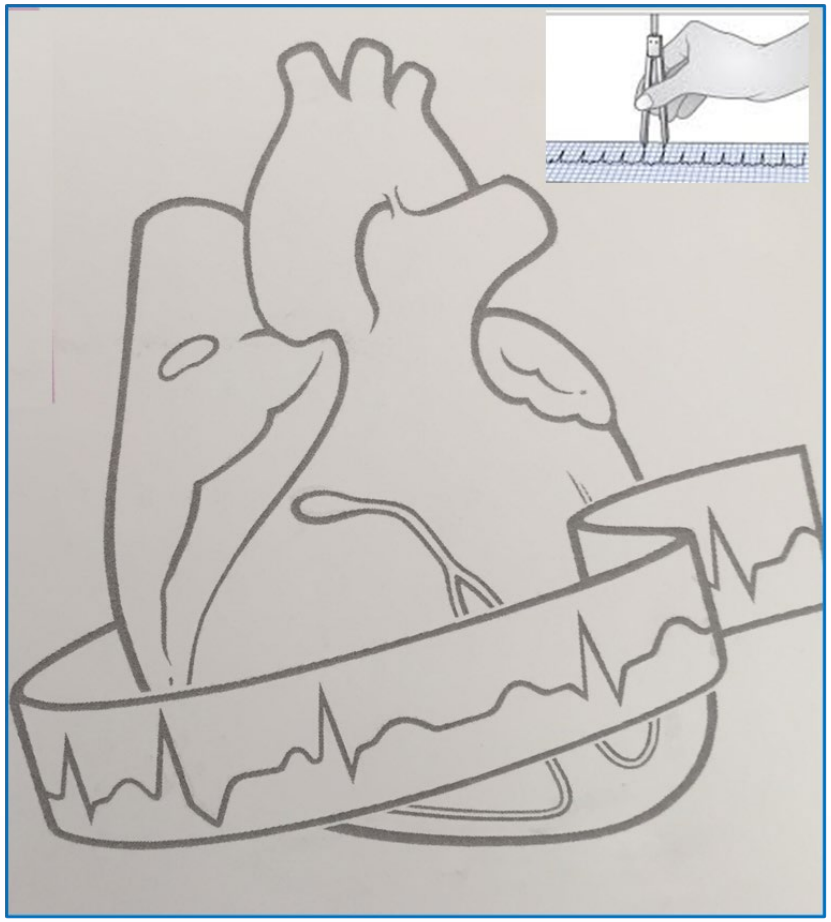
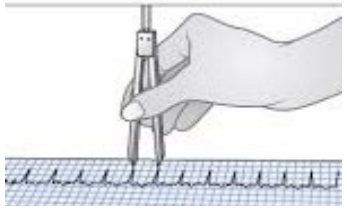
Advanced EKGs



Emőke Pósán

PartnerRe

Plan

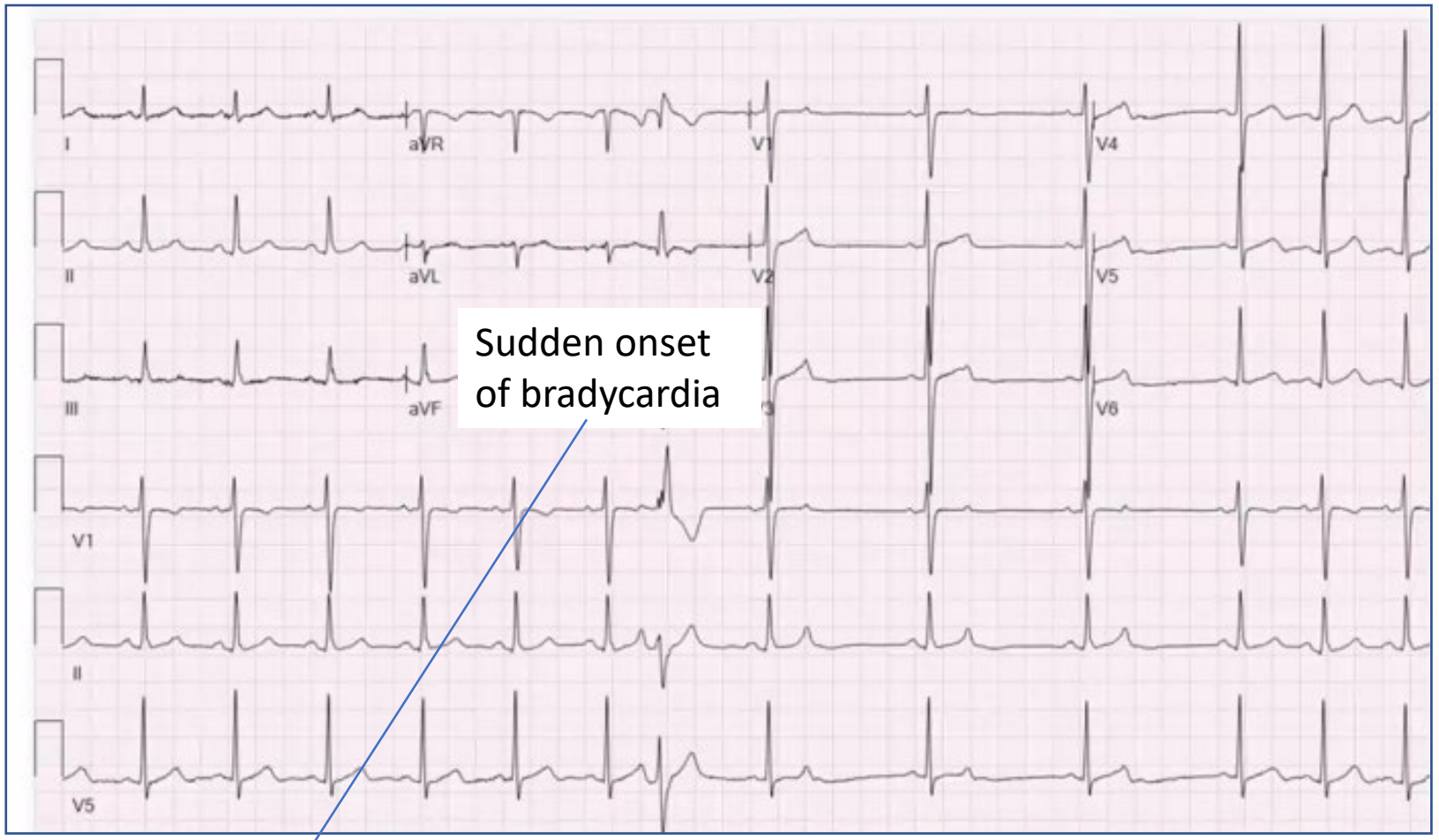


- Focus: What is the Rhythm
- Pearls of ‘knowns’
  - **Quick** Diagnosis **Tips** →
  - how to make a diagnosis
- Short risk assessment

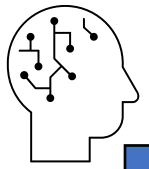
Part 1

What is the Rhythm?

Case: 50 y F
No Medical hx



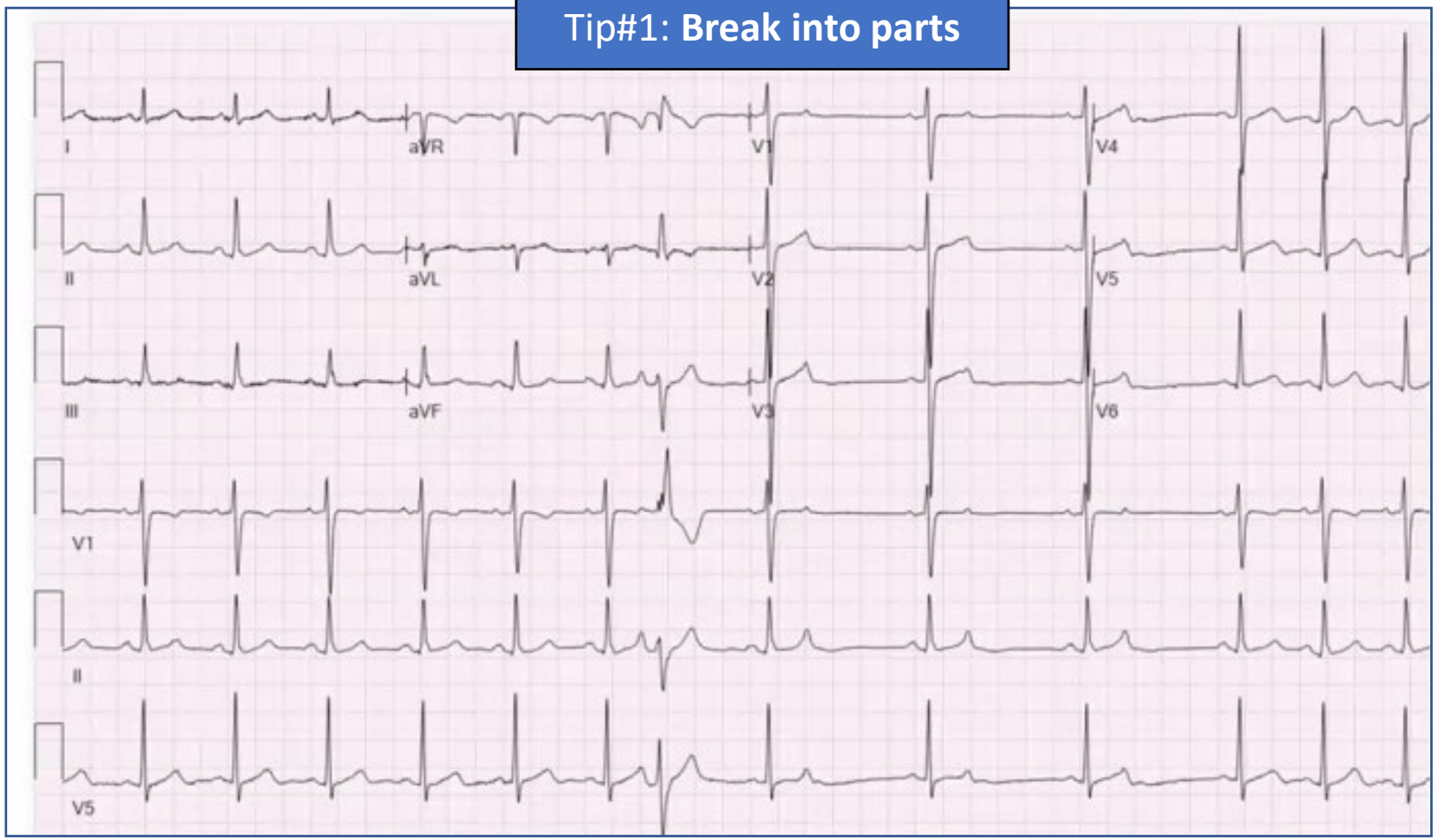
Is a PM indicated?
Sinus node dysfunction?? YES NO Don't Know



What is the Rhythm?

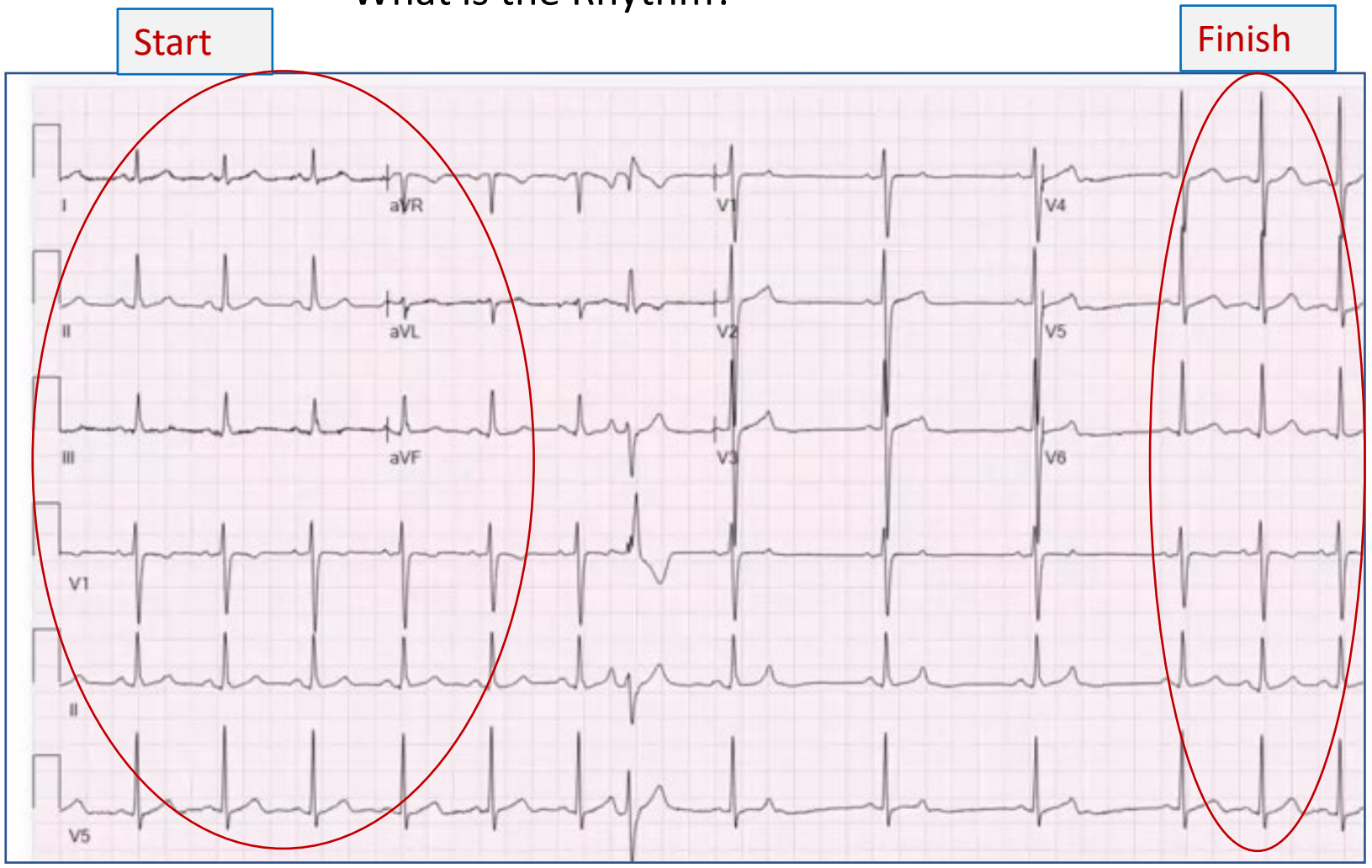
Case: 50 y F
No Medical hx

Tip#1: **Break into parts**



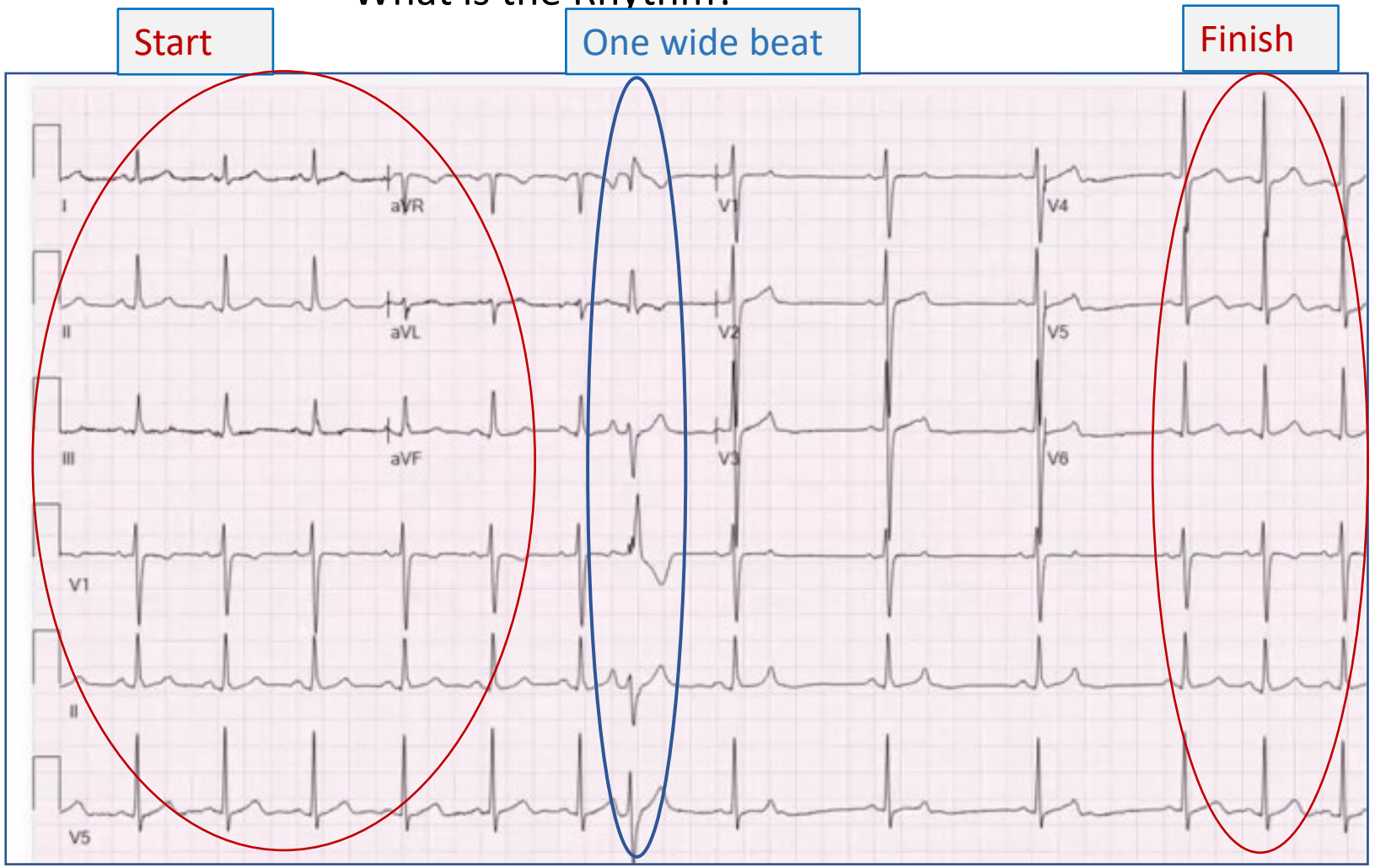
YES NO Don't Know

What is the Rhythm?



