete AV block)

# Premature complexes

- ❑ Premature atrial complexes(PACs)
- ❑ Premature AV junctional complexes(JPCs)
- ❑ Premature Ventricular complexes(PVCs)

# Tachyarrhythmia

- Narrow complex tachycardia
  - Sinus tachycardia
  - Atrial tachycardia
    - Paroxymal atrial tachycardia(PAT)
    - Multifocal atrial tachycardia(MAT)
  - AV junctional tachycardia
  - AVNRT
  - WPW syndrome
  - Atrial fibrillation
  - Atrial flutter

- Wide complex tachycardia
  - SVT
  - Accelerated idioventricular rhythm
  - VT
  - Ventricular fibrillation
  - Torsades de pointes

# Conduction disturbance

## □ 원인

- Hemorrhage, Edema, Suture, Debridement near the AV node and His
- Transseptal approach ; nodal artery, internodal pathway  
interatrial pathway
- Long CPB time, ACC time,
- Use of cold potassium cardioplegia
- LV function, HTN, CAD

## □ 치료

- Catecholamine
- Pacing (Epicardial, Transcutaneous, Transvenous, Permanent)

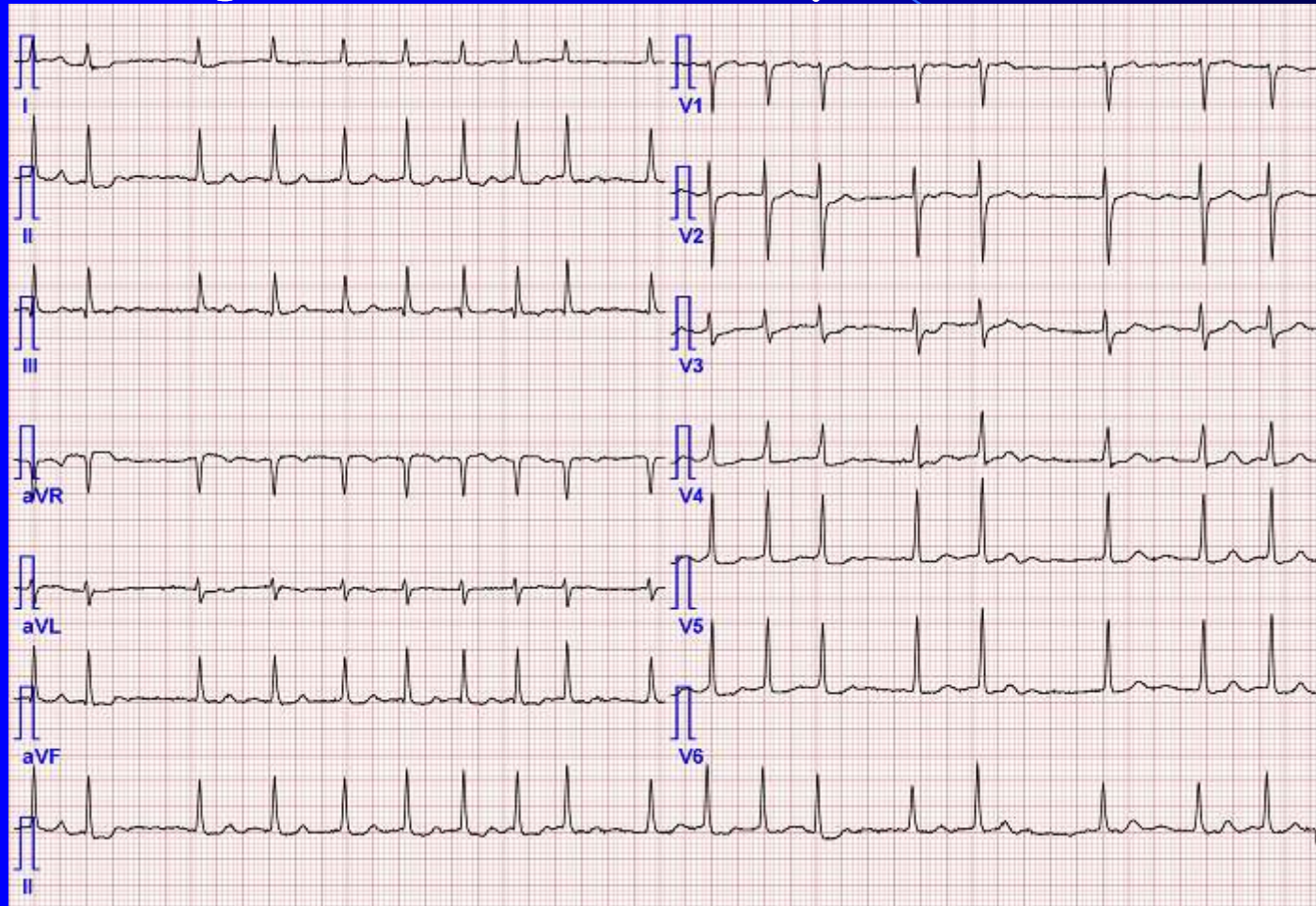
# Atrial Fibrillation

- Atrium의 rapid reentry circuit에 존재하는 multiple ectopic pacemaker에 의해 발생하여 atrium이 연속적으로 흔들리는 현상
- Cardiac output 30% 감소
- Thromboembolism의 원인
- 심장수술환자의 약 30%에서 발생

f-wave

Normal QRS

Irregular ventricular response

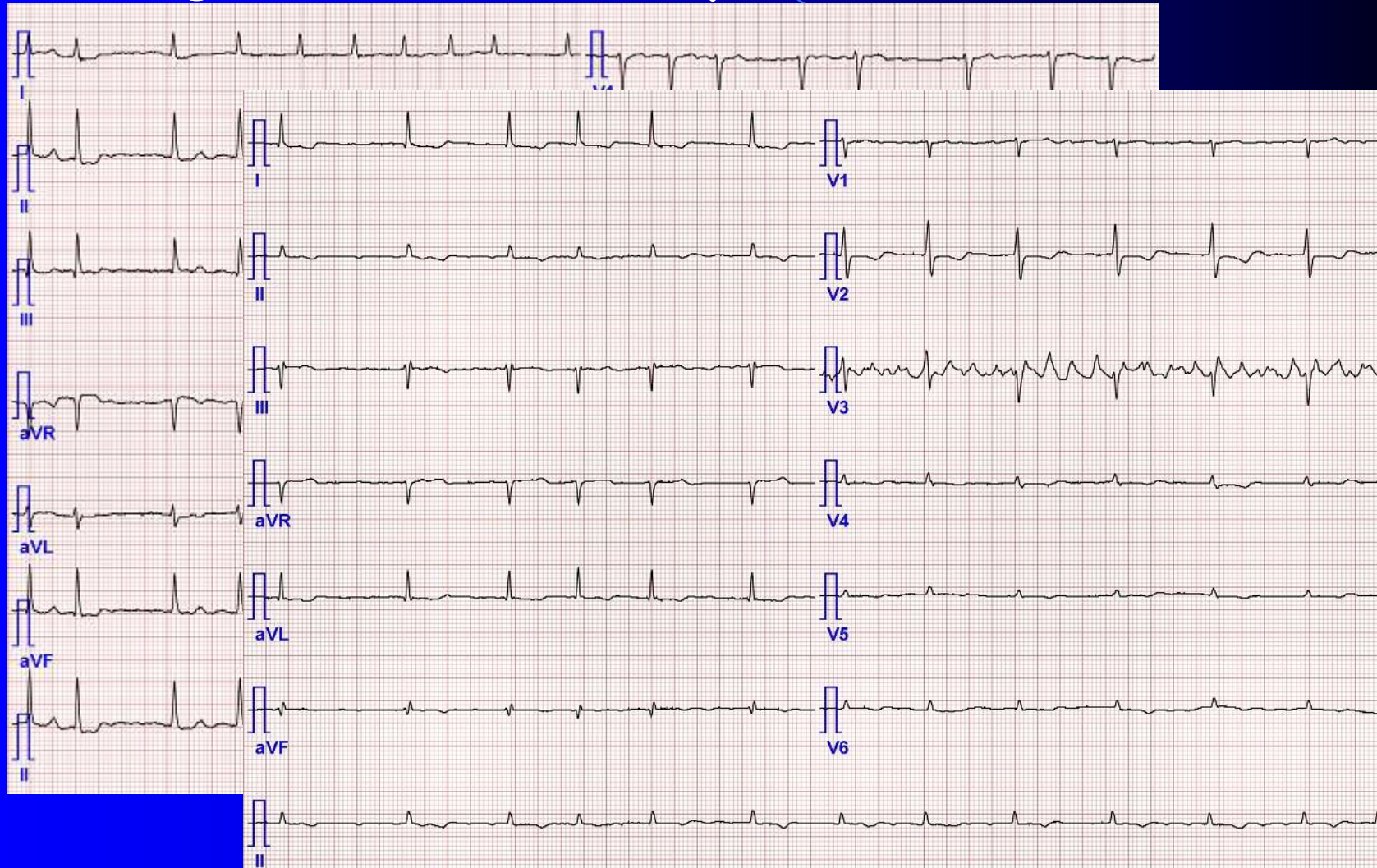




f-wave

Normal QRS

Irregular ventricular response



# Etiology of A.fib

- ❑ Atrial ischemia
- ❑ Pre-op  $\beta$ -blocker
- ❑ Surgical trauma
- ❑ Pericarditis, Pericardial effusion
- ❑ Electrolyte imbalance
- ❑ Atrial distension
- ❑ IHD, VHD, Hypertension, Hyperthyroidism, Alcohol

# Tx of A.fib

## □ Goal of Tx

- Sinus Conversion
- Decrease HR

## □ Tx

- Electrolyte, Volume control
- Cardioversion(Synchronous)
- Rapid atrial pacing
- Amiodarone, Digitalis, Ca-blocker,  $\beta$ -blocker, Quinidine