Case: 50 y F
No Medical hx

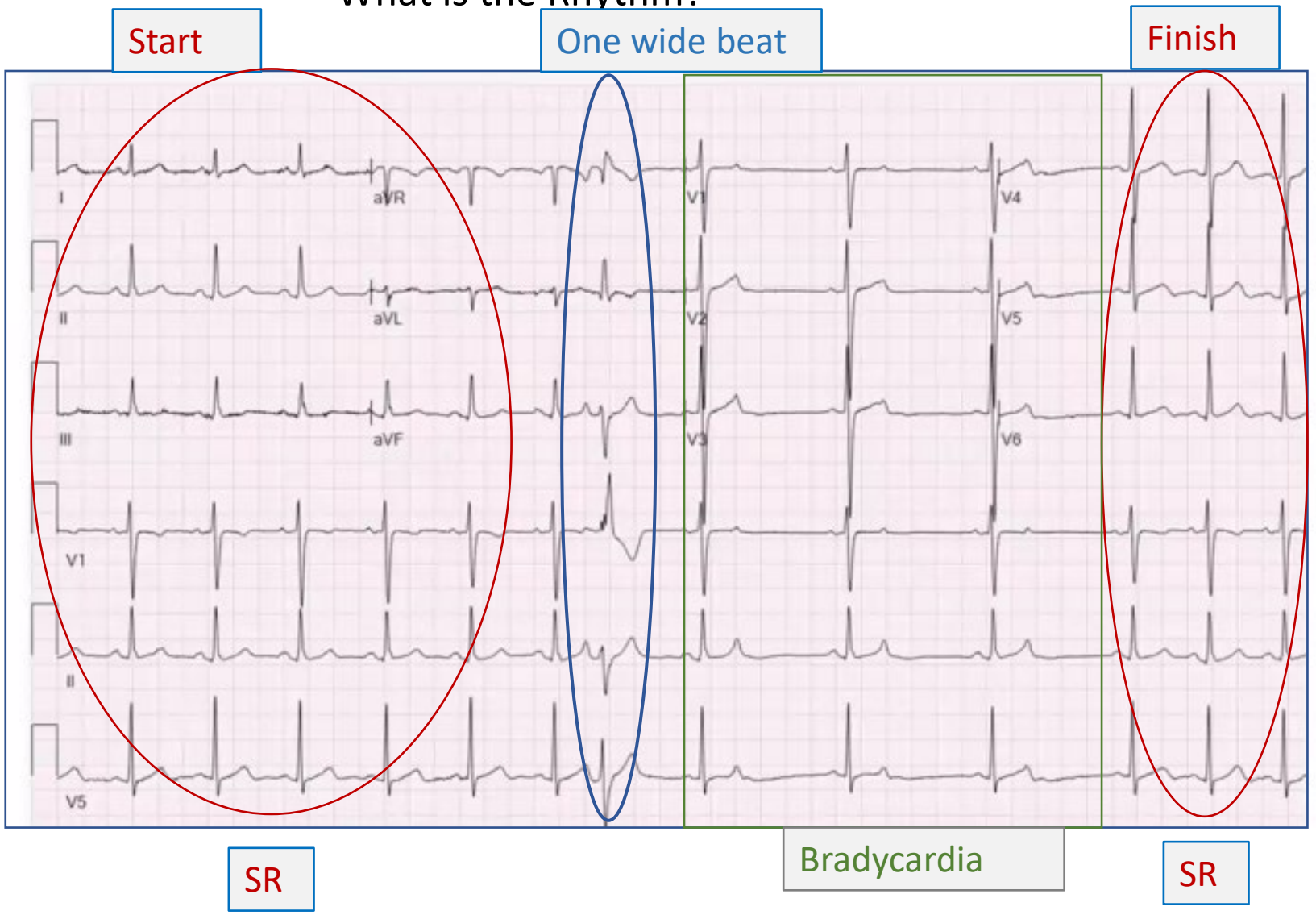
What is the Rhythm?



Case: 50 y F
No Medical hx

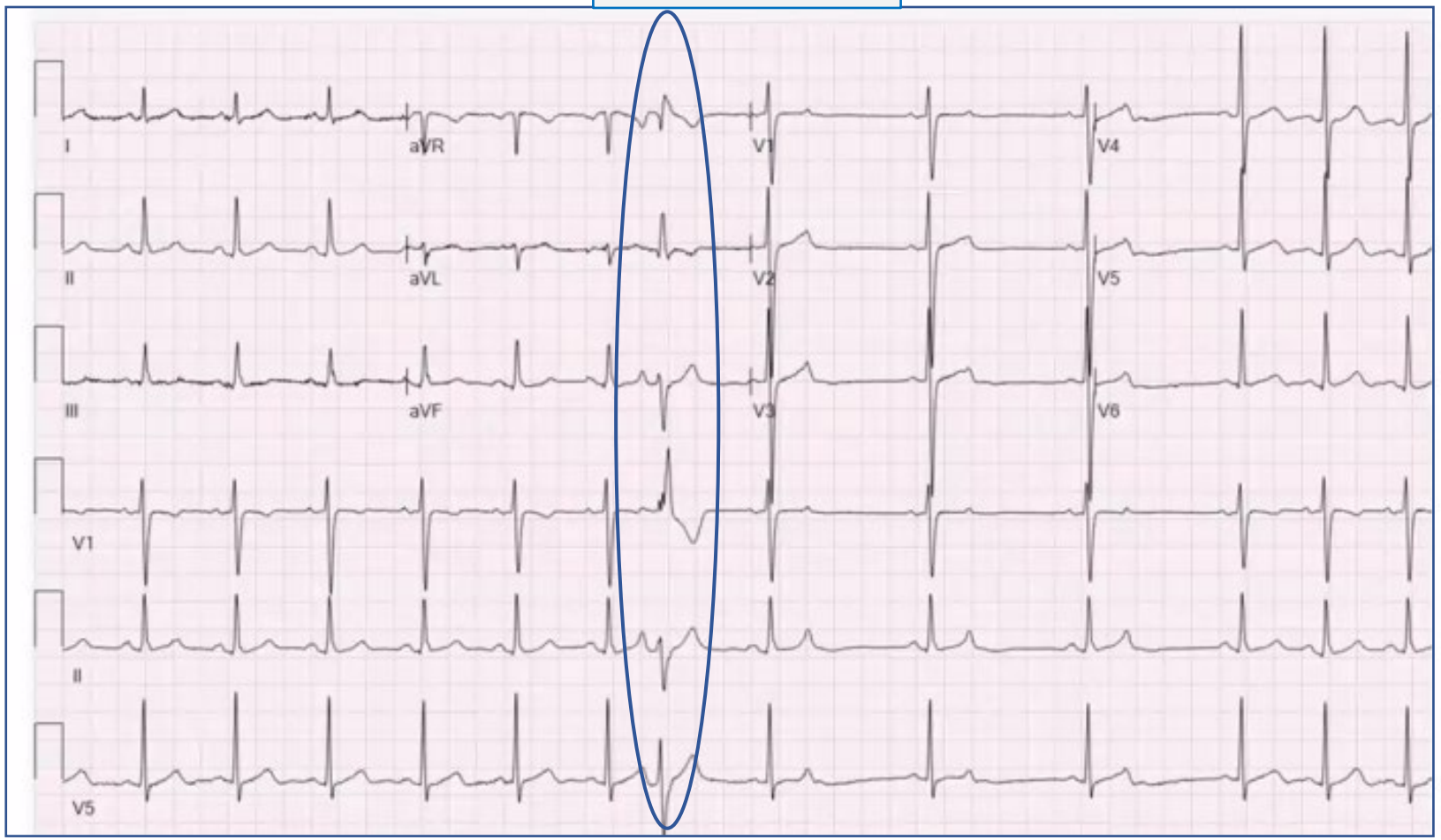
What is the Rhythm?

Case: 50 y F
No Medical hx



What is the Rhythm?

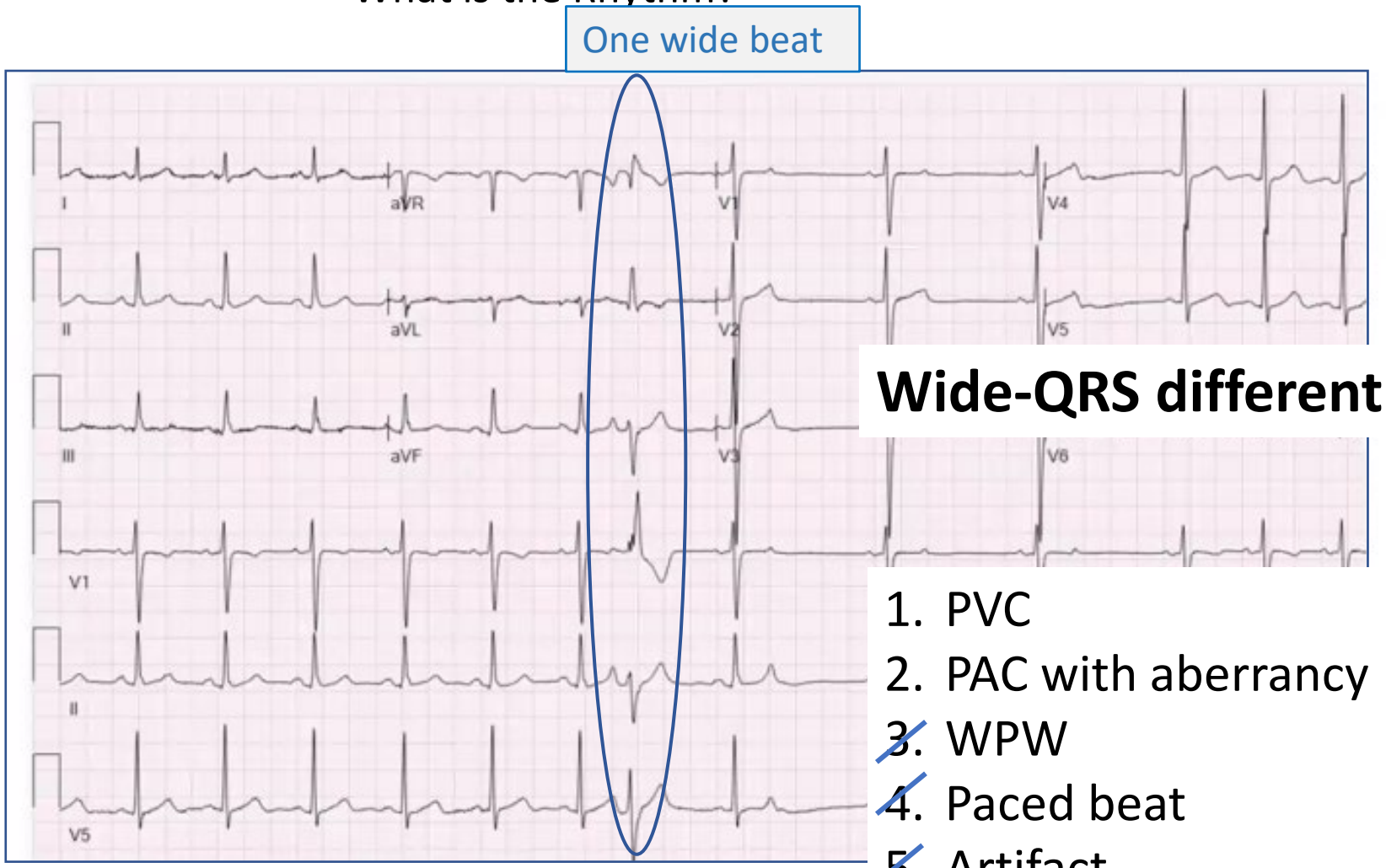
One wide beat



Case: 50 y F
No Medical hx

What is the Rhythm?

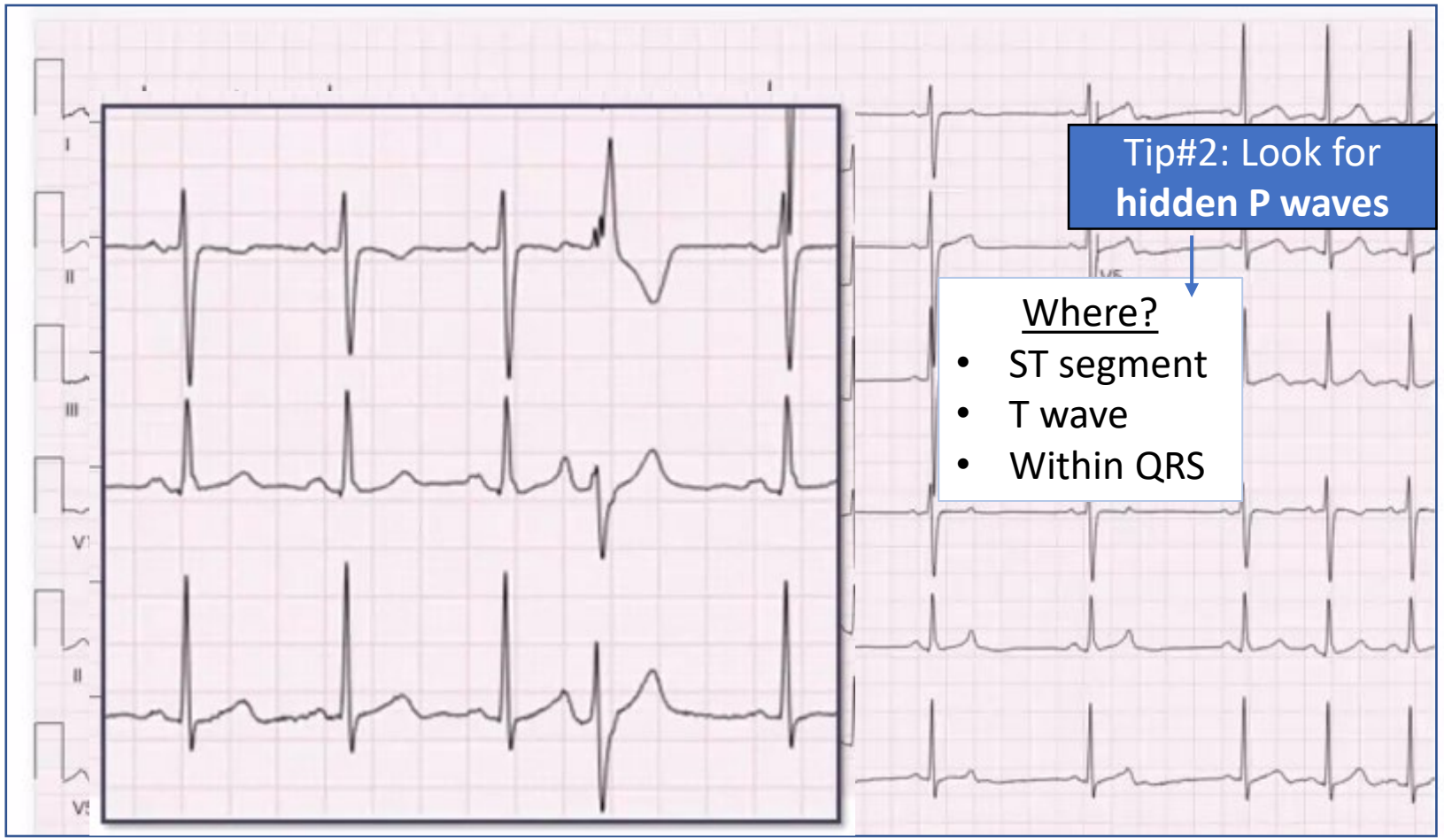
Case: 50 y F
No Medical hx



Wide-QRS differential diagnosis

1. PVC
2. PAC with aberrancy
3. ~~WPW~~
4. ~~Paced beat~~
5. ~~Artifact~~

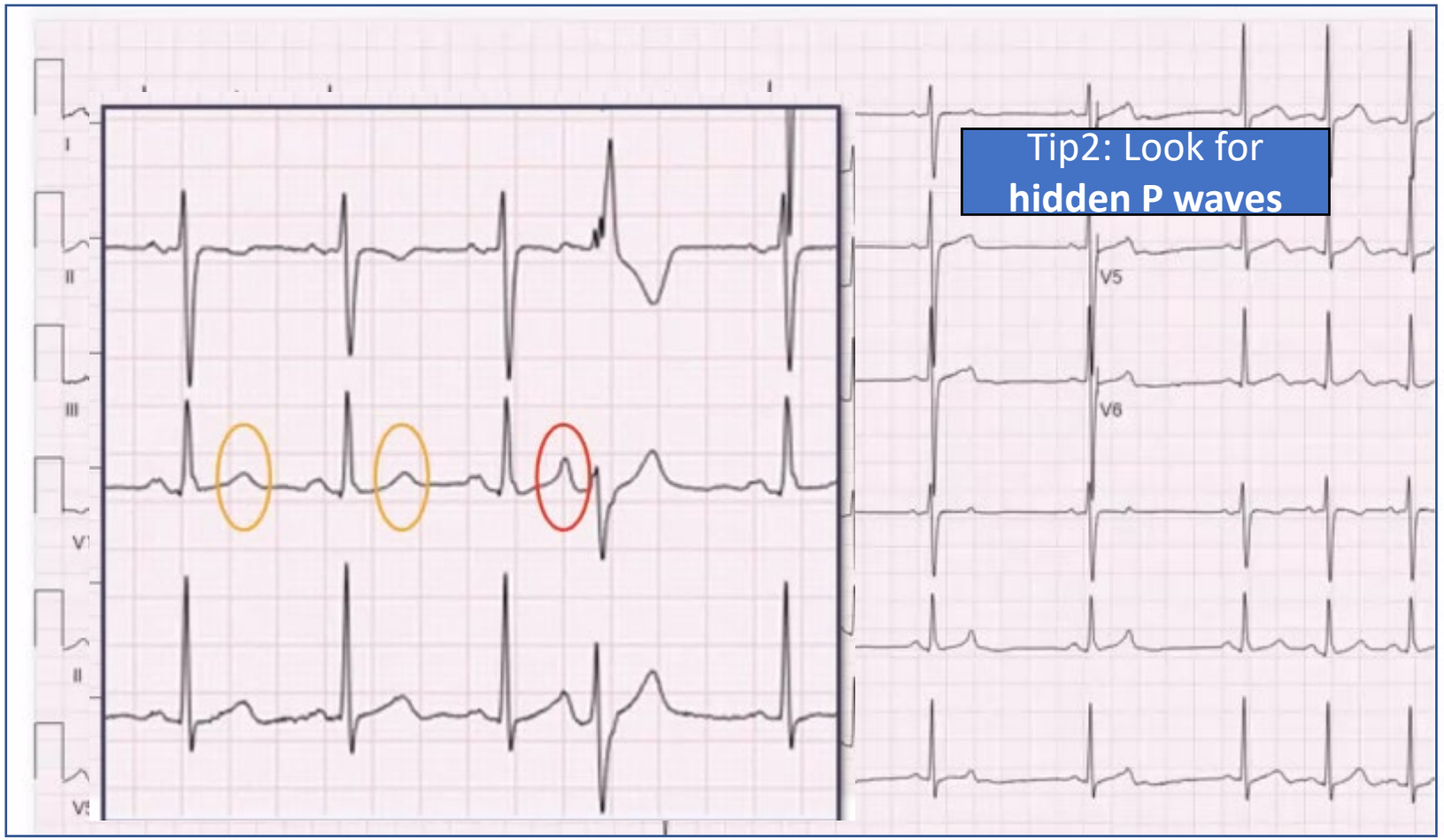
What is the Rhythm?



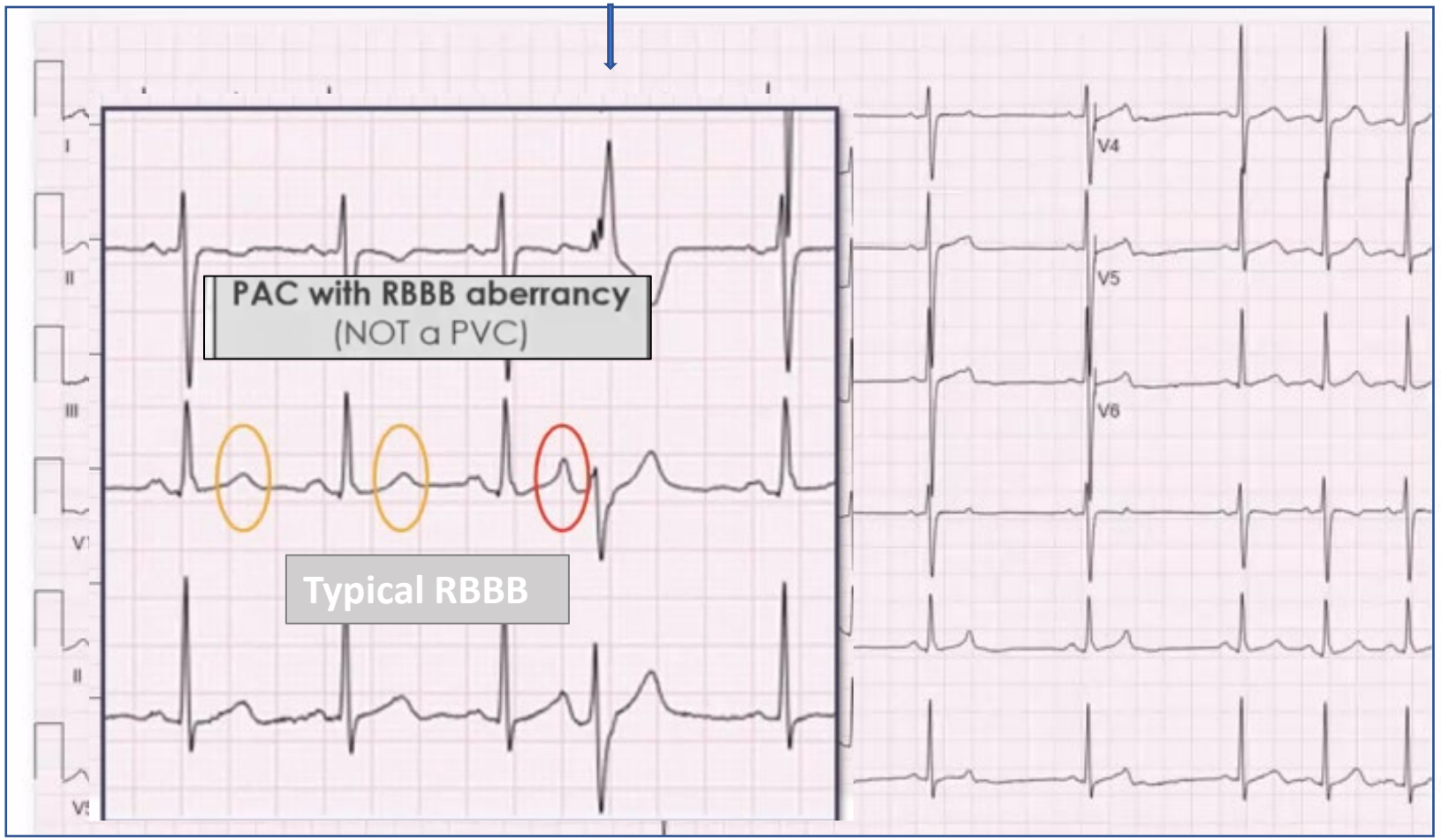
Differential diagnosis

1. PVC
2. PAC with aberrancy

What is the Rhythm?

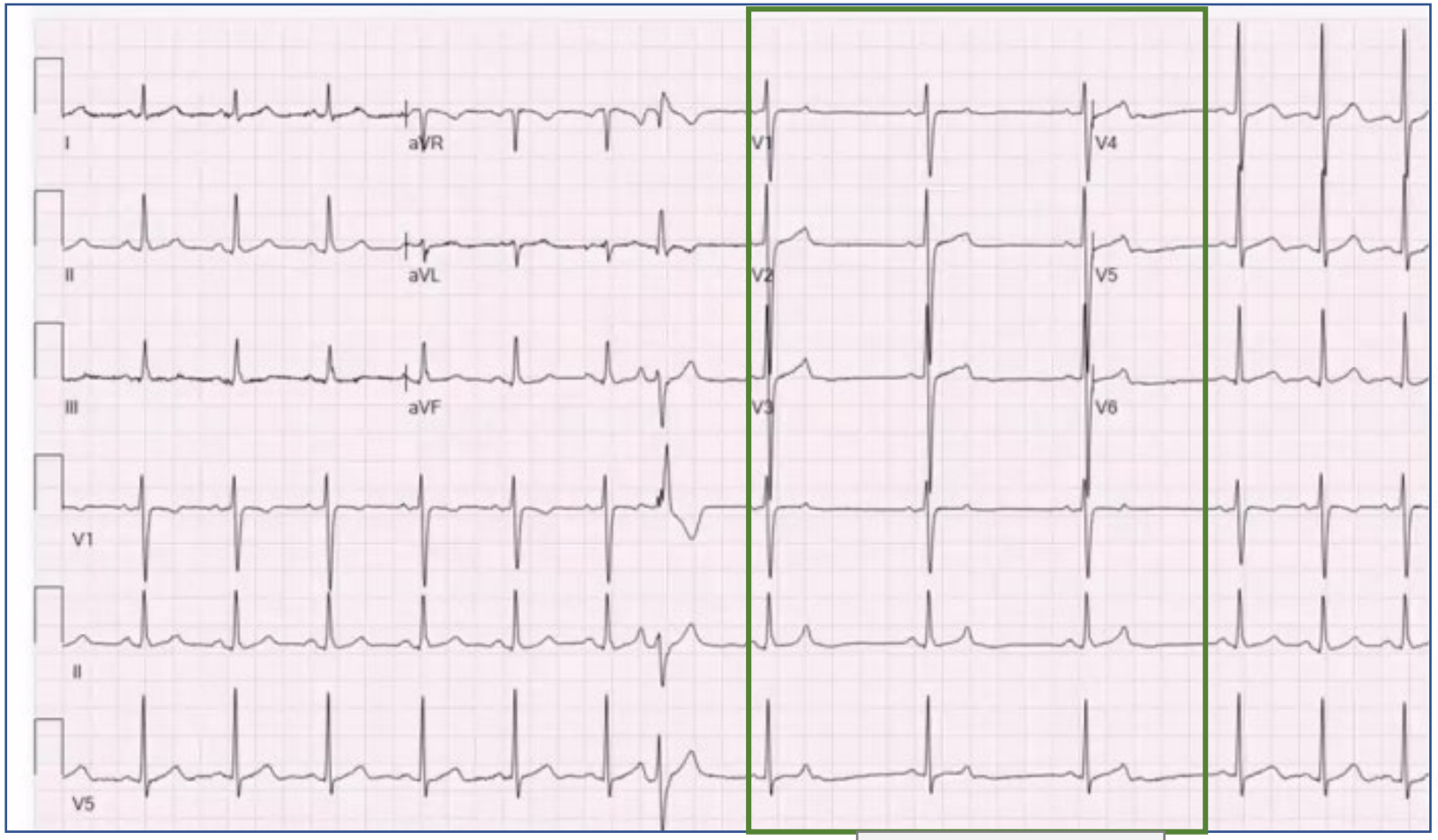


What is the Rhythm?



What is the Rhythm?

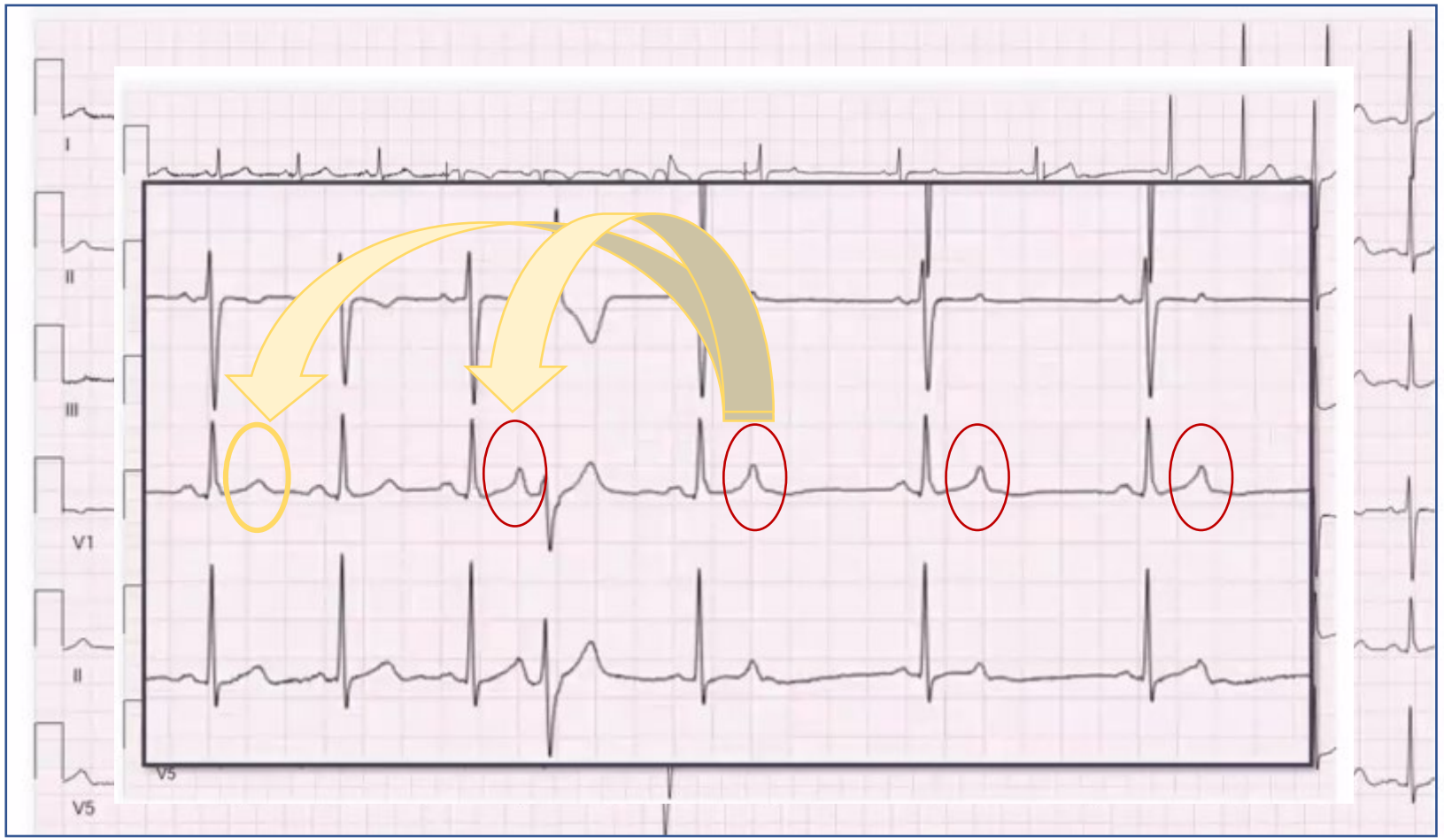
Case: 50 y F
No Medical hx



Bradycardia

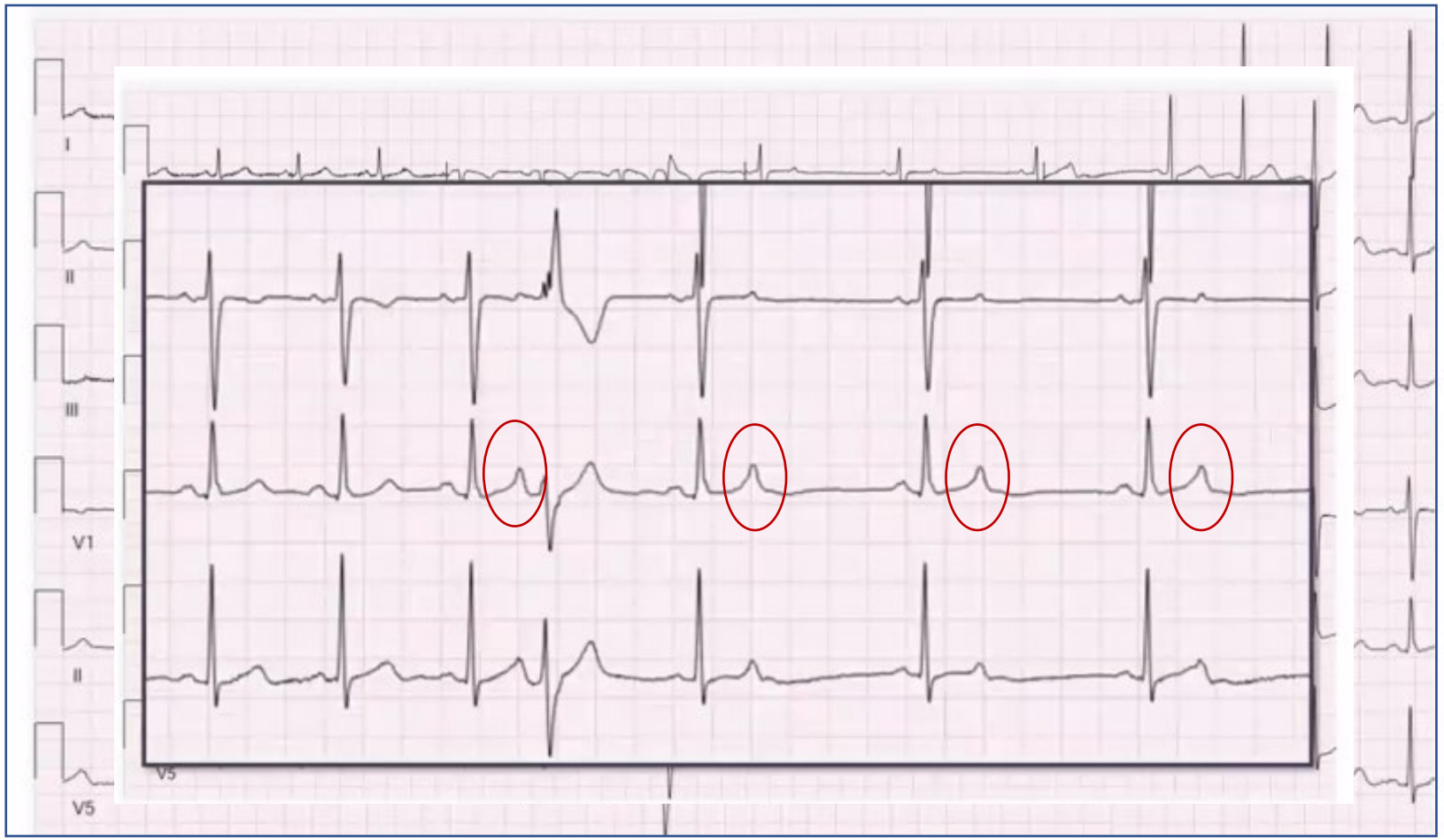
What is the Rhythm?