# Prevention of Post-op A.fib

- Effective
  - $\beta$ -blocker
  - Amiodarone
  - Mg
  - Atrial pacing
- Ineffective
  - DIG
  - Verapamil
  - Procainamide, Quinidine

# Type of Pacemaker

- Single Chamber Pacemaker
  - AOO ; Asynchronous atrial pacing
  - AAI ; Atrial demand pacing
  - VVI ; Ventricular demand pacing
- Dual Chamber Pacemaker
  - DVI ; AV sequential pacing
  - DDD

# Epicardial Pacing Wire Site

- ❑ Ventricular pacemaker
  - RV wall
- ❑ Atrial pacemaker
  - RA
- ❑ Unipolar
  - Diaphragm, Skin (ground, Positive)

# Pacemaker Malfunction

- ❑ Failure to capture
  - Pacemaker spike 후에 depolarization이 없을 때
  - Generator의 output가 낮은 경우
- ❑ Failure to sense
  - Pacemaker spike is present when it should not be
  - Sensitivity 조절
- ❑ Failure to discharge

# Restore Pacemaker Function

- ❑ Changing all connections including connecting cord
- ❑ Unipolarization
- ❑ Increasing the output of the generator
- ❑ Using the different pacing wires
- ❑ Using the new generator
- ❑ Converting to V-pacing if the atrial stimulus fails to produce capture
- ❑ Using a chronotropes
- ❑ Placing a transvenous pacing wires



# Amiodarone

- ❑ Originally developed as an anti angina drug
- ❑ Possess all 4 class effect  
block INa, ICa, IK, and beta block
- ❑ Mild negative inotropic effect
- ❑ More potent at higher HR

# Clinical application

## □ Recurrent Ventricular arrhythmia

### ➤ Chronic

Post MI → significant survival benefit

Non ischemic : → no survival benefit

### ➤ Acute use IV : VF or VT

## □ Recurrent paroxysmal A.fib/FL, AVNRT

## Dosage and administration

- Oral : 600mg~1600 for 1~ 3wk  
800mg for 2~4wk,  
600mg for 4~8wk. Total 2~3mth
- IV : Loading 5~10mg/kg over 30min  
600mg ~ 1,000mg /day  
300mg IV bolus in shock refractory VF

# Adverse effect ; Cardiac

- ❑ Bradycardia
- ❑ Heart block
- ❑ Prolongs QT interval ; Proarrhythmic in about 30% Pt.
- ❑ Reduces clearance of Warfarin, DIG, Quinidine

# Adverse effect ; Non-cardiac

- ❑ Pulmonary toxicity with chr. Use
  - Chr interstitial pneumonitis, BOOP, ARDS, SPN
- ❑ Hepatic dysfunction
- ❑ CNS ; Tremor, ataxia, paresthesia
- ❑ Corneal deposit
- ❑ GI trouble

(Dizziness, Nausea, Blurred vision, INR ↑ )

# Case

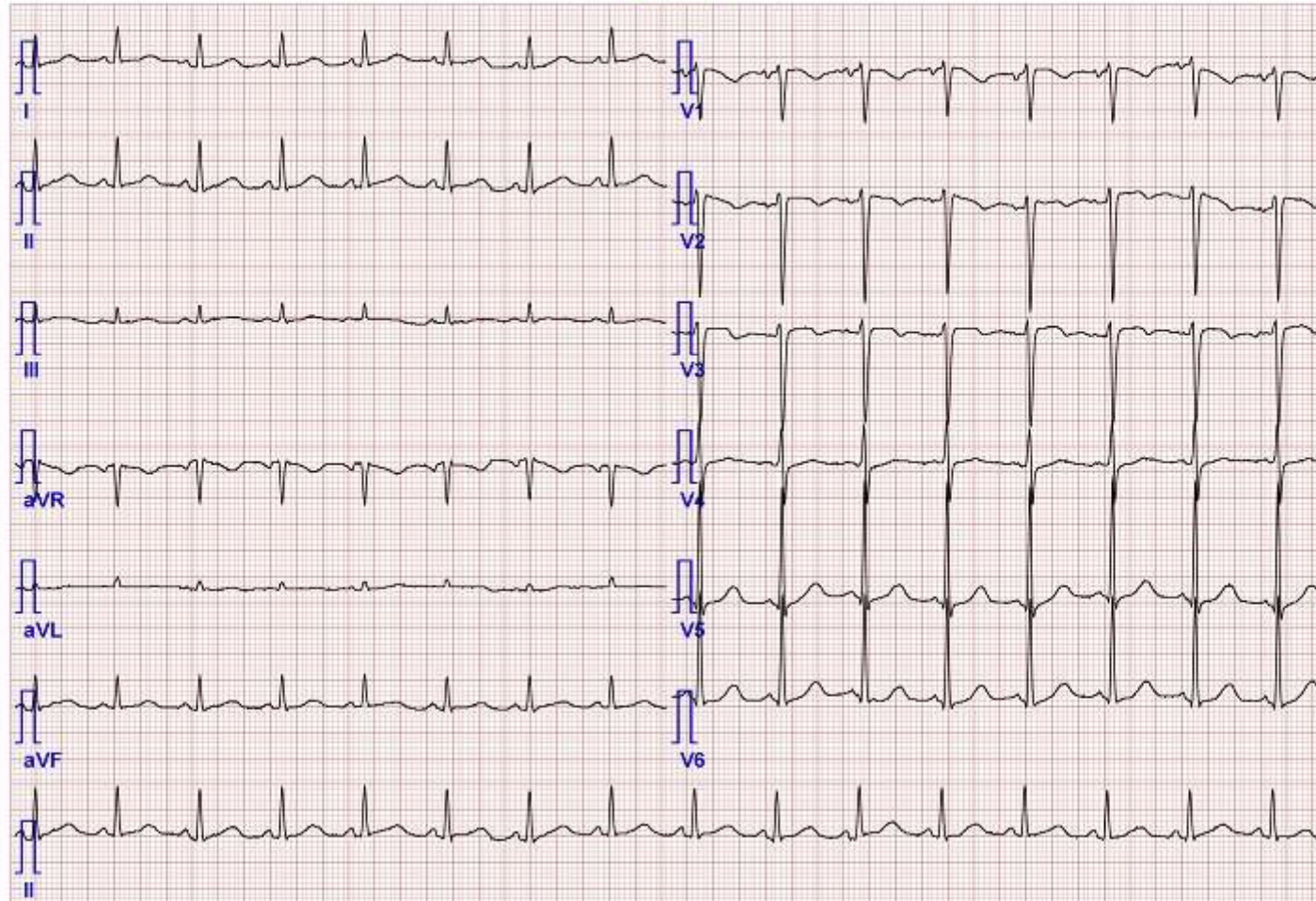
- M/64
- Infective endocarditis, AV
- Cb infarction
- Multiple myeloma
- Sudden cardiac arrest로 CPR후 응급 수술

HR : 94 bpm  
R-R : 0.638 sec  
P-R : 0.113 sec  
QRS : 0.095 sec  
QT : 0.397 sec  
QTc : 0.498  
AXIS : 53 deg

401 Short P-R Interval  
141 QT Prolongation  
Abnormal

Result:

Abnormal

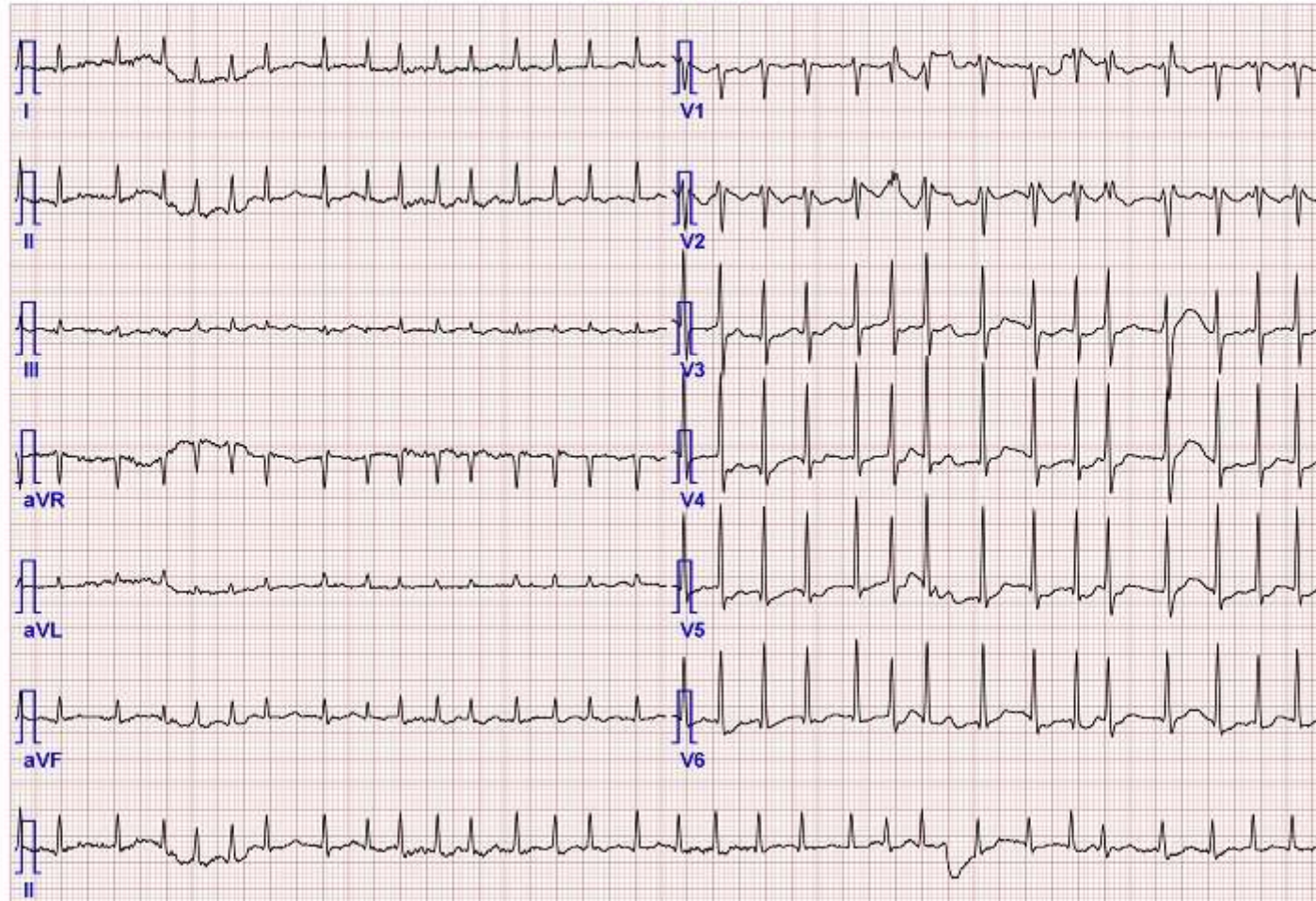


HR : 183 bpm  
R-R : 0.328 sec  
P-R : 0.143 sec  
QRS : 0.086 sec  
QT : 0.249 sec  
QTc : 0.435  
AXIS : 49 deg