Case: 50 y F
No Medical hx



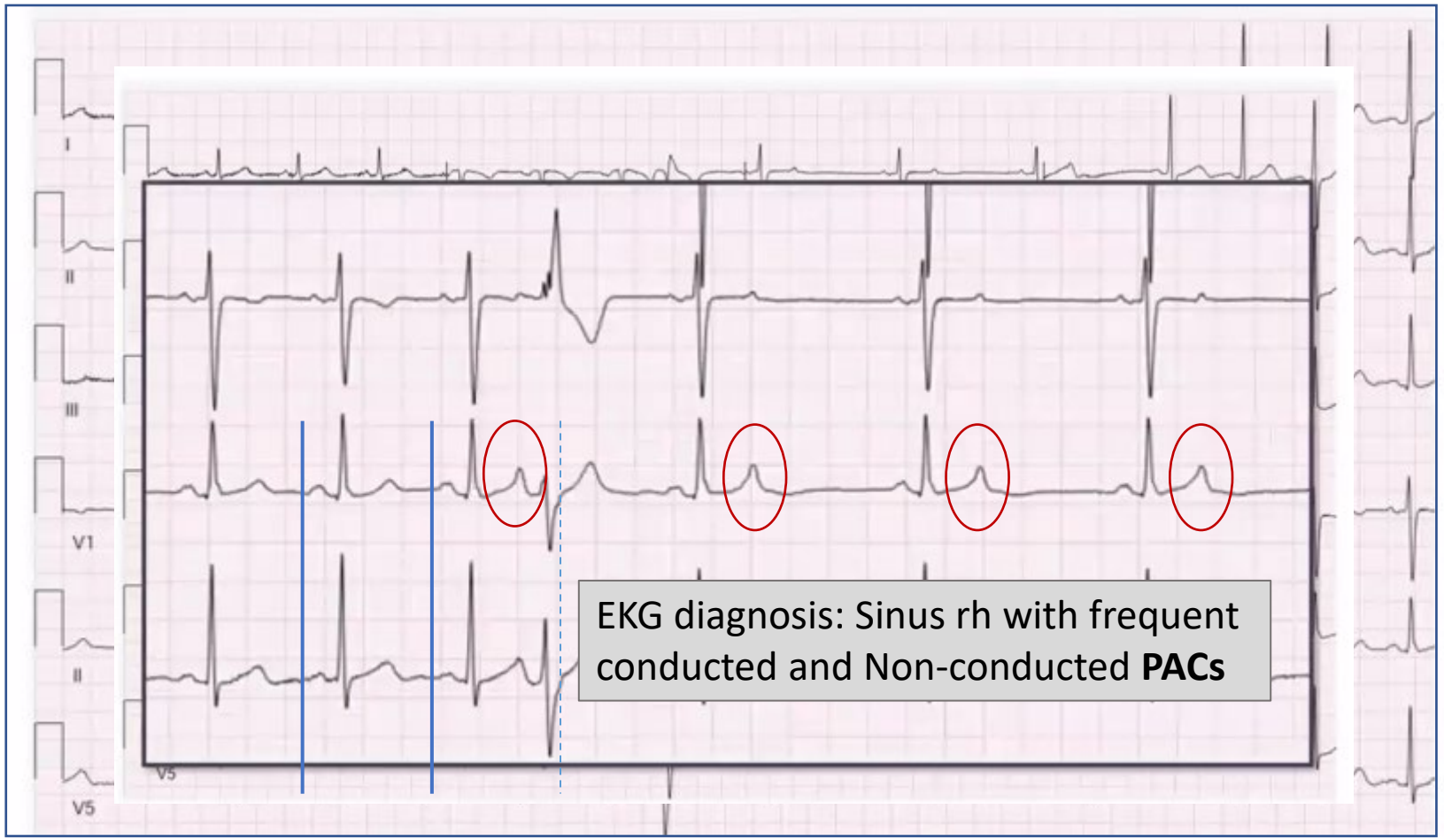
What is the Rhythm?

Case: 50 y F
No Medical hx



What is the Rhythm?

Case: 50 y F
No Medical hx

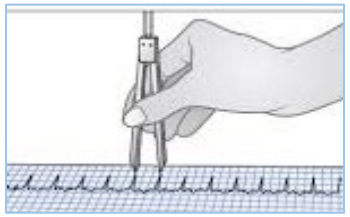


Is a Pacemaker indicated?

YES

NO

Don't Know



EKG Learning Points

Case: 50 y F
No Medical hx

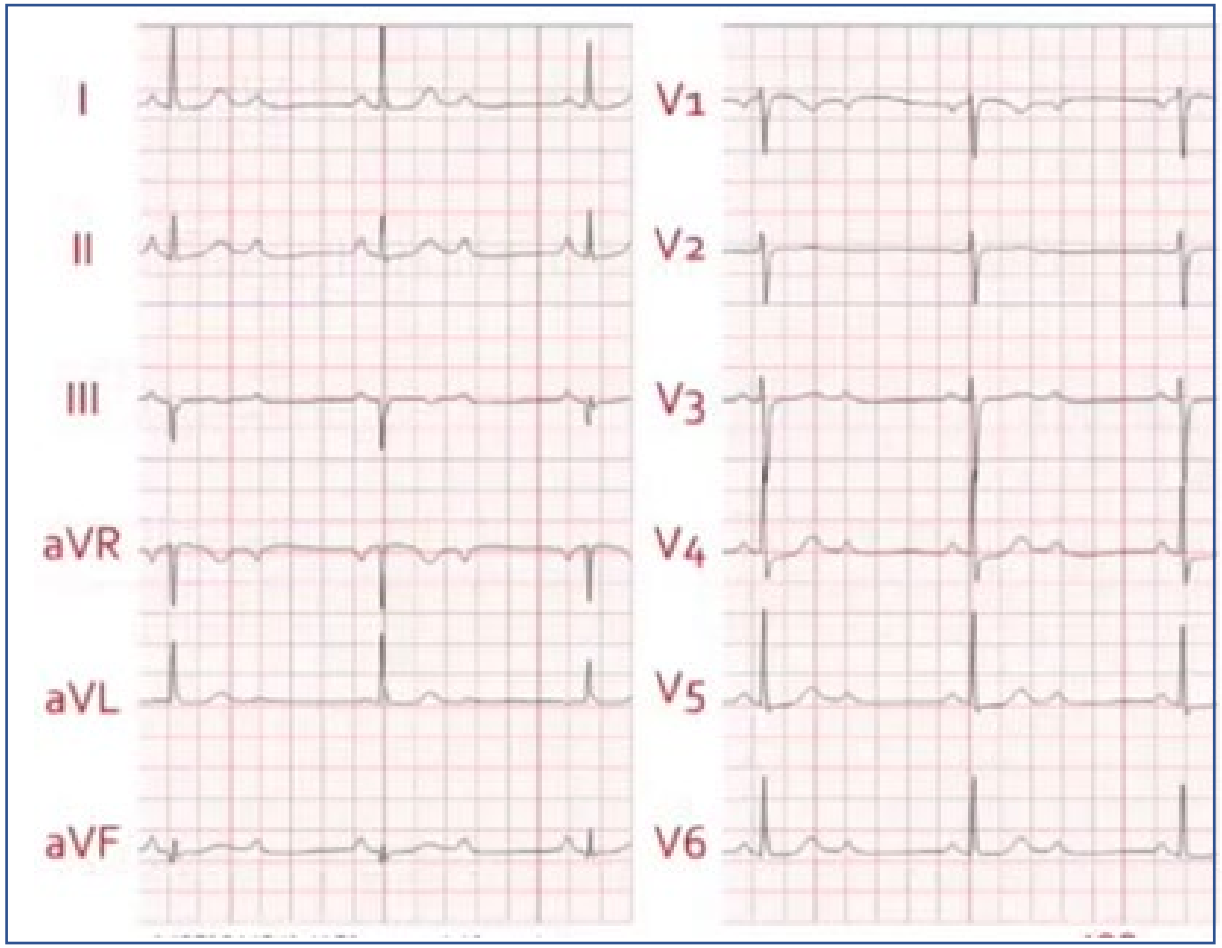
1. Break down complex EKG into smaller manageable parts

2. Look for hidden P waves – in ST segment, QRS and T waves comparing to a normal one

3. Nonconducted PACs is a common fooler for Sinus Node Dysfunction

4. Know the differential diagnosis of wide QRS beats

Case: 72y F with recent fatigue and decreased exercise tolerance without dizzy spell or syncope.
Recent echo: Ao valve and mitral annulus calcifications



1. Long-QT 2. Sinus Node Disease 3. Blocked PACs 4. 2:1 AVB

Case: 72y F with recent fatigue and decreased exercise tolerance without dizzy spell or syncope.
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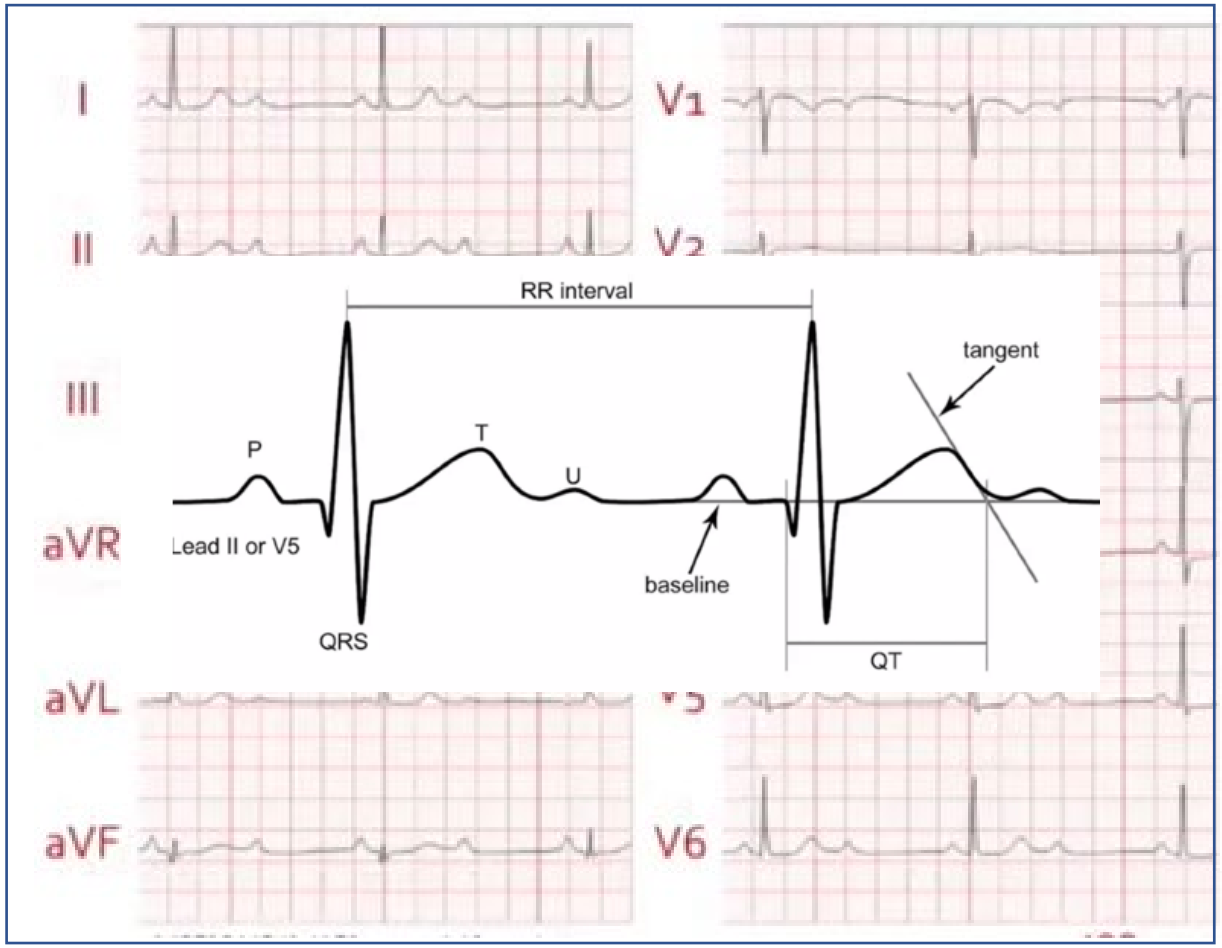

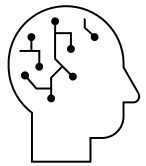

1. Long-QT 2. Sinus Node Disease 3. Blocked PACs 4. 2:1 AVB

Gregg A, Lehmann MH: Prolonged QT interval/computerized ECG https://doi.org/10.1161/CIRCEP.112.976803

Viskin S, Rosovki U et al: Inaccurate ECG interpretation of Long QT: https://doi.org/10.1016/j.hrthm.2005.02.011

Case: 72y F with recent fatigue and decreased exercise tolerance without dizzy spell or syncope.
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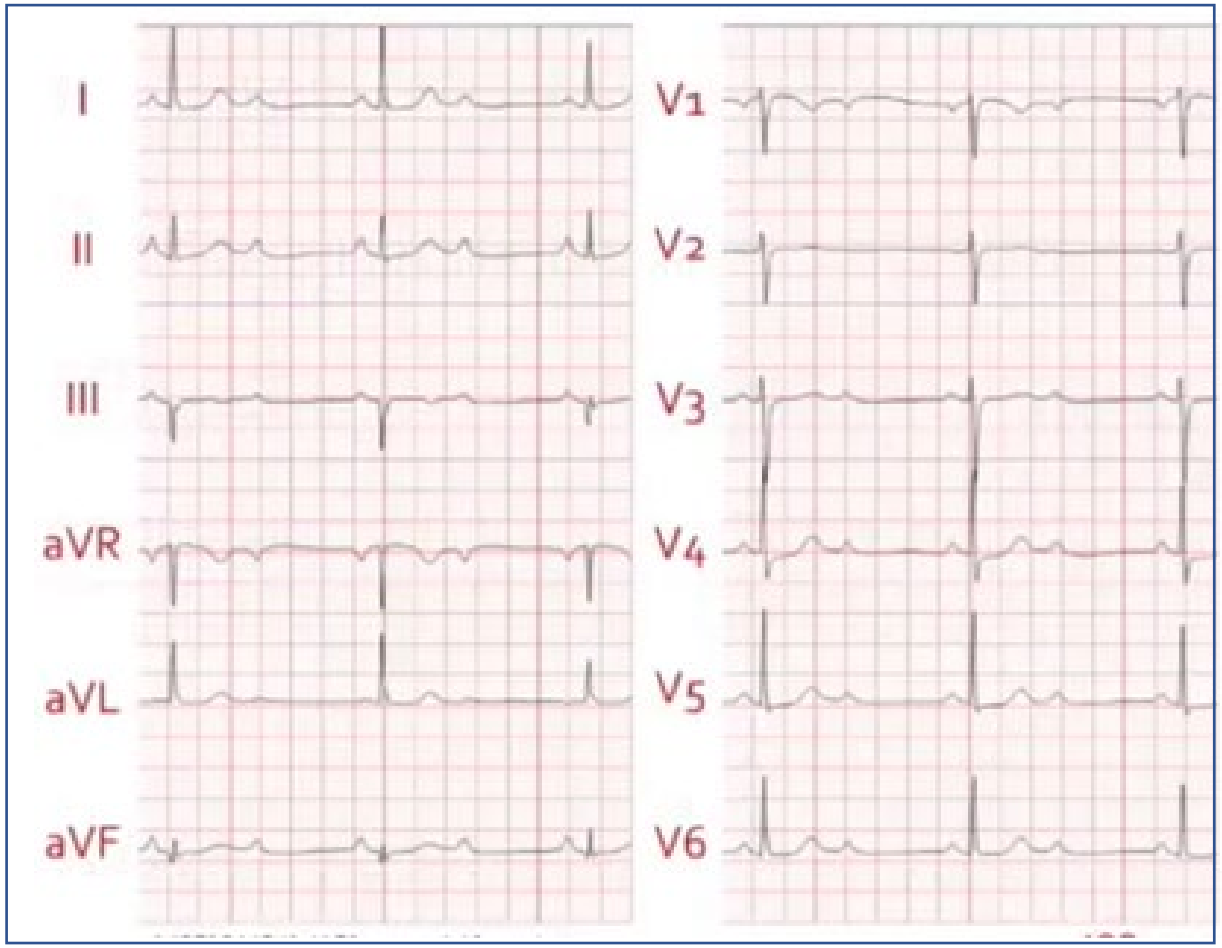
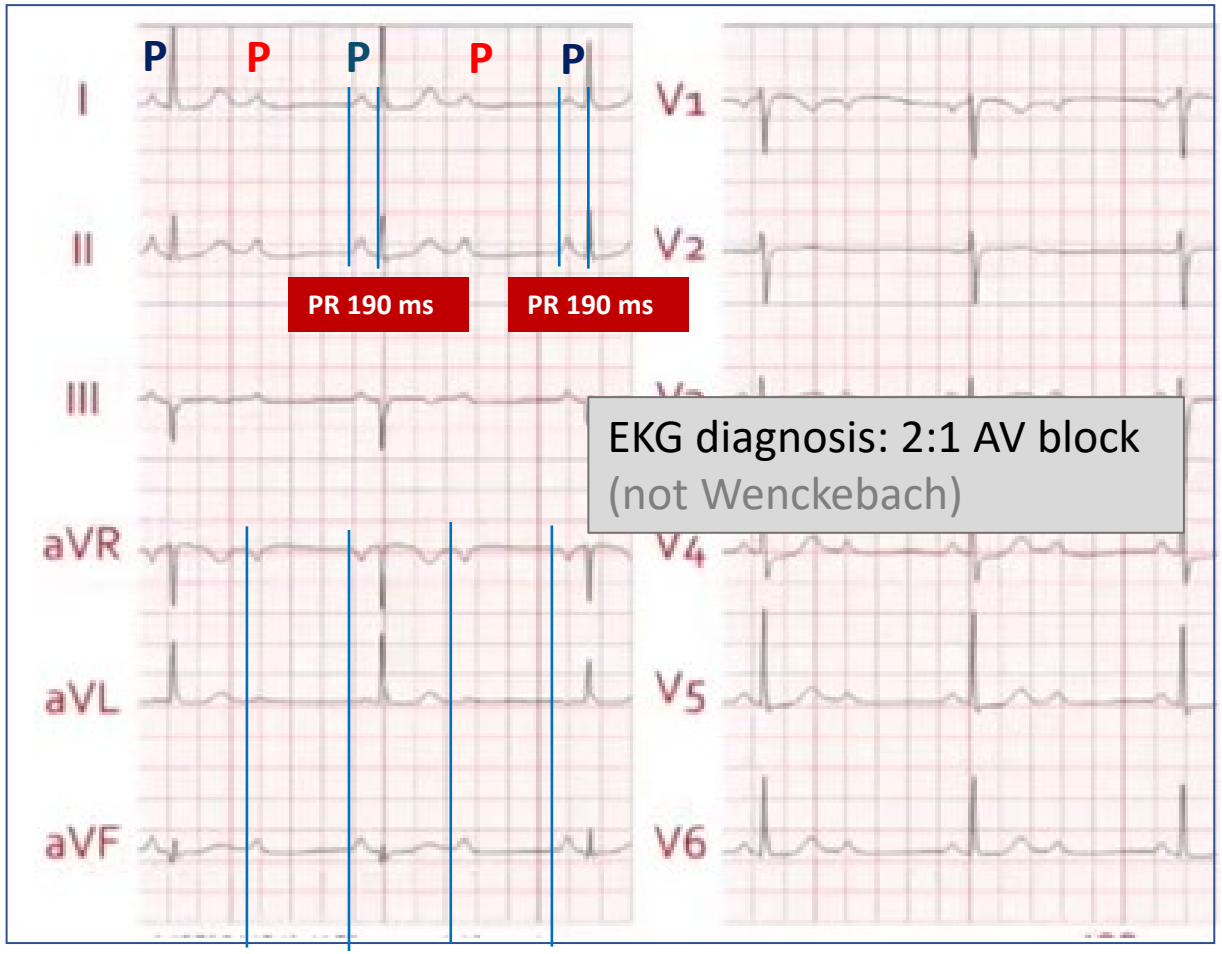


Tip: **Use Caliper**

Check :
P-P regular?
QRS regular?
PR fixed or changing?

1. Long-QT 2. Sinus Node Disease 3. Blocked PACs 4. 2:1 AVB

Case: 72y F with recent fatigue and decreased exercise tolerance without dizzy spell or syncope.
Recent echo: Ao valve and mitral annulus calcifications

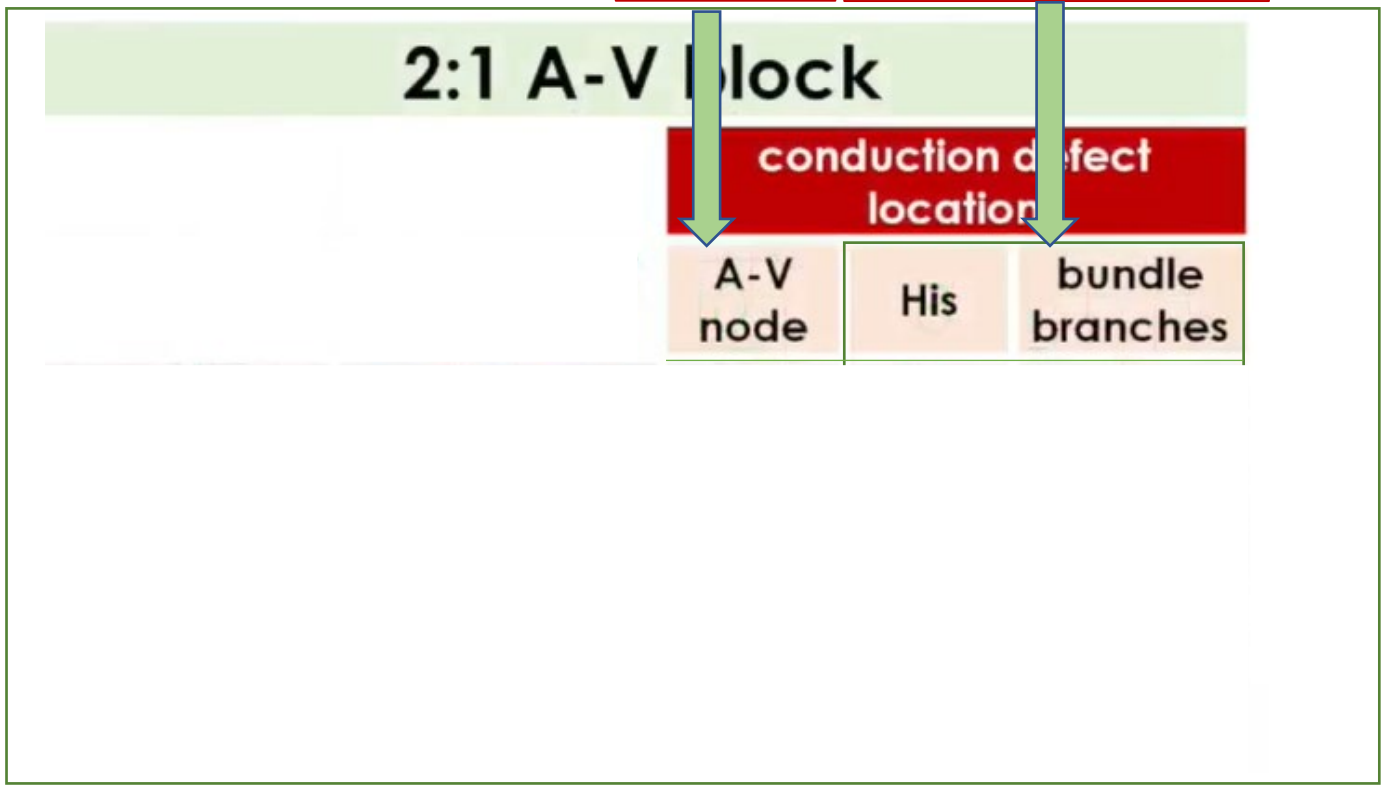


LEVEL of Block → Prognosis

1. Long-QT 2. Sinus Node Disease 3. Blocked PACs 4. 2:1 AVB

https://esc365.escardio.org/results?page=1&query=ellenbogen

AV Node | Below the Node



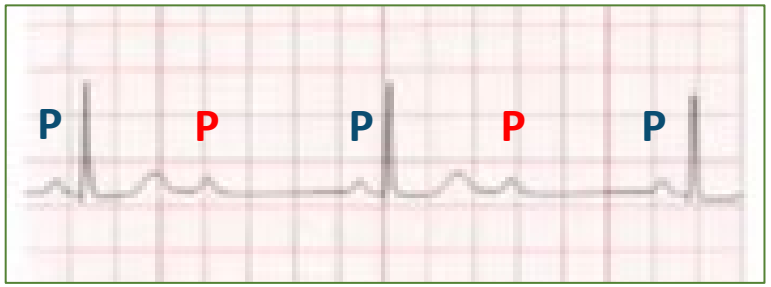
https://esc365.escardio.org/results?page=1&query=ellenbogen

2:1 A-V block

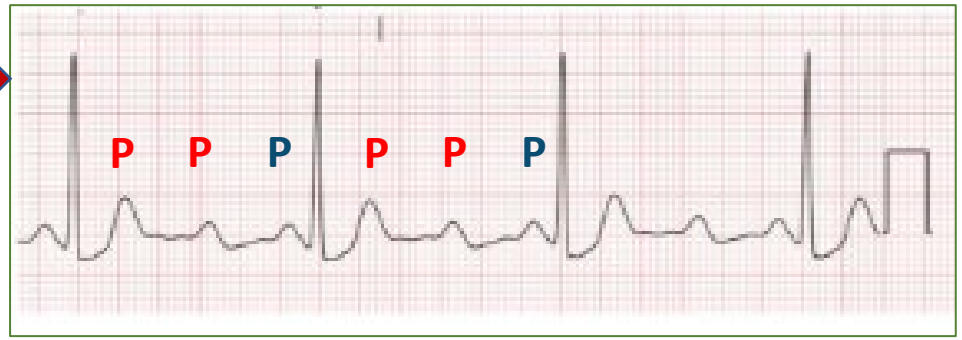
		conduction defect location		
	effect on A-V conduction	A-V node	His	bundle branches
carotid sinus massage	worsens	++++	± ¶	± ¶
	improves	–	++++	++++
exercise	worsens	–	++++	++++
	improves	++++	–	–
atropine	worsens	–	++++	++++
	improves	++++	–	–

¶ very sick His/Purkinje systems may develop pause-dependent AV block

Baseline 2:1 AV block



Exercise High-degree AV block



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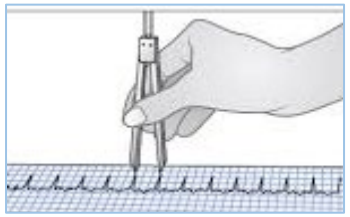


EKG Learning Points

1. AV Block prognosis is based on the Level of block
   → infraNodal block is high risk

2. 2:1 AVB with narrow QRS:
   Red flags for block below the AVN
   - Block worsen with exercise
   - PR<200ms
   - Symptoms
   - History (structural HD, valvular disease)

Case: 72y F with recent fatigue and decreased exercise tolerance without dizzy spell or syncope. Recent echo: Ao valve and mitral annulus calcifications

Case : 72y F with fatigue and decreased exercise tolerance in the past 2 weeks without dizzy spell or syncope.
Recent echo: Ao valve and mitral annulus calcifications

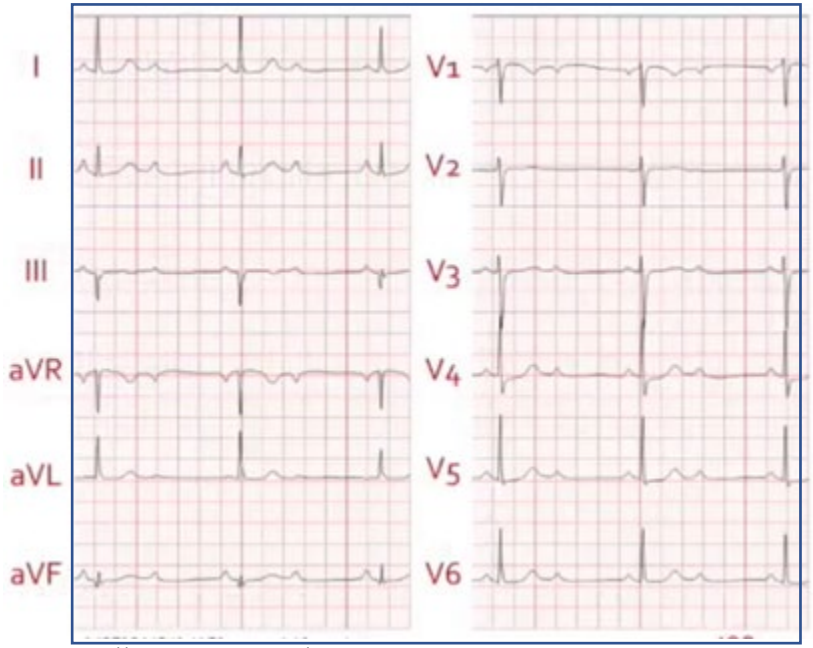
2:1 A-V block

		conduction defect location		
		A-V node	His	bundle branches
symptoms	asymptomatic	++++	+	+
	dizzy spells	–	++++	++++
	syncope	–	++++	++++
	↓ exercise tolerance	±	++++	++++
PR interval	normal	–	++++	++++
	prolonged	++++	++	++
QRS width	normal (narrow)	++++	++++	± *
	prolonged (wide)	++	++	++++
other AV conduction defects	Mobitz I	++++	+	+
	Mobitz II	–	++++	++++

* concordant trifascicular conduction defect may exhibit narrow QRS complexes

LEVEL of Block → Prognosis

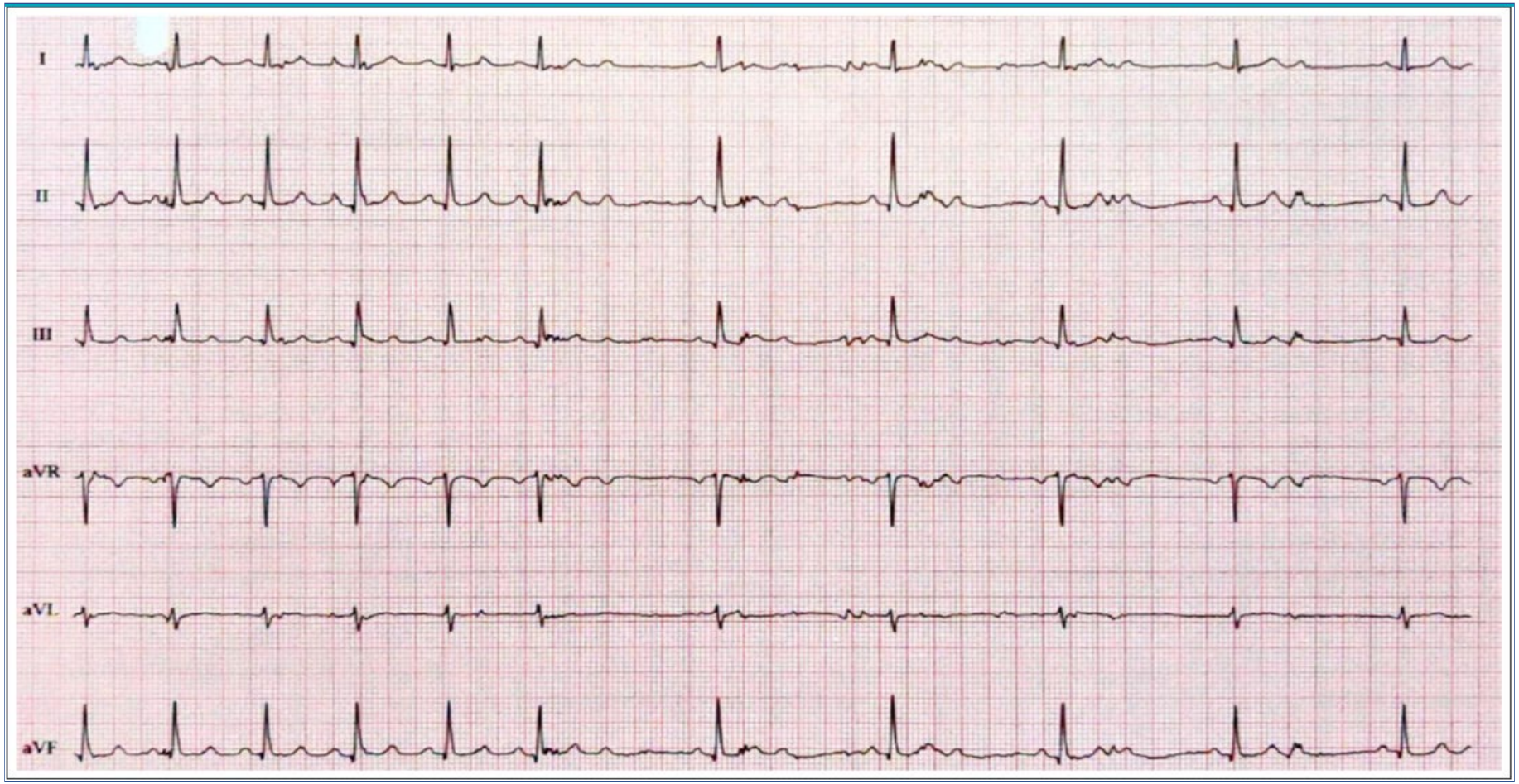
Below AVN



https://esc365.escardio.org/results?page=1&query=ellenbogen

Case: 52y F with recent fatigue and impaired exercise tolerance, past hx breast cancer therapy (in remission>5ys)