Within Normal Limits

Result:

Within Normal Limits



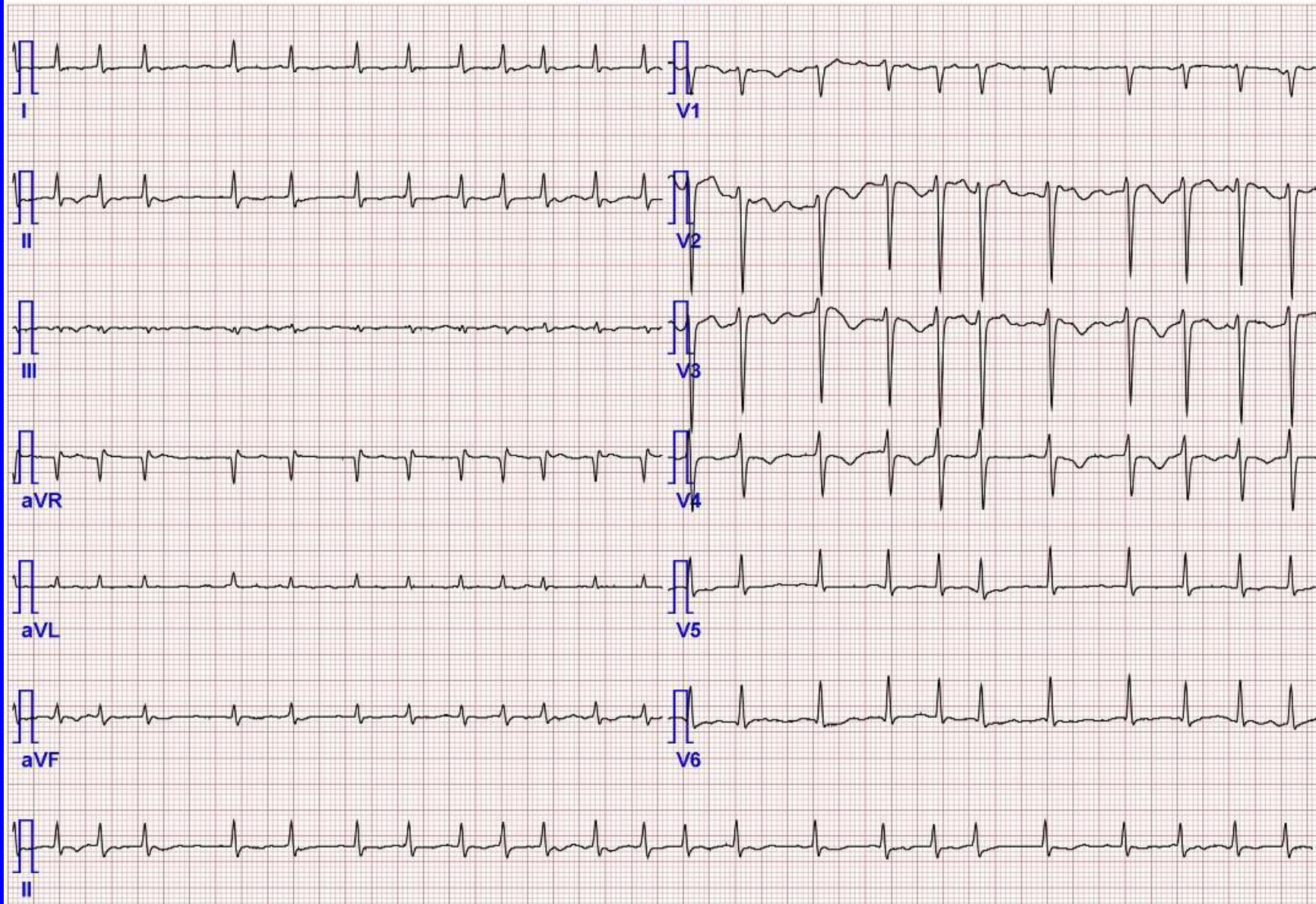


HR : 139 bpm  
R-R : 0.432 sec  
P-R : 0.158 sec  
QRS : 0.097 sec  
QT : 0.309 sec  
QTc : 0.470  
AXIS : 26 deg

Within Normal Limits

Result:

Within Normal Limits

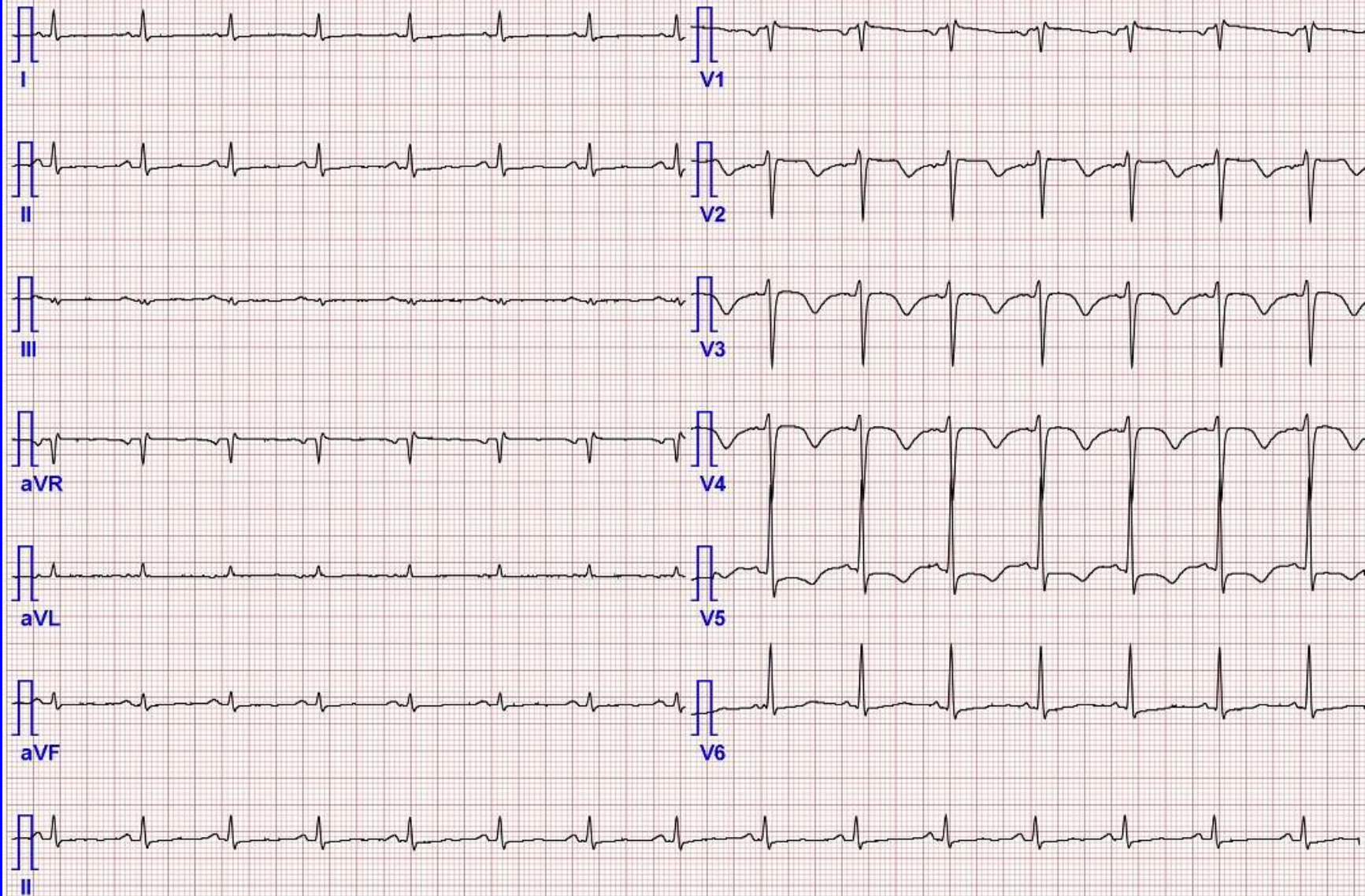


HR : 90 bpm  
R-R : 0.667 sec  
P-R : 0.111 sec  
QRS : 0.099 sec  
QT : 0.365 sec  
QTc : 0.448  
AXIS : 16 deg

Within Normal Limits

Result:

Within Normal Limits

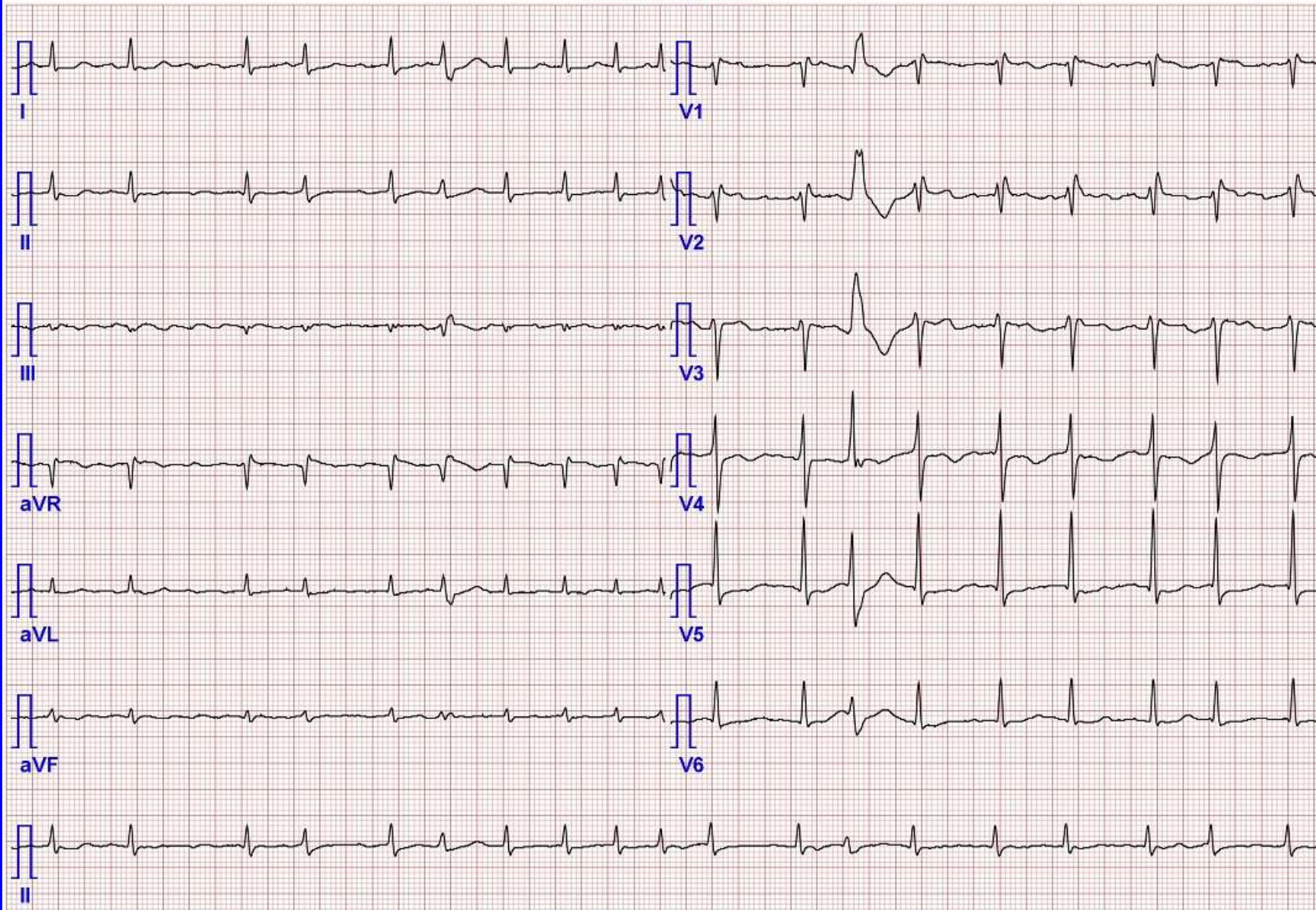


HR : 114 bpm  
R-R : 0.526 sec  
P-R : 0.025 sec  
QRS : 0.092 sec  
QT : 0.344 sec  
QTc : 0.474  
AXIS : 11 deg

Within Normal Limits

Result:

Within Normal Limits

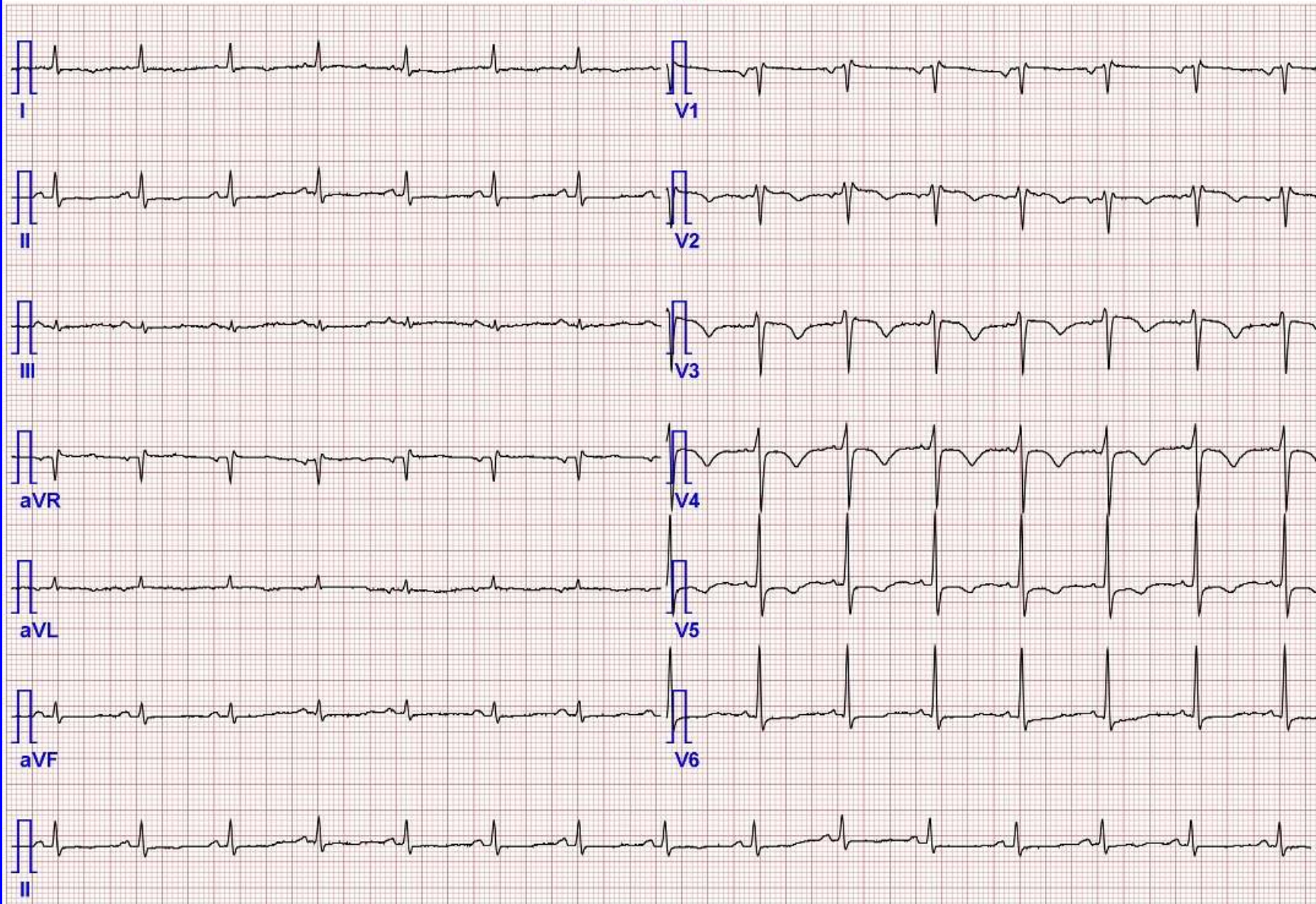


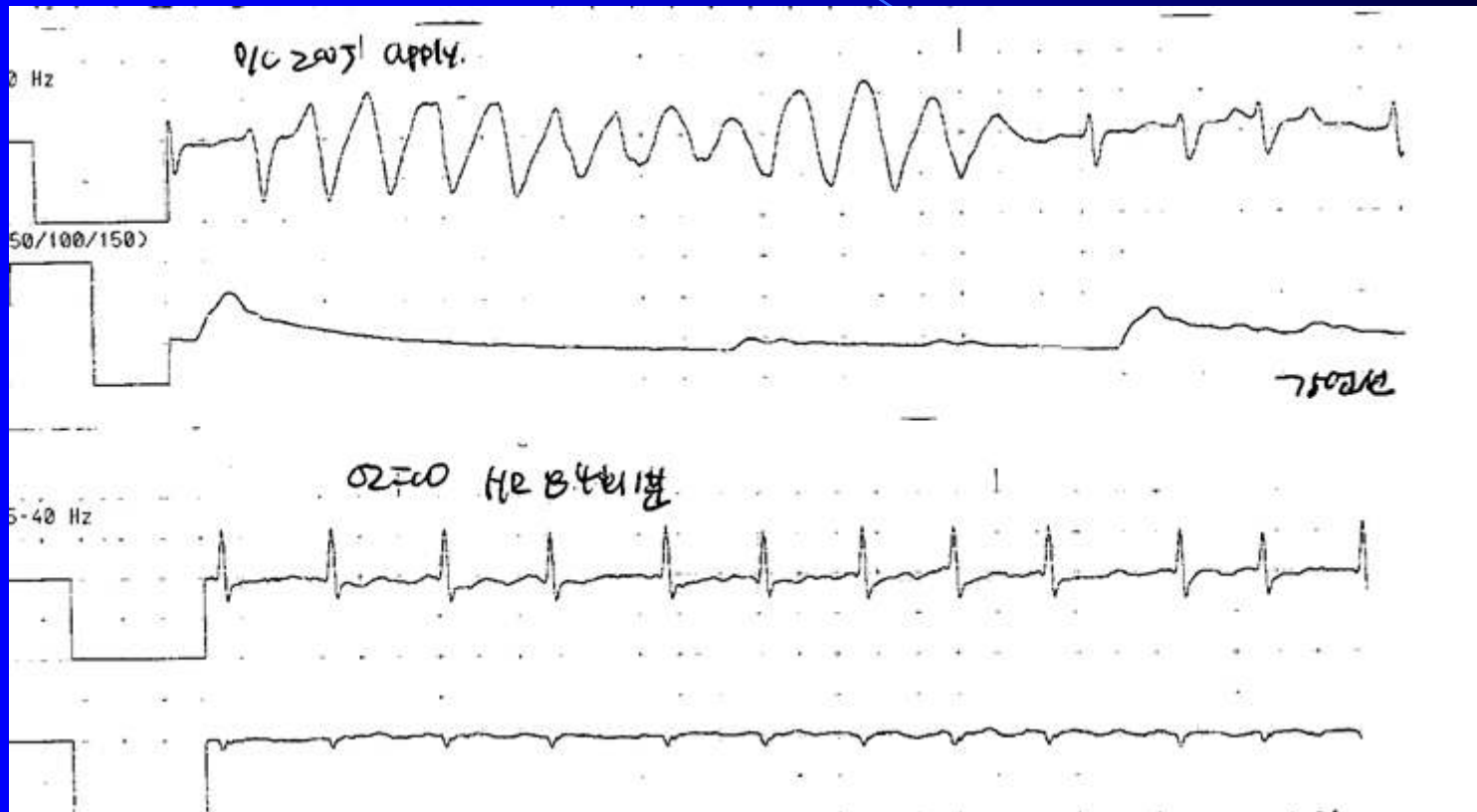
HR : 89 bpm  
R-R : 0.674 sec  
P-R : 0.127 sec  
QRS : 0.101 sec  
QT : 0.407 sec  
QTc : 0.496  
AXIS : 20 deg