Exercise TEST stage 2

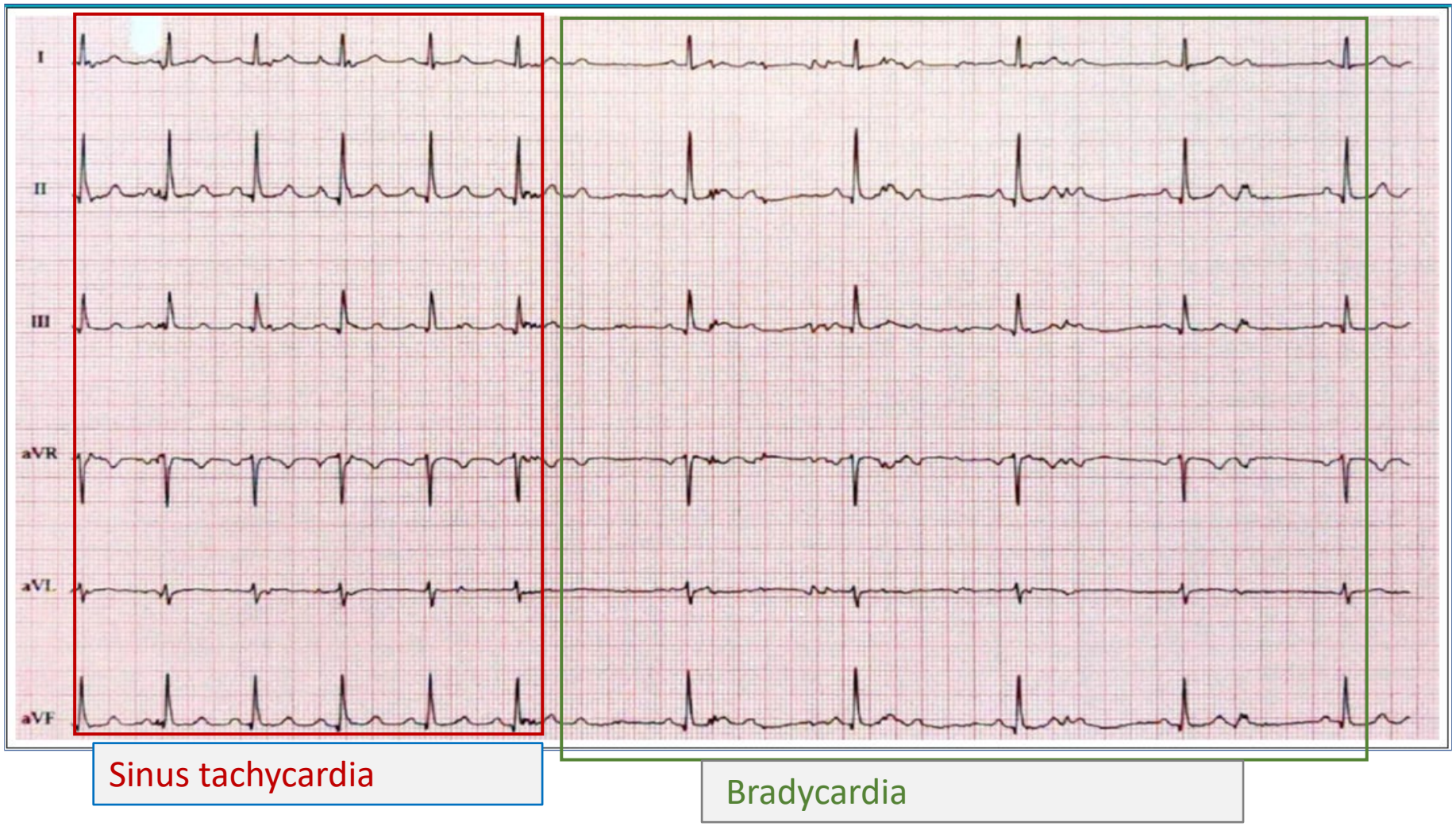


1. No risk
2. Low risk
3. High risk

Circulation. 2020;142:1684–1686. DOI: 10.1161/CIRCULATIONAHA.120.050344

Case: 52y F with fatigue and impaired exercise tolerance past hx breast cancer therapy (in remission>5 years)

Exercise TEST stage 2



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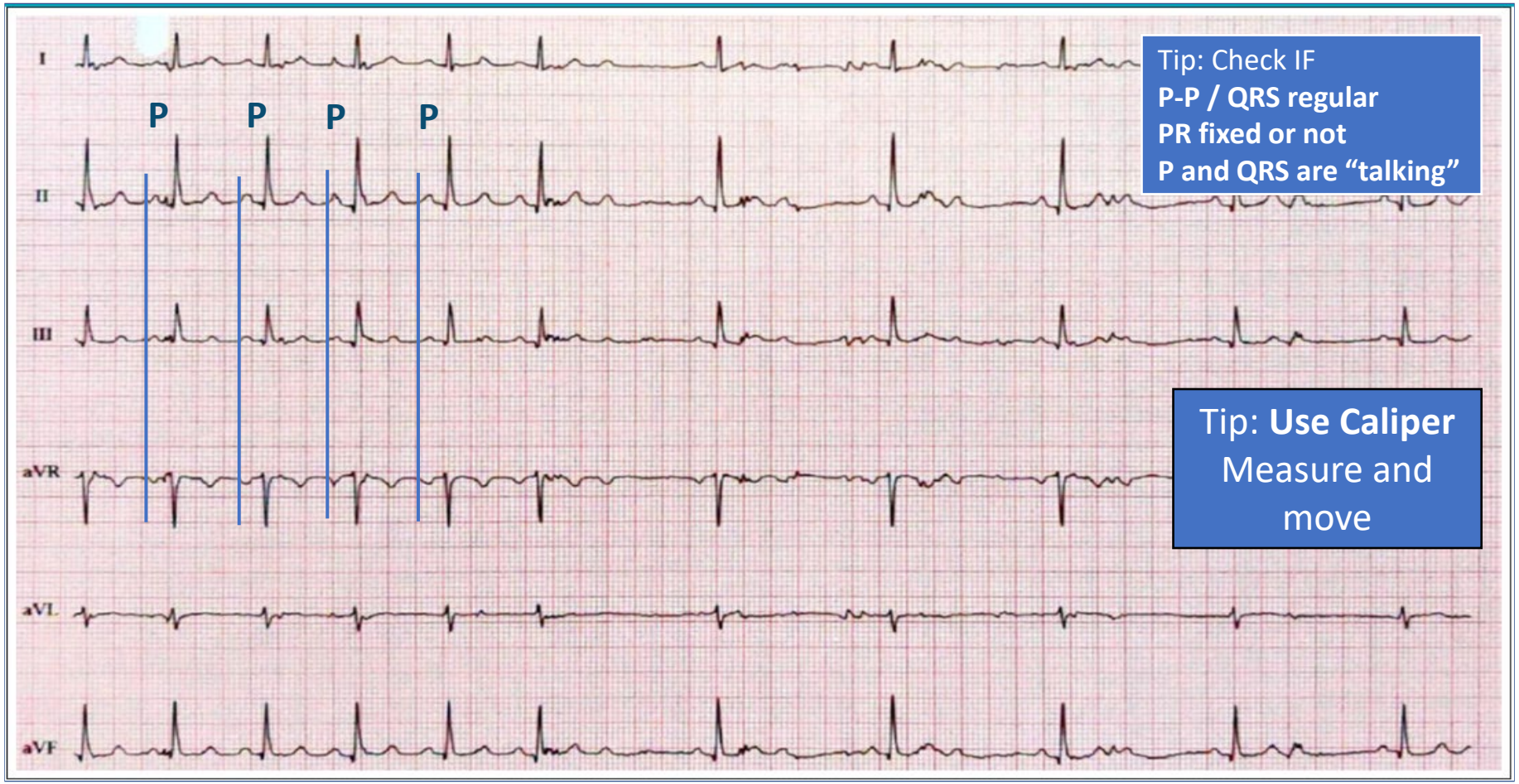
Case: 52y F with fatigue and impaired exercise tolerance past hx breast cancer therapy (in remission>5 years)

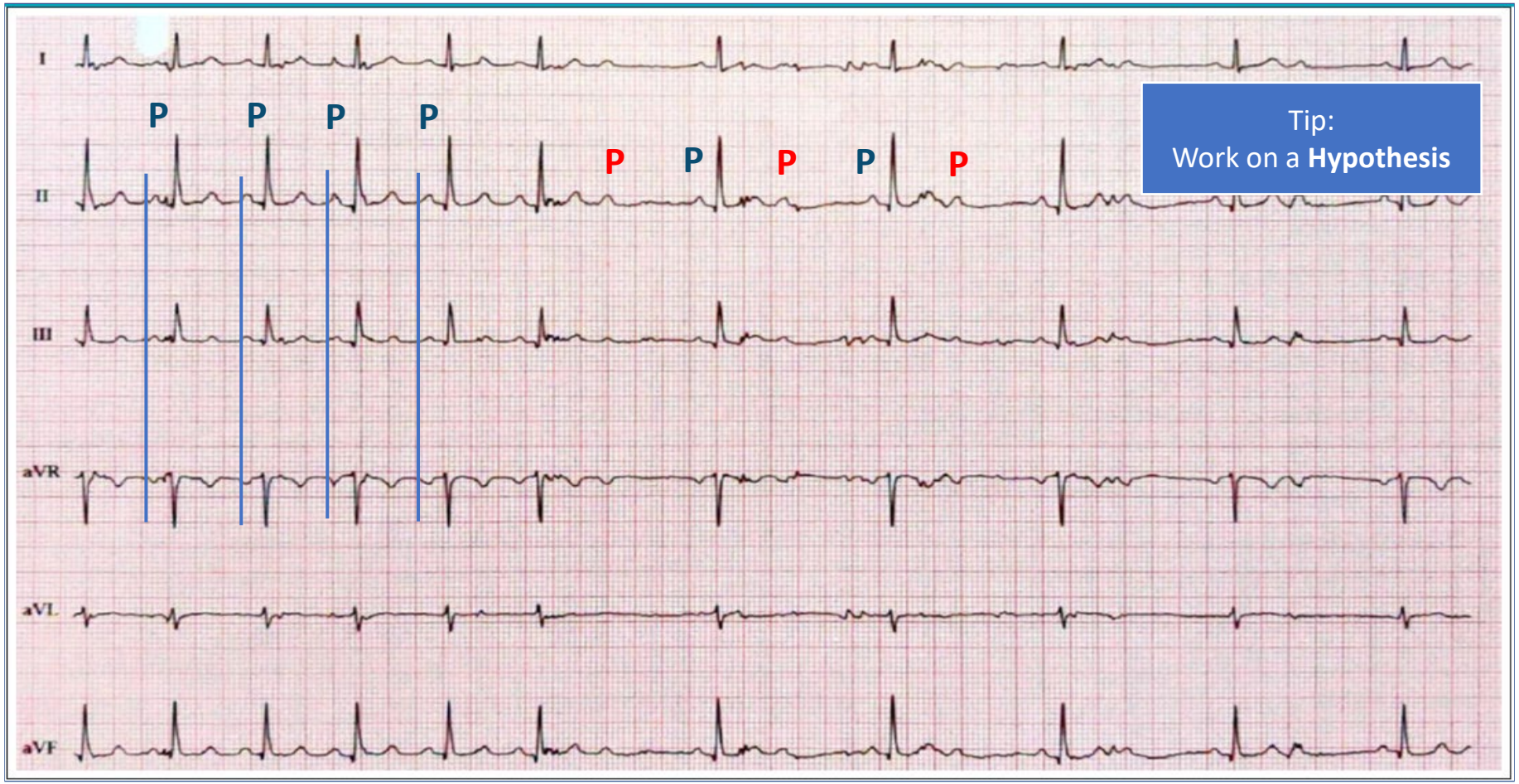
Exercise TEST



Circulation. 2020;142:1684–1686. DOI: 10.1161/CIRCULATIONAHA.120.050344

Case: 52y F with fatigue and impaired exercise tolerance past hx breast cancer therapy (in remission>5 years)

Exercise TEST



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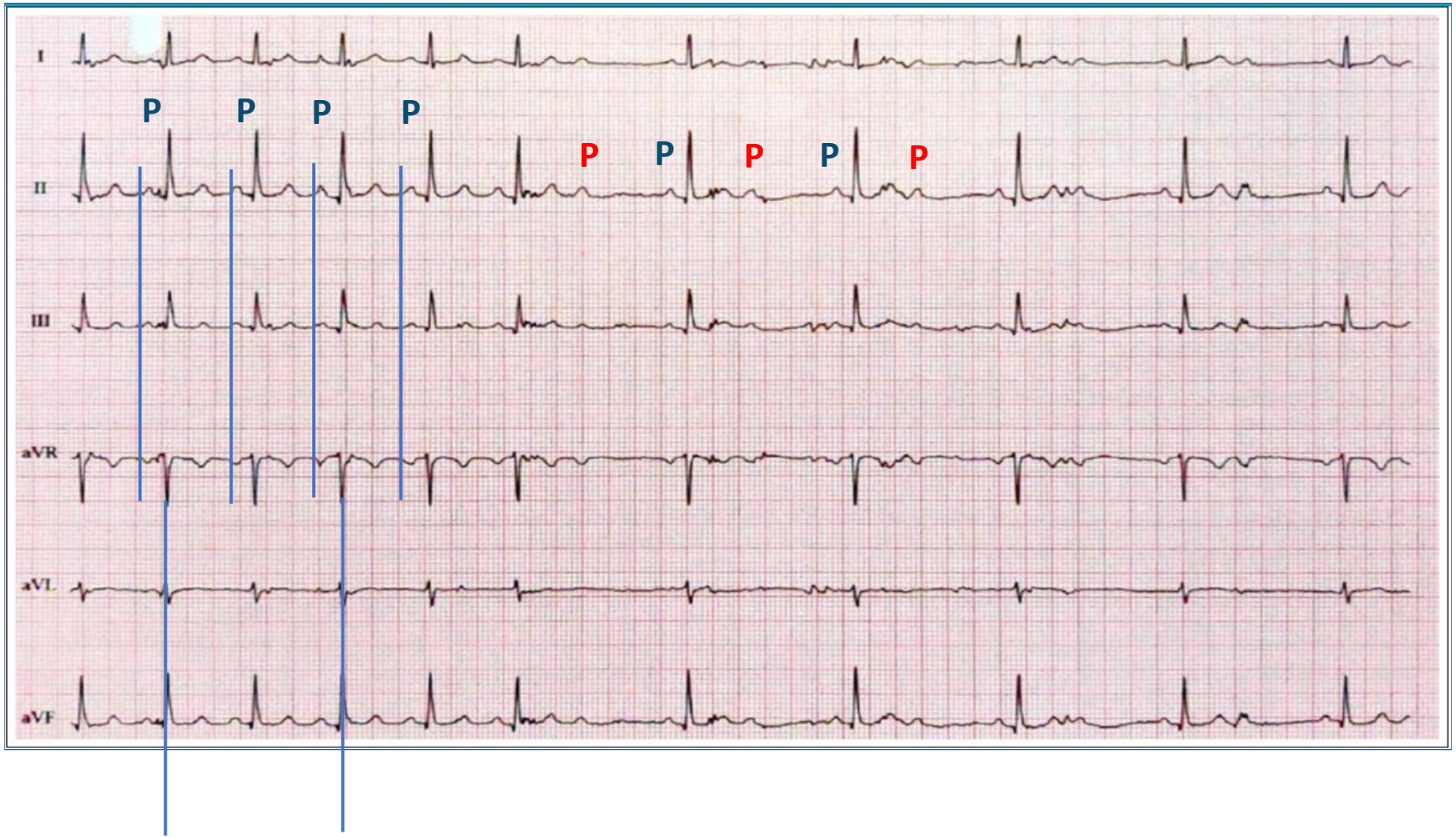

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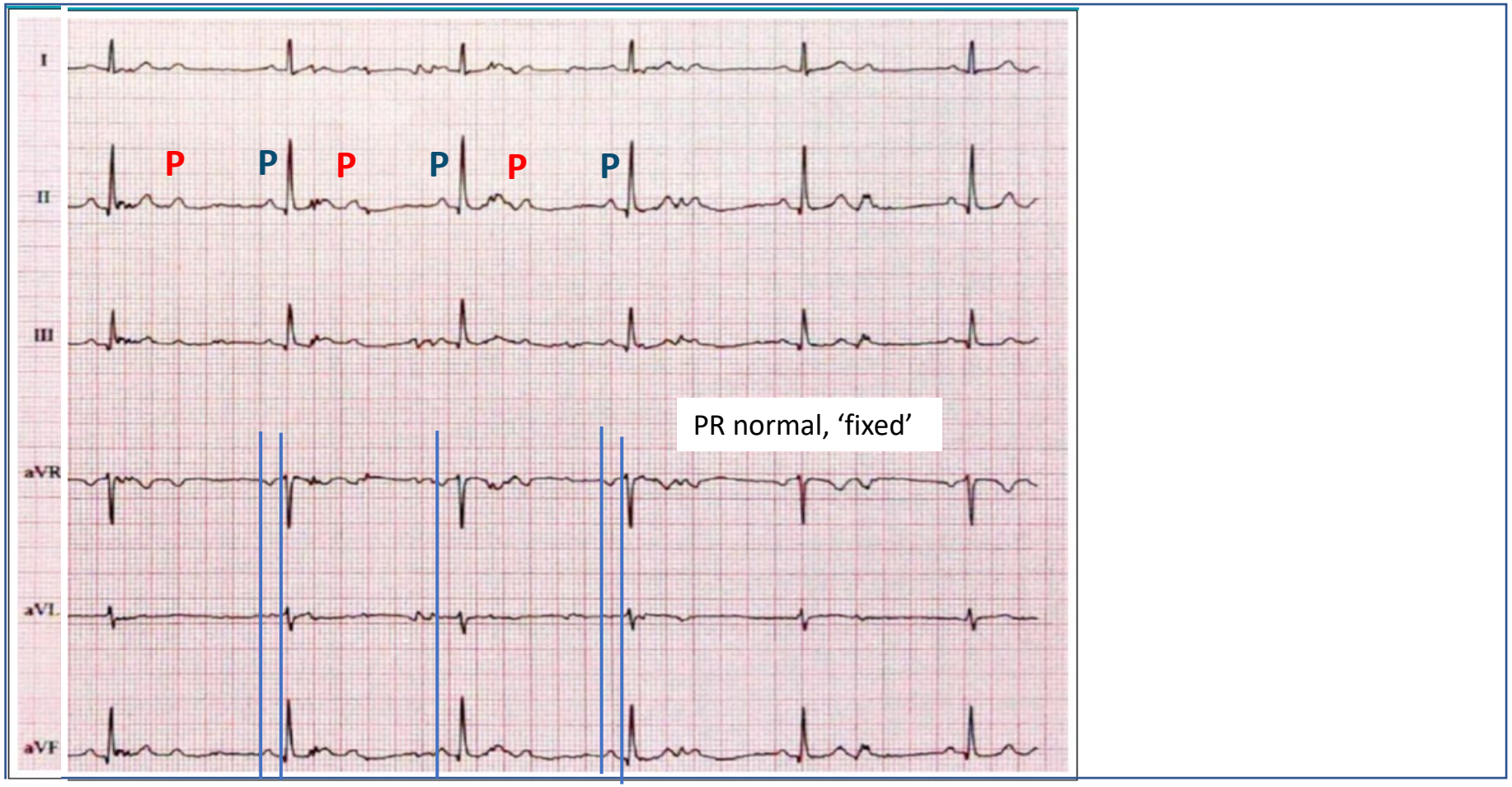
Case: 52y F with fatigue and impaired exercise tolerance past hx breast cancer therapy (in remission>5 years)



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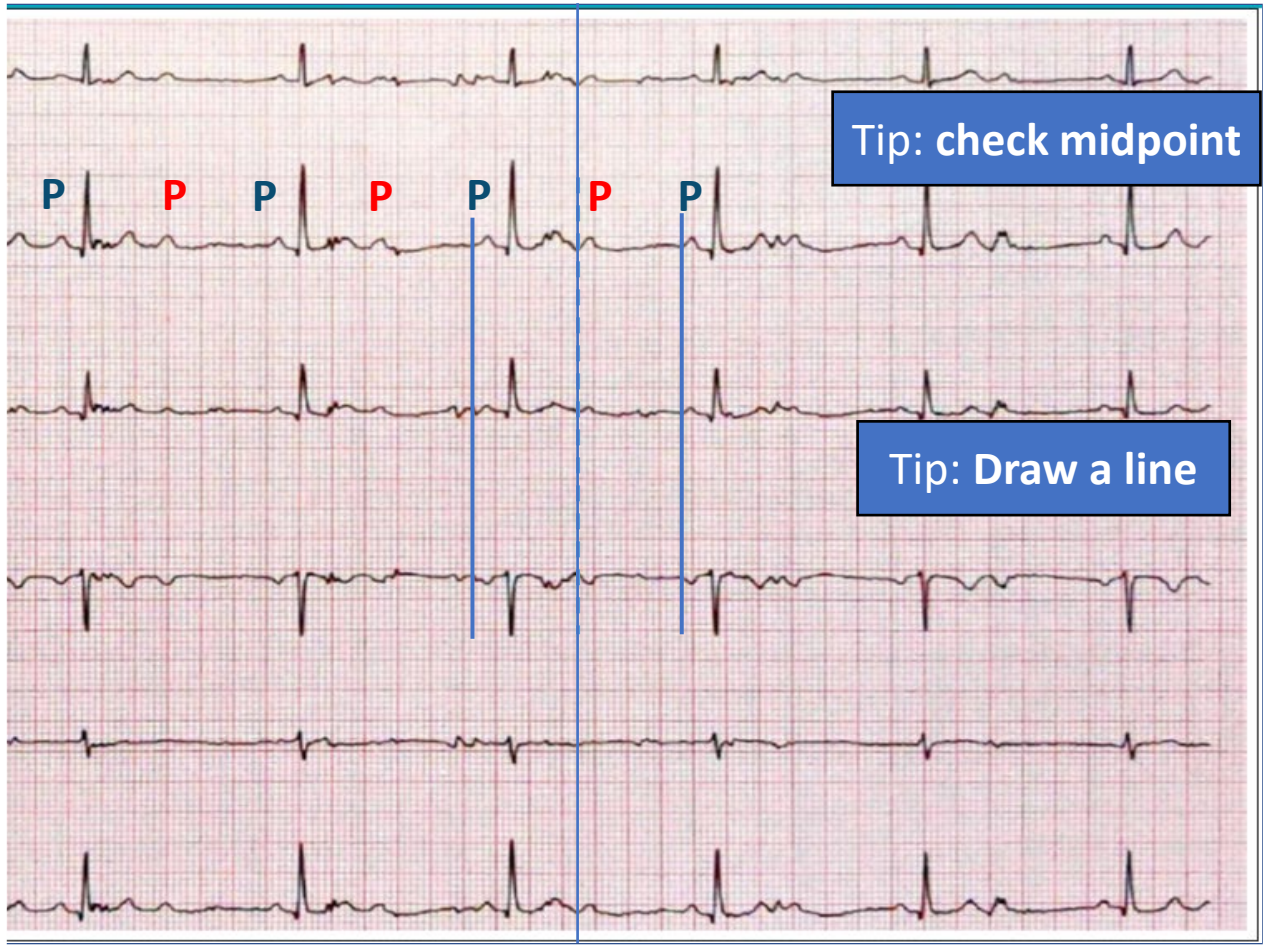
Case: 52y F with fatigue and impaired exercise tolerance past hx breast cancer therapy (in remission>5 years)



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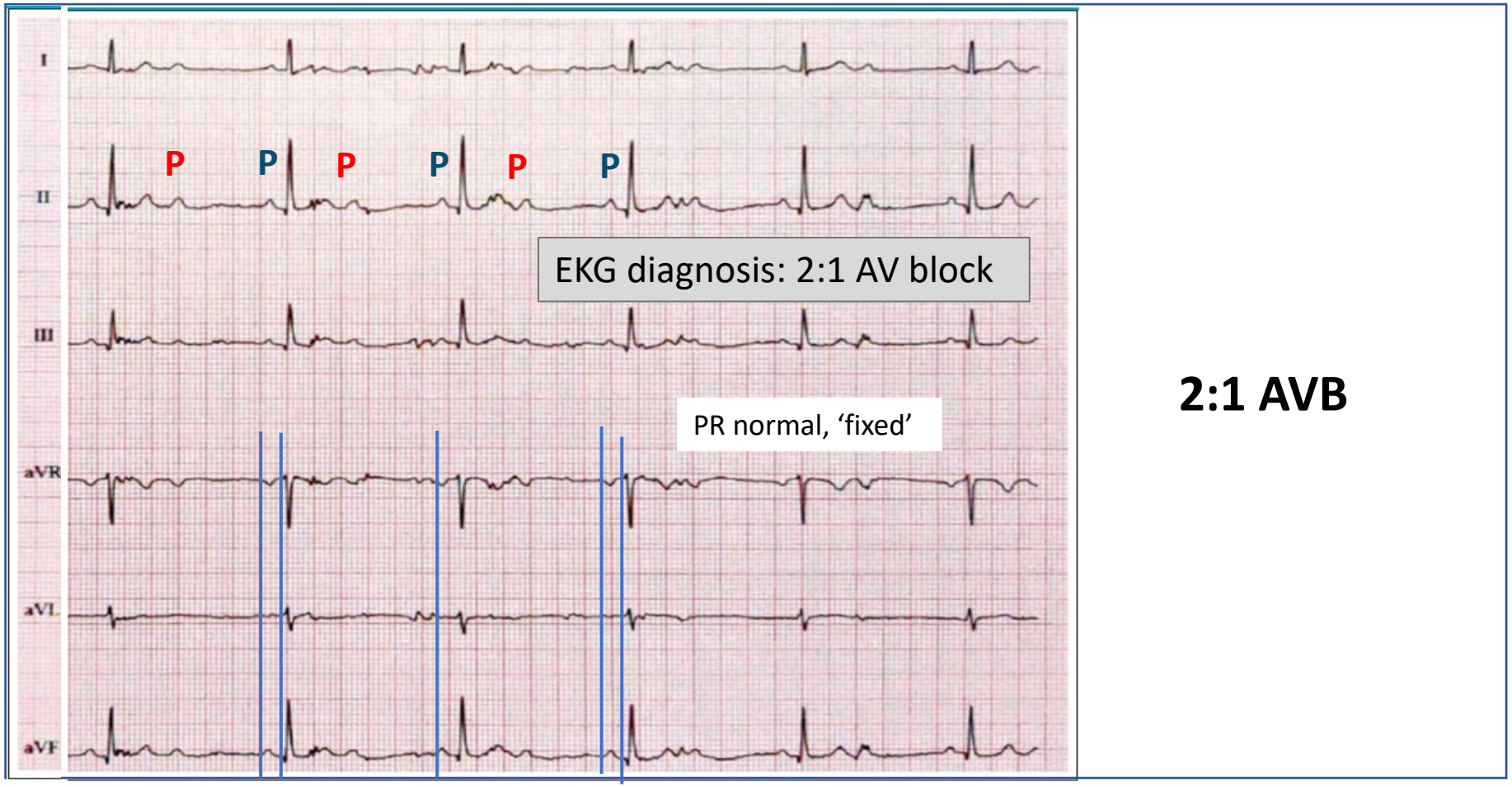

1. No risk
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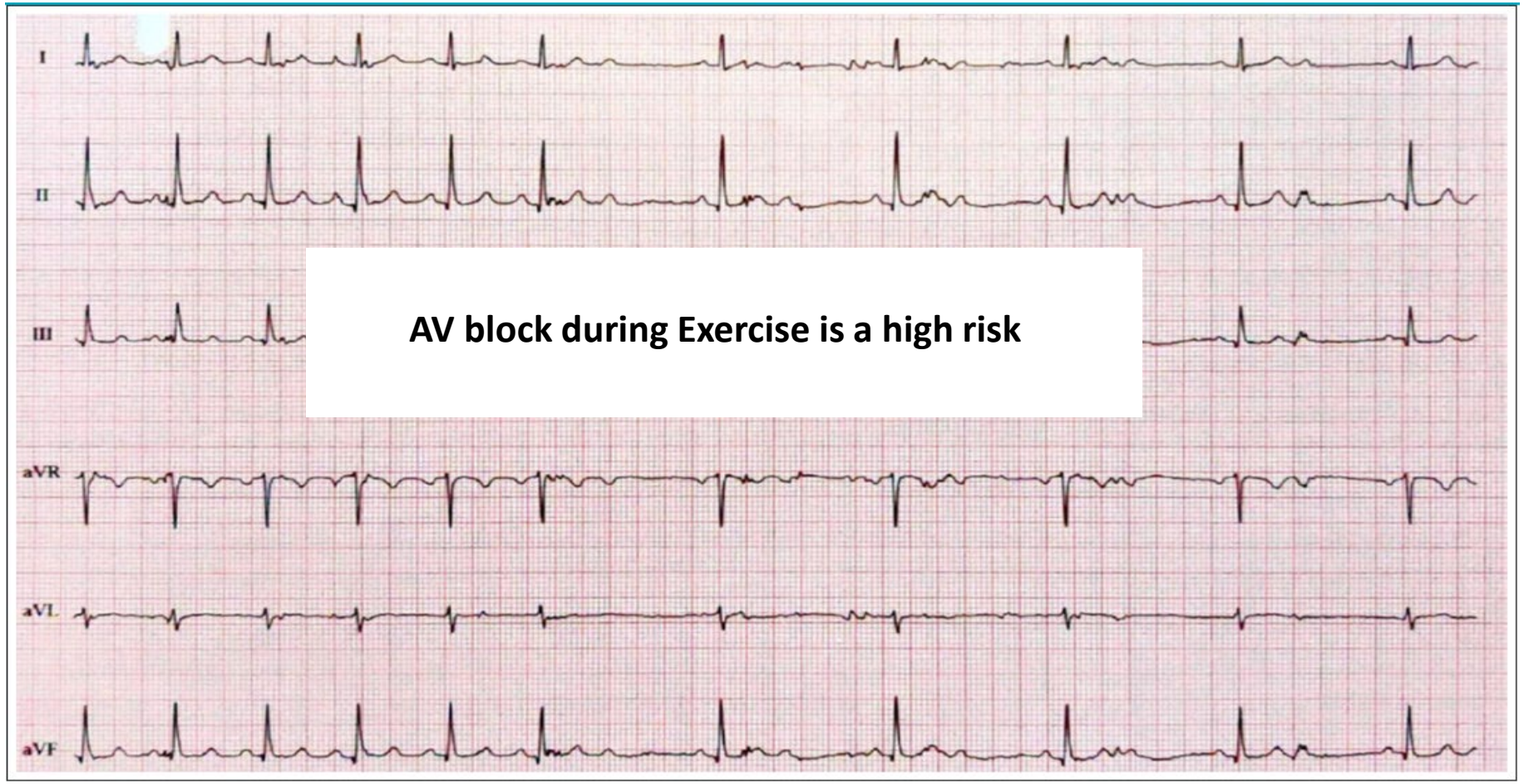
Circulation. 2020;142:1684–1686. DOI: 10.1161/CIRCULATIONAHA.120.050344

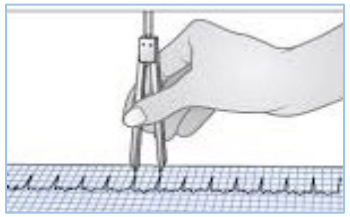
Case: 52y F with fatigue and impaired exercise tolerance past hx breast cancer therapy (in remission>5 years)

Exercise



LEVEL of Block ?

1. AV Node 2. Below AVN



EKG Learning Points

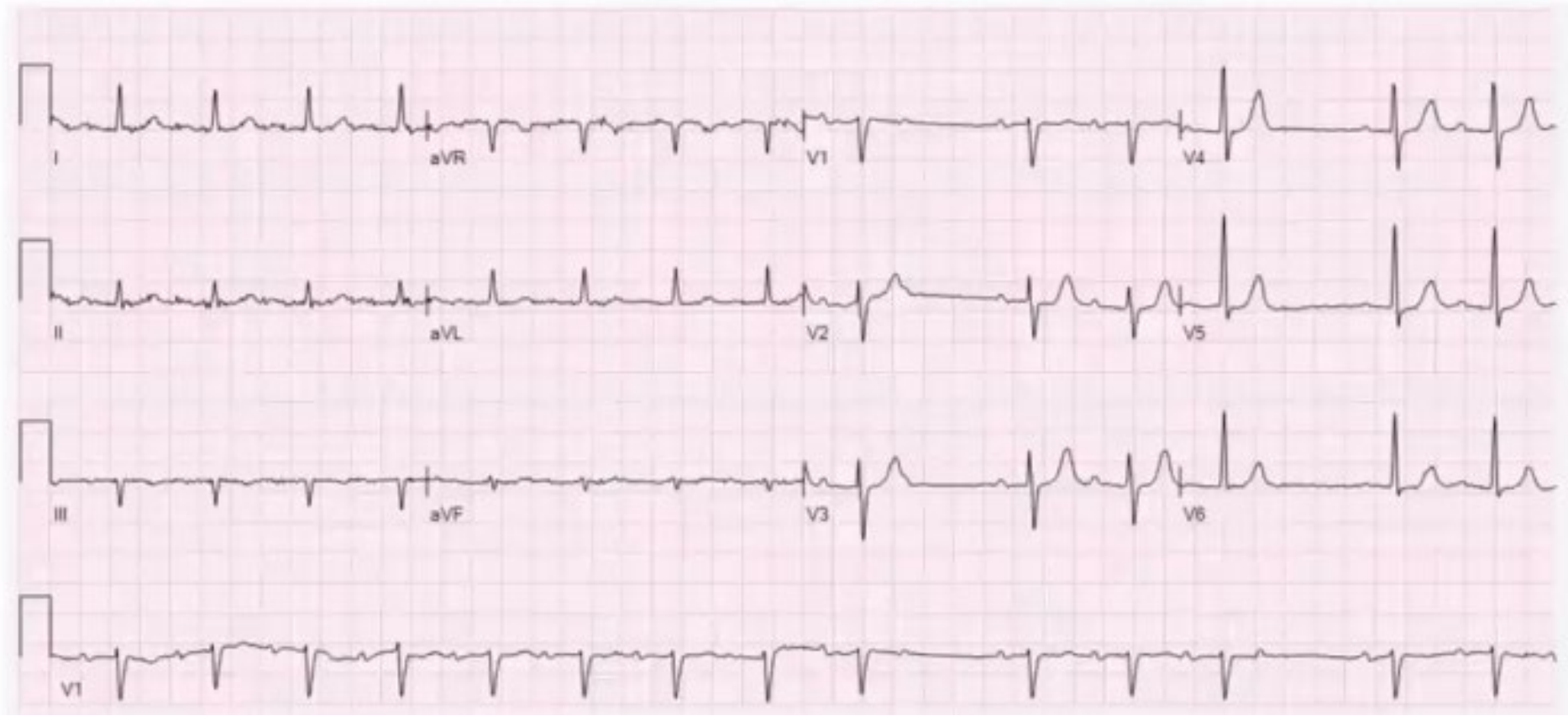
Case: 52y F with fatigue and impaired exercise tolerance; past hx breast cancer therapy