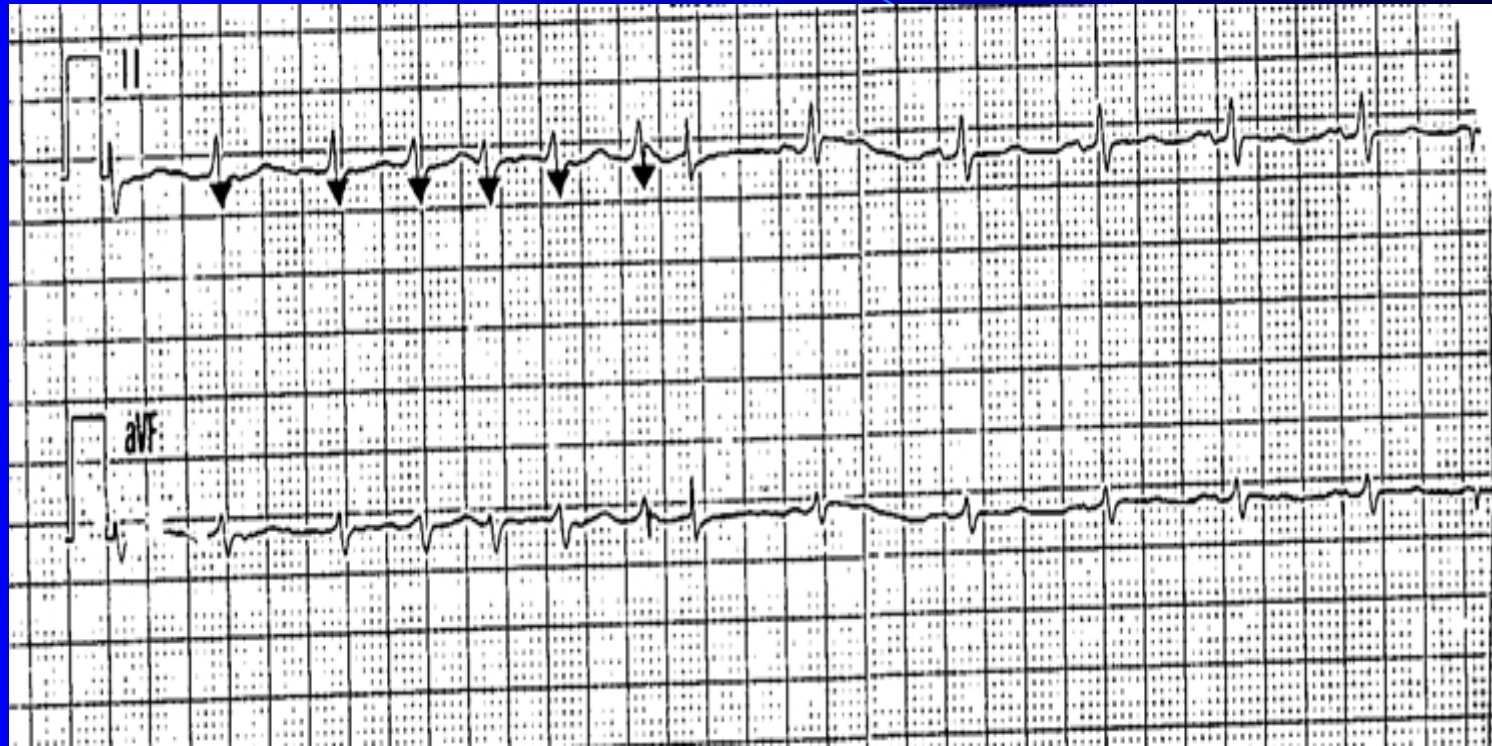
Within Normal Limits

Result:

Within Normal Limits





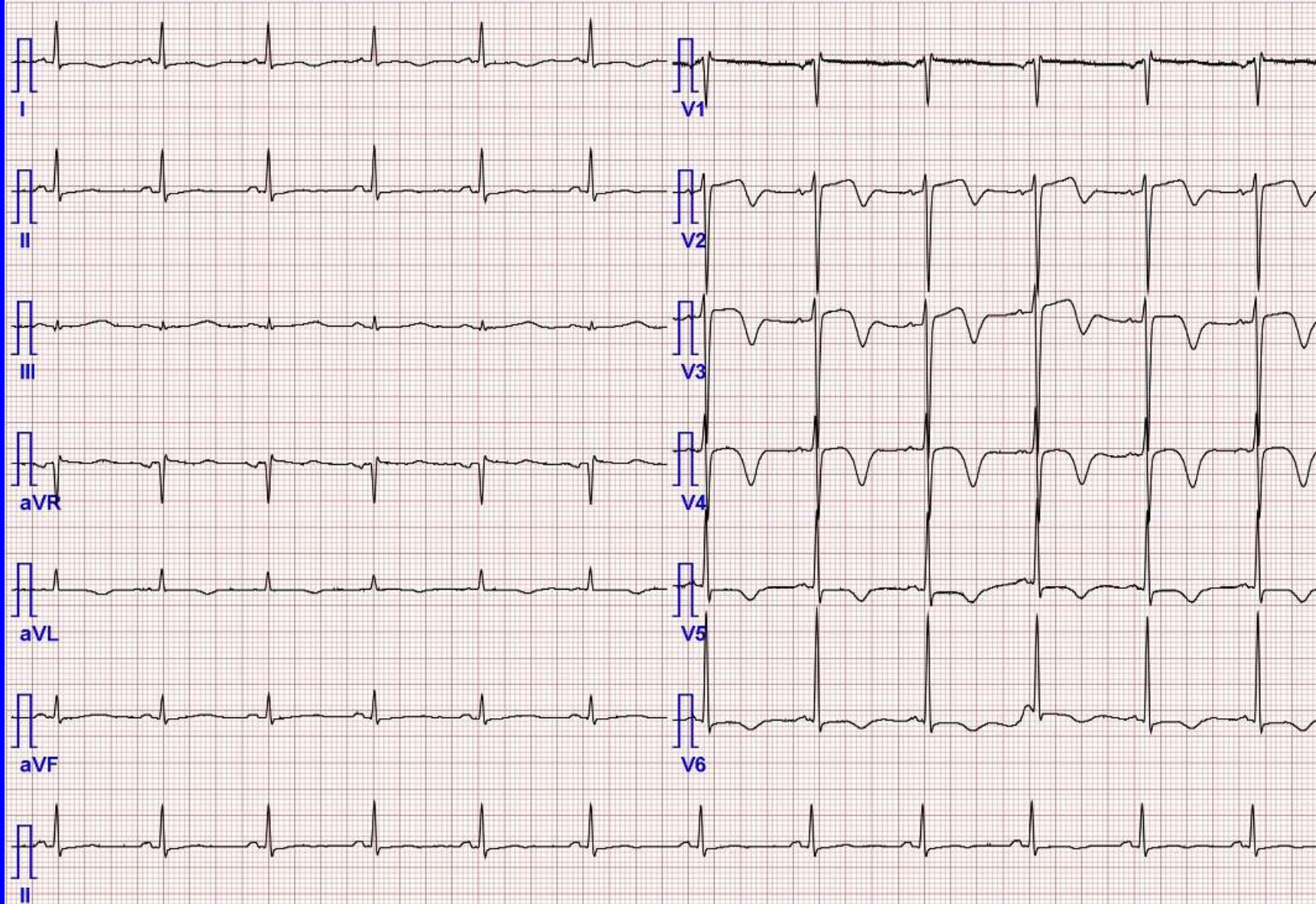


HR : 72 bpm  
R-R : 0.833 sec  
P-R : 0.130 sec  
QRS : 0.092 sec  
QT : 0.493 sec  
QTc : 0.541  
AXIS : 33 deg

Within Normal Limits

Result:

Within Normal Limits

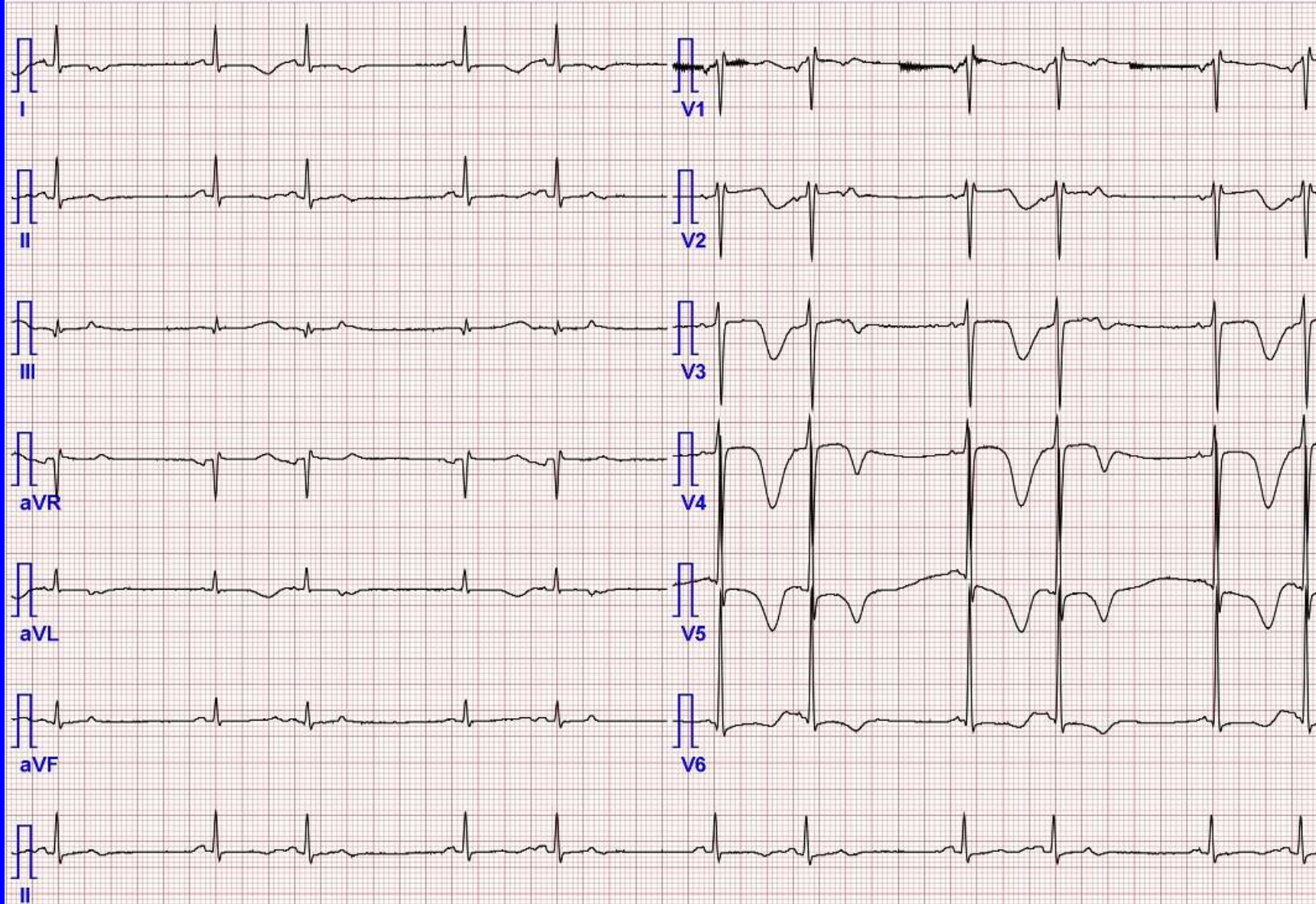


HR : 61 bpm  
R-R : 0.984 sec  
P-R : 0.086 sec  
QRS : 0.097 sec  
QT : 0.532 sec  
QTc : 0.538  
AXIS : 25 deg

633 ST-T Abnormality  
Within Normal Limits

Result:

Within Normal Limits



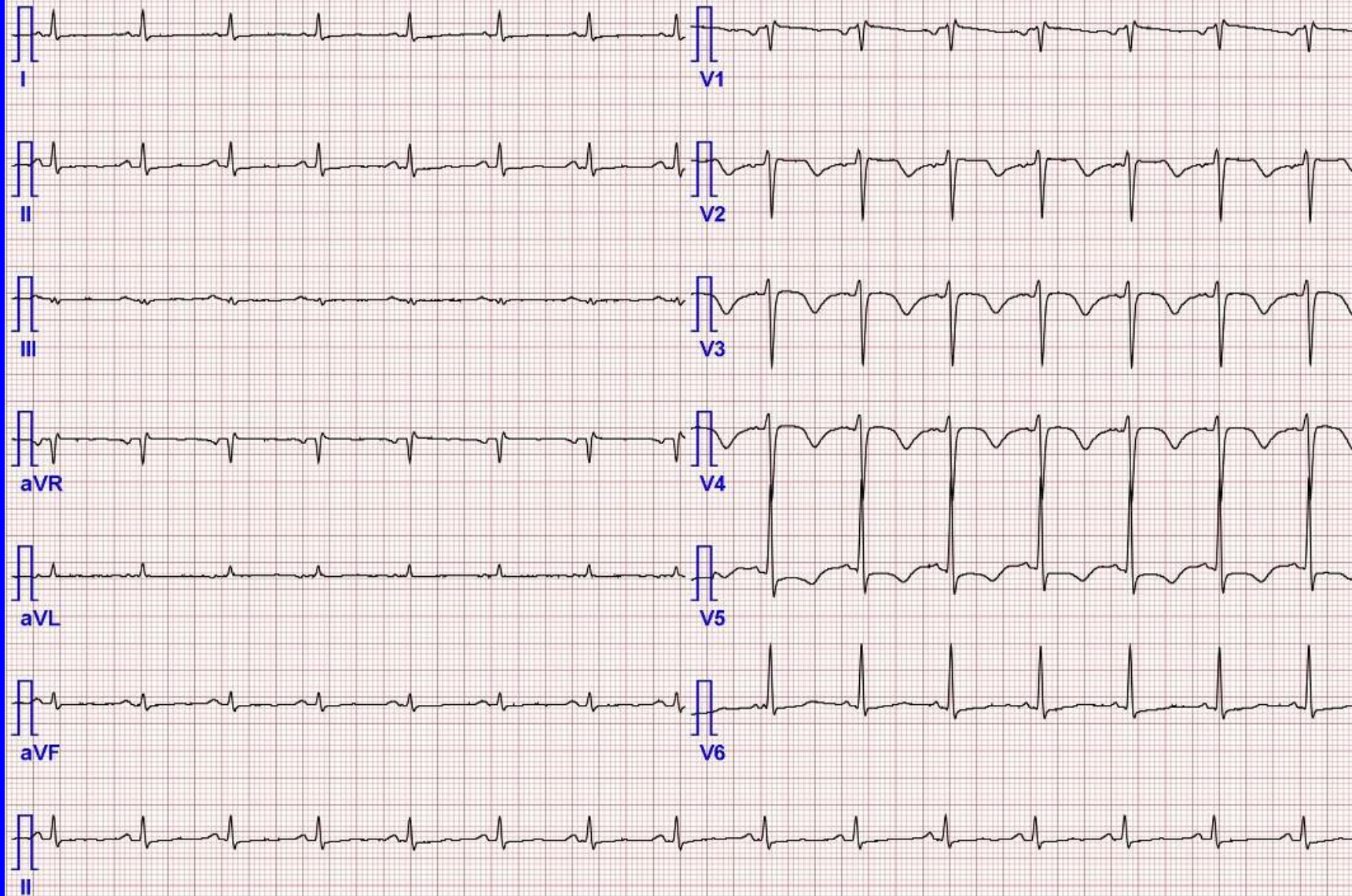


HR : 90 bpm  
R-R : 0.667 sec  
P-R : 0.111 sec  
QRS : 0.099 sec  
QT : 0.365 sec  
QTc : 0.448  
AXIS : 16 deg

Within Normal Limits

Result:

Within Normal Limits

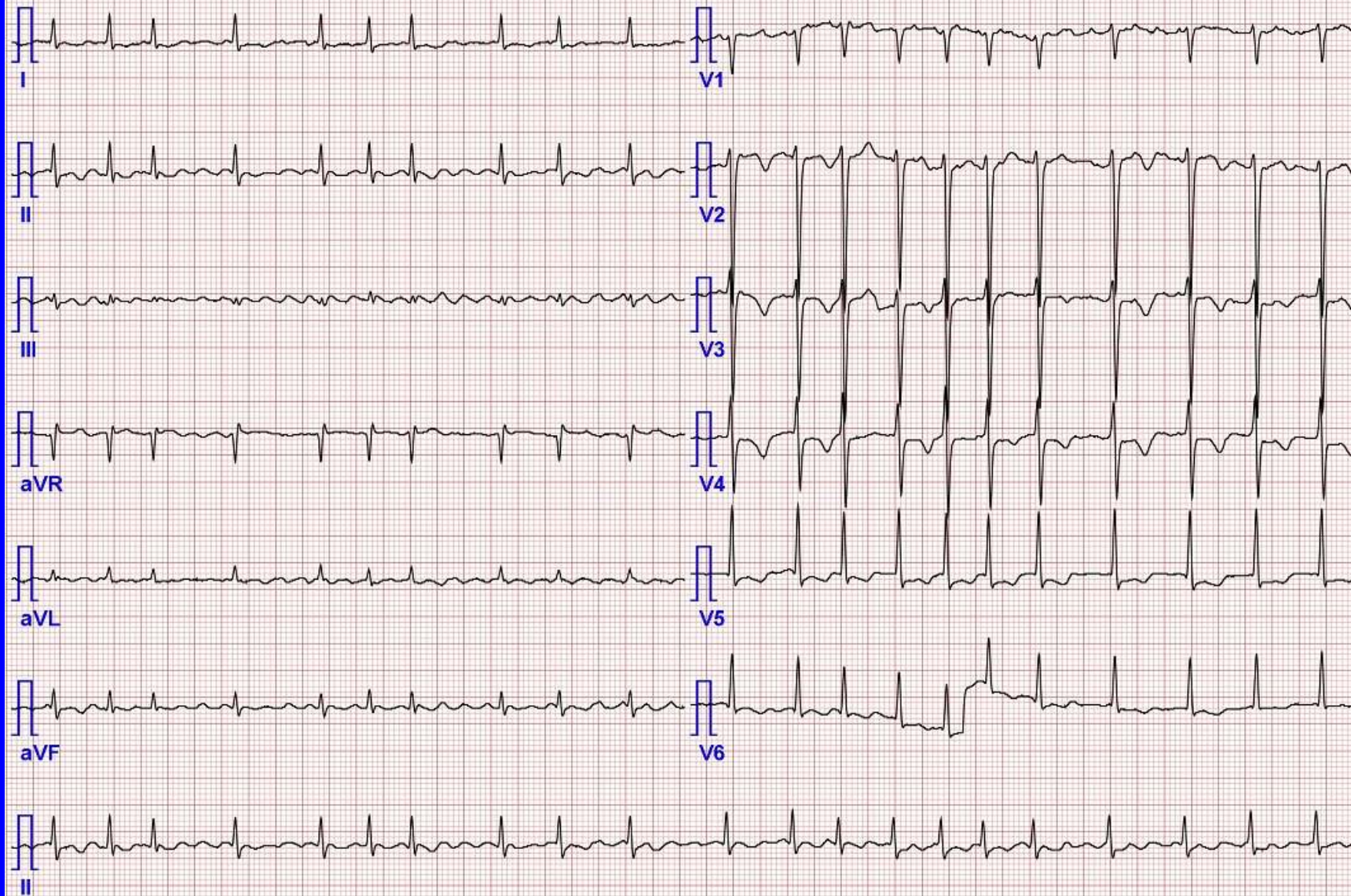


HR : 128 bpm  
R-R : 0.469 sec  
P-R : 0.113 sec  
QRS : 0.078 sec  
QT : 0.294 sec  
QTc : 0.429  
AXIS : 33 deg

Within Normal Limits

Result:

Within Normal Limits

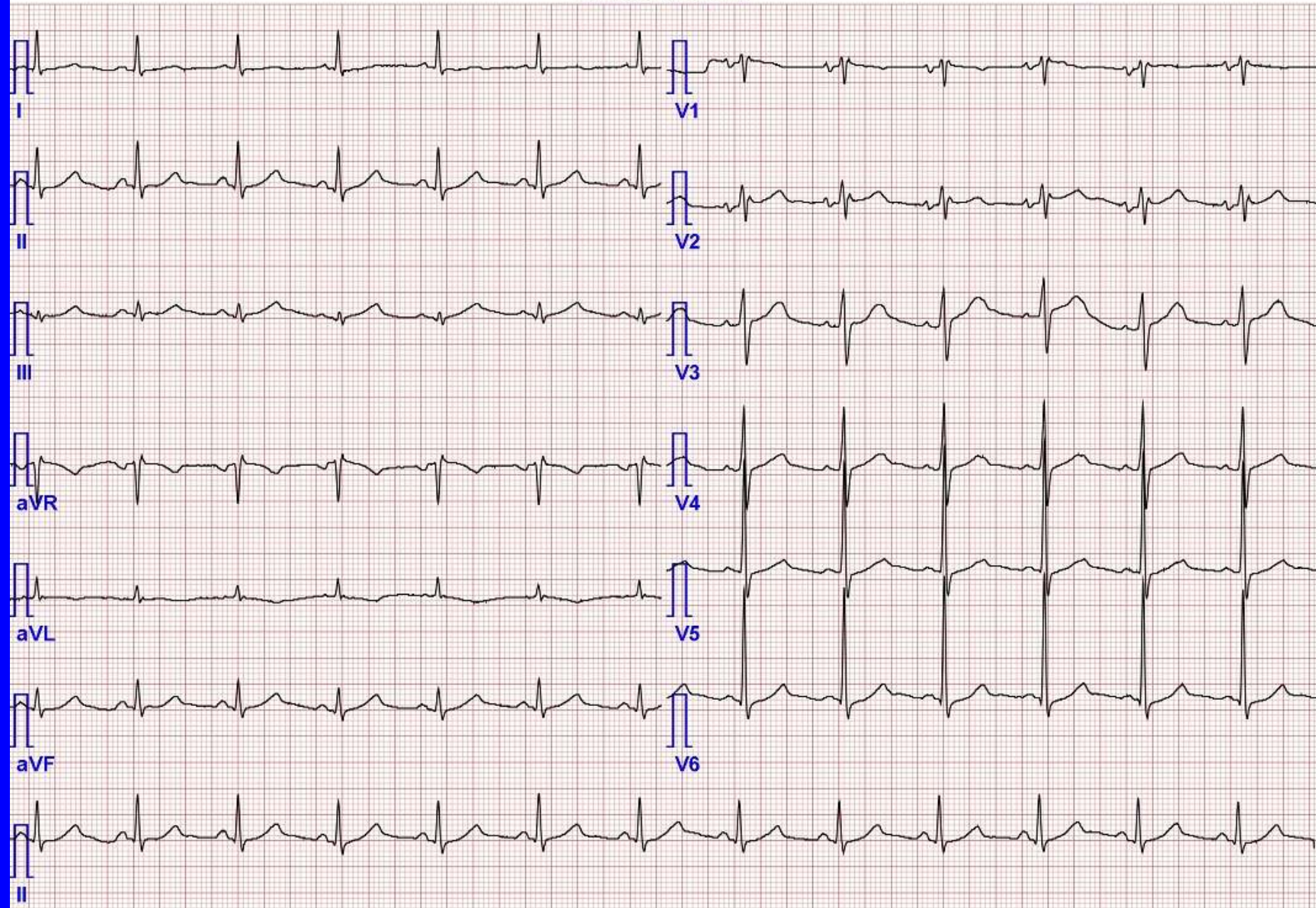


HR : 78 bpm  
R-R : 0.769 sec  
P-R : 0.129 sec  
QRS : 0.109 sec  
QT : 0.403 sec  
QTc : 0.460  
AXIS : 23 deg

501 IRBBB(Incomplete Right Bundle Branch Block)  
143 Slight QT Prolongation  
Borderline Abnormal

Result:

Borderline Abnormal



# Antithrombotic Tx

ACCP, ACC/AHA guideline

# ACC/AHA 2006

Valve Type	Aspirin (75-100 mg)	Warfarin (INR 2.0-3.0)	Warfarin (INR 2.5-3.5)	No Warfarin
<b>Mechanical Prosthetic</b>				
A. AVR – Low Risk				
■ Less than 3 months	Class I	Class I	Class IIa	
■ Greater than 3 months	Class I	Class I		
B. AVR – High Risk				
	Class I		Class I	
C. MVR				
	Class I		Class I	
<b>Biological Prosthetic</b>				
A. AVR – Low Risk				
■ Less than 3 months	Class I	Class IIa		Class IIb
■ Greater than 3 months	Class I			Class IIa
B. AVR – High Risk				
	Class I	Class I		
C. MVR – Low Risk				
■ Less than 3 months	Class I	Class IIa		
■ Greater than 3 months	Class I			Class IIa
D. MVR – High Risk				
	Class I	Class I		

Risk Factors ; AF. LV dysfunction, Prev TE, Hypercoagulable

# ACCP 2008, ACC/AHA 2008

	Warfarin	Antiplatelet Drugs
AVR – tissue	INR 2.0–3.0 for 3 months if risk factors (ACC/AHA)	Aspirin 75–100 mg alone if no risk factors
AVR – mechanical	INR 2.0–3.0 indefinitely	Aspirin 75–100 mg
Mitral valve repair	INR 2.0–3.0 for 3 months (use either warfarin or aspirin)	Aspirin 75–100 mg (use either warfarin or aspirin)
MVR – tissue	INR 2.0–3.0 for 3 months (ACCP) Continue indefinitely if risk factors	Aspirin 75–100 mg with warfarin if risk factors Aspirin 75–100 mg alone if no risk factors (ACC/AHA) Aspirin 75–100 mg after warfarin is stopped
MVR – mechanical	INR 2.5–3.5 indefinitely	Aspirin 75–100 mg
AVR-MVR – tissue	INR 2.0–3.0 for 3 months	Aspirin 325 mg after 3 months
AVR-MVR – mechanical	INR 3.0–4.5 indefinitely	Aspirin 75–100 mg
Atrial fibrillation with any of above	Continue warfarin indefinitely	
<p>Risk factors: hypercoagulable state, history of systemic thromboembolism, ejection fraction &lt;35%, history of anteroapical infarction, atrial fibrillation.</p> <p>ACCP, American College of Chest Physicians recommendations 2008;<sup>65</sup> ACC/AHA, American College of Cardiology/American Heart Association recommendations 2008.<sup>66</sup></p>		

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# Bleeding





# Etiology

- ❑ Surgical bleeding
  - Suture line, Soft tissue, Sternum, LV rupture
- ❑ Non-surgical bleeding
  - Thrombocytopenia and PLT dysfunction
  - Residual Heparin
  - Fibrinolysis
  - Coagulation factor depletion
  - Hypothermia
  - Postop HTN

# Assessment

- ❑ Drain count and tube patency
- ❑ Color
- ❑ Pattern
- ❑ Chest PA
- ❑ Echocardiogram
- ❑ Hemodynamic parameter

# Management

- ❑ Chest tube patency 유지
- ❑ Warm to normothermia
- ❑ Control HBP & Shivering
- ❑ PEEP
- ❑ Check coagulation status
  - ACT, INR, aPTT, PLT count
- ❑ Medical Tx ; Protamine, Calcium, 지혈제
- ❑ Blood component
  - FFP, PC, Cryo ppt,
- ❑ Surgical Tx

# Indication of Re-exploration

- ❑ 500cc during 1st hour
- ❑ 300cc/hr for 2~3 hour
- ❑ 200cc/hr for 4 hours
- ❑ Total drainage > 1,500cc
- ❑ Sudden increase of drainage
- ❑ Cardiac tamponade

# Cardiovascular Management



# Cardiac Output

- Cardiac output
  - Stroke volume × Heart rate
- Determinant of stroke volume
  - Preload
  - Afterload
  - Myocardial contractility

# Rhythm

- ❑ Arrhythmia may significantly off-set the generation of optimal cardiac output
- ❑ Loss of sinus rhythm may reduce the cardiac output by 10-25%
- ❑ Normalization of Heart rate
  - pacing /defibrillation
  - reduction of catecholamines
  - Beta blockers or amiodarone

# Preload

- ❑ Preload usually pertains to intracardiac volume which directly affects stretch on the cardiac sarcomere
- ❑ Monitoring
  - Pulmonary capillary wedge pressure
  - Pulmonary artery diastolic pressure
- ❑ Normalization of preload
  - Blood products or volume expanders
  - Blood if Hct < 25%



# Afterload

- ❑ Refers to LV wall tension during systole
- ❑ Determined by the preload and systemic vascular resistance(SVR)
- ❑ Affecting stroke volume and myocardial oxygen demand
- ❑ Manipulation of afterload alone can improve cardiac output and coronary blood flow

# Contractility

- Intrinsic strength of myocardial contraction at constant preload and afterload
- Indicator of contractility
  - Ejection fraction
  - Cardiac output
  - Ventricular wall motion

# Tissue Oxygenation

- ❑ Oxygen transport to tissues is the basic principles on which hemodynamic support should be based
- ❑ Determinants
  - Cardiac output
  - Hemoglobin level
  - Arterial oxygen saturation
- ❑  $O_2$  delivery =  $CO(Hb \times \% \text{ sat}) \times 1.39 + PaO_2 \times 0.031$

# MVO<sub>2</sub> Saturation

- ❑ Sensitive method of assessing cardiac output and the adequacy of tissue perfusion and oxygenation
- ❑ Decreased SvO<sub>2</sub>
  - Decreased systemic oxygen delivery
  - Decreased cardiac output
  - Anemia
  - Hypoxia
- ❑ When thermodilution CO is unreliable

## Aim of PA cath

- Measure PA pressure
- Measure PCWP (LAP, Preload)
- Measure Cardiac output
- Calculate SVR, PVR(간접, Afterload)
- Measure CVP
- Mixed venous oxygen saturation

Edwards Lifesciences™

SvO<sub>2</sub> **70**



CCO **4.9**

BT **37.9**

CCI 3.2

Cardiac Profile

8:26pm

6/27/05

CO*	5.3 L/min	CI*	3.4 L/min/m <sup>2</sup>
SVR	574 dn-s/cm <sup>5</sup>	SVRI	886 dn-s-m <sup>2</sup> /cm <sup>5</sup>
PVR	dn-s/cm <sup>5</sup>	PVRI	dn-s-m <sup>2</sup> /cm <sup>5</sup>
LVSWI	g-m/m <sup>2</sup> /b	RVSWI	3 g-m/m <sup>2</sup> /b
SV	62 mL/b	SVI	40 mL/b/m <sup>2</sup>
MAP*	63 mmHg	HR*	85 bpm
CVP*	25 mmHg	Height	156 cm
MPAP	31 mmHg	Weight	55.8 kg
PAWP	mmHg	BSA	1.54 m <sup>2</sup>

CCO running

Home

Edit

Oxygen Profile

Calc

New Patient

판매하고 있습니다. • 제조판매원 : 고려양행

# Low Cardiac Output

- $CI < 2.2L/min/m^2$
- Tachyarrhythmia or Bradyarrhythmia
- $SVR > 1500 \text{ dyne-sec/cm}^5$

# Low Cardiac Output -Etiology

## 1. Decreased ventricular preload

- Hypovolemia(Bleeding, Vasodilation...)
- Cardiac tamponade
- PEEP
- RV dysfunction
- Tension pneumothorax

## 2. Arrhythmia

- Tachycardia with reduced cardiac filling time
- Bradycardia
- Atrial arrhythmia with loss of atrial contraction
- AV dissociation



# Low Cardiac Output -Etiology

## 3. Decreased Contractility

- Low ejection fraction
- Myocardial ischemia
- Hypoxia, Hypercarbia, Acidosis

## 4. Increased Afterload

- Vasoconstriction
- Fluid overload

## 5. Syndrome associated with CV instability

- Sepsis(SVR 감소, Myocardial depression)
- Anaphylatic reaction(Drug, Blood)
- Protamine reaction

# Low Cardiac Output -Assessment

- Urine output
- 말초체온저하
- Chest X-ray
- EKG
- ABGA ; metabolic acidosis
- Measure C.O., SvO<sub>2</sub>, Calculate SVR

# Mechanical Circulatory Support

- ❑ IABP
- ❑ Direct Circulatory support
  - ECMO  
(Extracorporeal membrane oxygenation)
  - VAD (Ventricular Assist Devices)
    - LVAD, RVAD, BiVAD
  - Temporary Pulsatile Pumps
- ❑ Mechanical Ventricular Compression
- ❑ Artificial Heart



# Pharmacologic Circulatory Support

# Adrenergic receptor

- $\alpha$  stimulation
  - $\uparrow$  SVR, PVR
- Cardiac  $\alpha$ -1 stimulation
  - $\uparrow$  Contractility,  $\downarrow$  Heart rate
- $\beta$ -1 stimulation
  - $\uparrow$  Contractility, Heart rate, conduction
- $\beta$ -2 stimulation
  - Peripheral vasodilatation, Bronchodilatation

# Dopamine

- Low dose
  - Balanced  $\alpha$ ,  $\beta$  effect
  - Increase renal flow
- High dose
  - Predominant  $\alpha$  effect
  - Release of NE
  - Contractility 증가, SVR 증가
- 2 ~ 20 ug/kg/min

# Dobutamine

- ❑ Nonselective  $\beta$  agonist
- ❑ Augmentation of cardiac output (CO)
- ❑ Reduction of afterload (SVR)
- ❑ 2 ~ 20  $\mu\text{g}/\text{kg}/\text{min}$

# Epinephrine

- Low dose
  - $\beta$ -1,  $\beta$ -2 effect
  - Increase HR, Contractility
  - Decrease SVR
- High dose
  - $\alpha$ ,  $\beta$ -1 effect
  - Peripheral vasoconstriction
- 0.02 ~ 0.2  $\mu\text{g}/\text{kg}/\text{min}$



# Norneprhrine(Levodopa)

- Predominant  $\alpha$  effect ; SVR<sup>상승</sup>
- $\beta$ -1 effect ; contractility<sup>증가</sup>
- 0.02 ~ 0.2 ug/kg/min

# Hemodynamic Effects of Vasoactive Medications

Medication	SVR	HR	PCW	CI	MAP	MvO <sub>2</sub>
Dopamine	↓↑	↑↑↑	↓↑	↑	↓↑	↑
Dobutamine	↓	↑↑↑	↓	↑	↓↔↑	↑↔
Epinephrine	↓↑	↑↑	↓↑	↑	↑	↑
Milrinone/ Inamrinone	↓↓	↑	↓	↑	↓	↓↑
Isoproterenol	↓↓	↑↑↑↑	↓	↑	↓↑	↑↑
Calcium chloride	↑	↔	↑	↑	↑↑	↑
Norepinephrine	↑↑	↑↑	↑↑	↑	↑↑↑	↑
Phenylephrine	↑↑	↔	↑	↔	↑↑	↔↑
Vasopressin	↑↑	↔	↑	↔	↑↑↑	↔↑
Nesiritide	↓	↔	↓↓	↑*	↓	↓↓

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# Management of Hemodynamic Problems

**Table 7.2** Management of Hemodynamic Problems

BP	PCWP	CO	SVR	Plan
↓	↓	↓	↕	Volume
N	↑	N	↕	Diuretic or venodilator
↓	↑	↓	↕	Inotrope
↑	↑	↓	↑	Vasodilator
↓	↑	↓	↑	Inotrope/vasodilator/IABP
↓	N	N	↓	α-agent

↑ = increased  
 ↓ = decreased  
 N = normal  
 ↕ = variable

# Hypertension

## -Etiology

- ❑ Vasoconstriction from hypothermia
- ❑ Fever, Anxiety, Pain, Consciousness
- ❑ Hypoxia, Hypercobia, Acidosis
- ❑ Hyperdynamic LV syndrome
  - AVR, CABG with normal LV
- ❑ Pharyngeal manipulation
- ❑ Severe acute hypoglycemia
- ❑ Altered baroreceptor function

# Hypertension -Treatment

- ❑ Ensure satisfactory oxygenation
- ❑ Inotropic support if C.O is marginal
- ❑ Sedation
- ❑ Control shivering
- ❑ Use of vasodilator Medication

# Hypertension - Medications

Medication	Mix	Dosage Range
Nitroprusside	50 mg/250 mL	0.1–10 µg/kg/min
Nitroglycerin	50 mg/250 mL	0.1–10 µg/kg/min
Calcium-channel blockers		
Nicardipine	50 mg/250 mL	2.5 mg over 5 min; repeat × 4 at 10 min intervals, then 2–4 mg/h
Isradipine	20 mg/250 mL	0.3–0.6 µg/kg/min
Nifedipine	15 mg/250 mL	0.3–1 µg/kg/min
Diltiazem	250 mg/250 mL	0.25 mg/kg over 2 min, then 0.35 mg/kg over 2 min, then 5–15 mg/h
Verapamil	120 mg/250 mL	0.1 mg/kg bolus over 2 min, then 2–5 µg/kg/min
β-blockers		
Esmolol	2.5 g/250 mL	0.25–0.5 mg/kg/min bolus, then 50–200 µg/kg/min
Labetalol	200 mg/200 mL	1–4 mg/min
Trimethaphan	500 mg/500 mL	0.5–4 mg/min
Prostaglandin E <sub>1</sub>	5 mg/250 mL	0.03–0.2 µg/kg/min