1. **Exercise induced AV block is high risk**

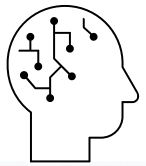
2. History is important
   - Symptoms are red flags in AV blocks
   - Cancer therapy can have long-term CV mortality impact

1. Use ‘tools’ ie. *Calipers*, midline etc → establish regular P and QRS regularity and their relationship (Y: pattern? or NO)

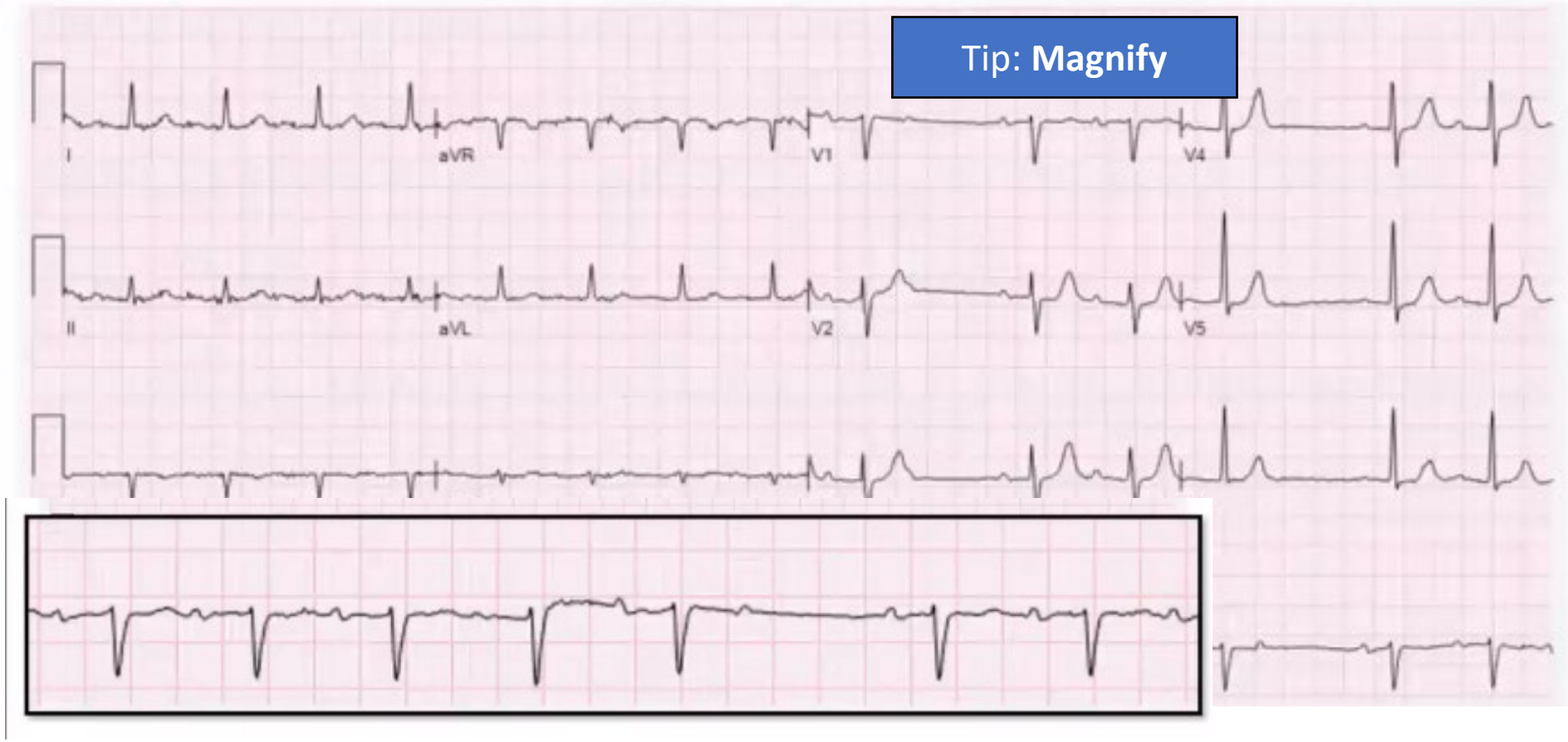
AVB – Mobitz 1 vs Mobitz 2



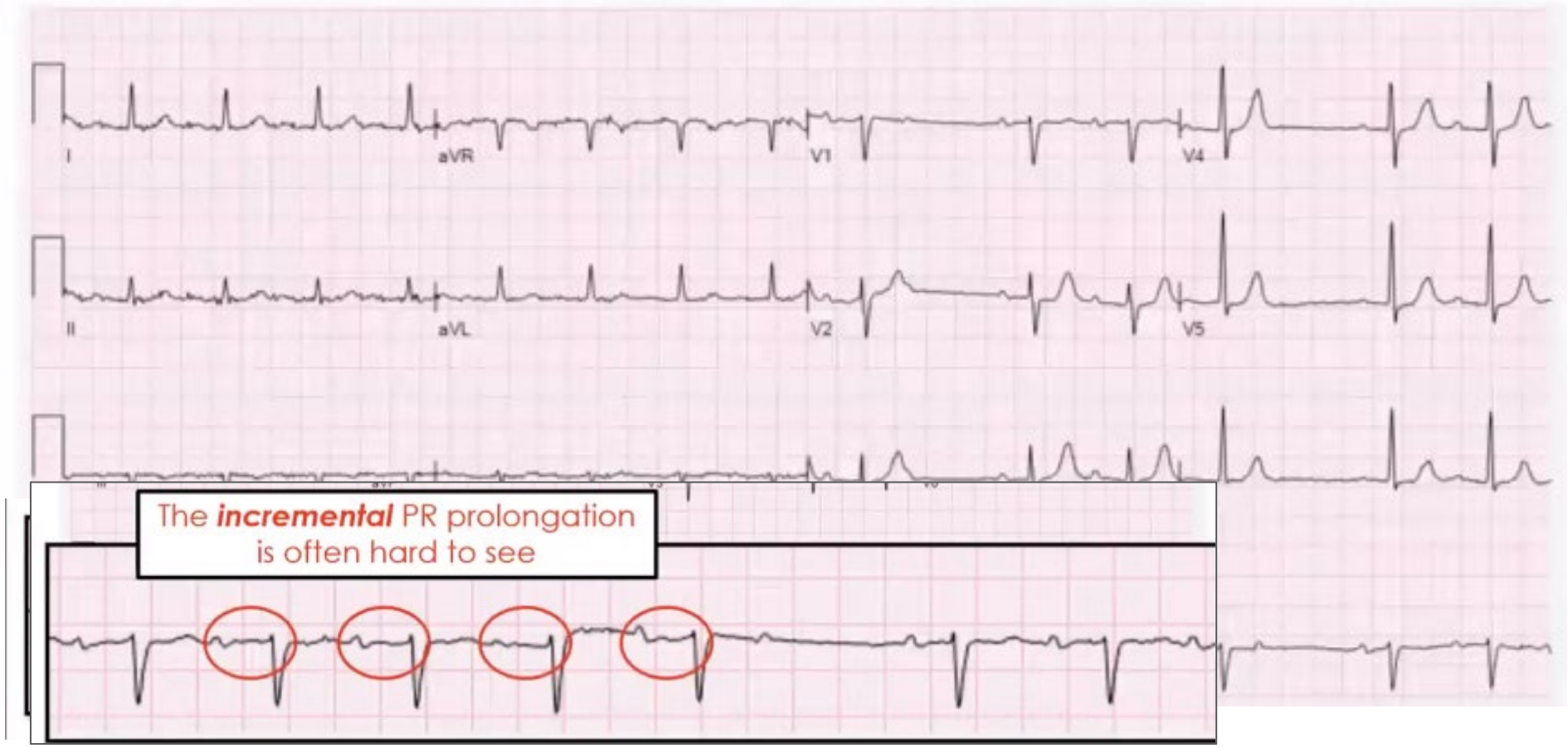
AVB – Mobitz 1 vs Mobitz 2



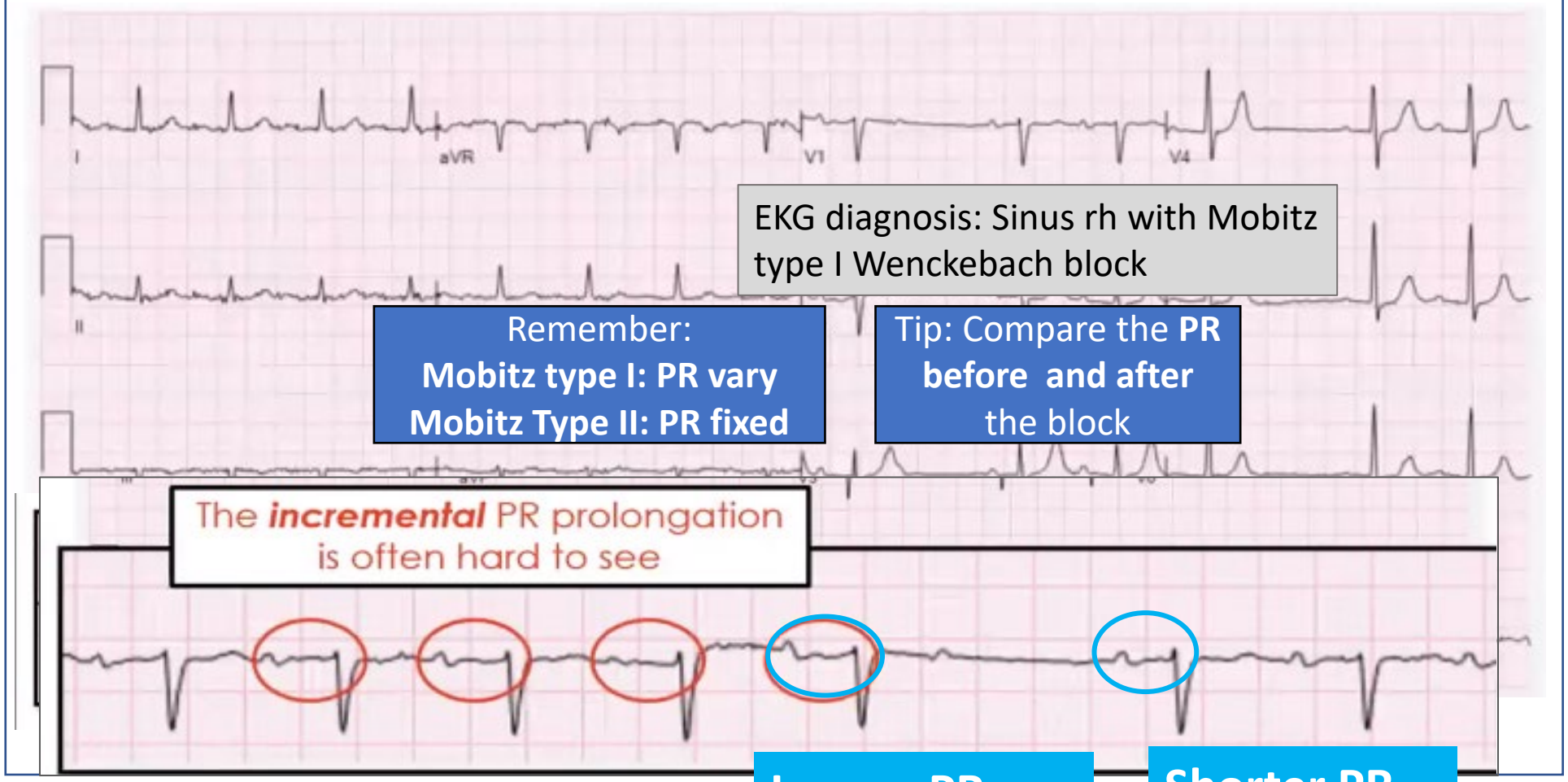
Tip: **Magnify**



AVB – Mobitz 1 vs Mobitz 2

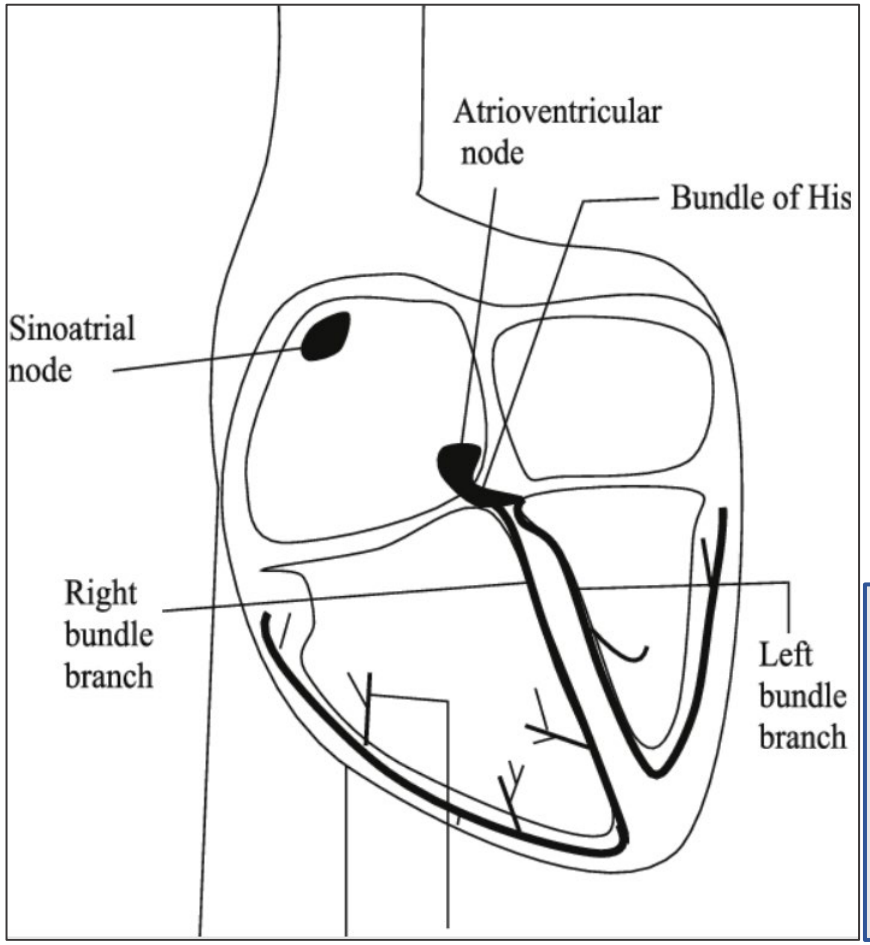


AVB – Mobitz 1 vs Mobitz 2



2nd degree AVB (Mobitz I and II)

Anatomical site- LEVEL of the block determines the **prognosis**



WHEN TO WORRY?

Block Below the AV Node → High risk

Mobitz Type II block

- Always Below the AV Node (70% wide QRS)

Type I block with a narrow QRS

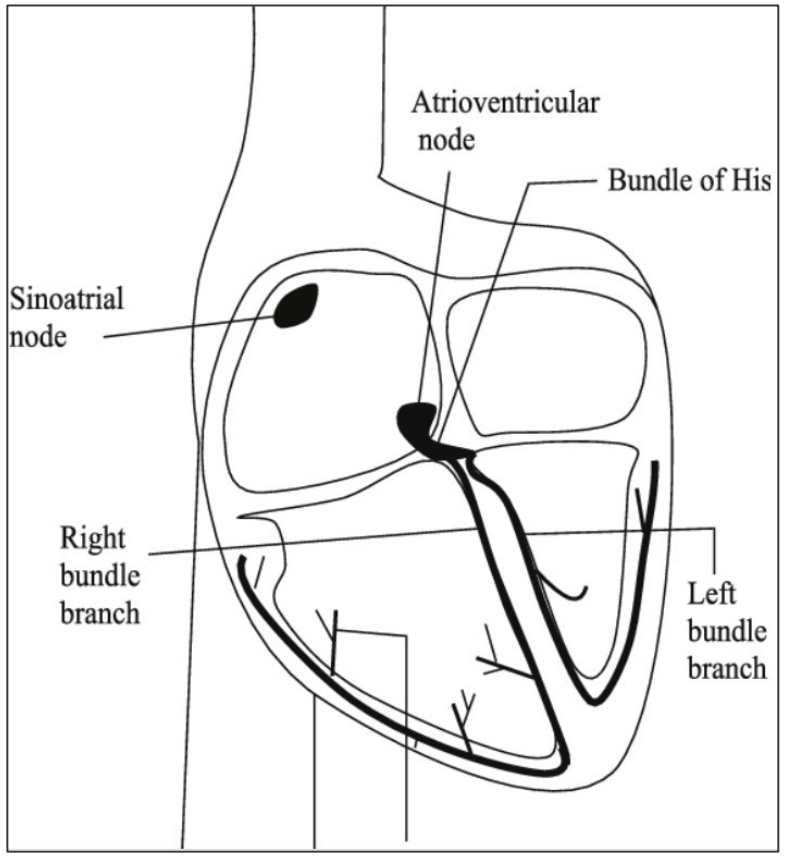
- AV Node (80-**90**%)
- Below AVN (10-20%)

Type I block with a wide QRS

- AV Node (30–40%)
- Below AVN (60–70%)

https://www.researchgate.net/figure/Fig-A5-Conducting-system-of-the-heart_fig48_43161158

WHY there is a PR fluctuation?



Type I block with a narrow QRS

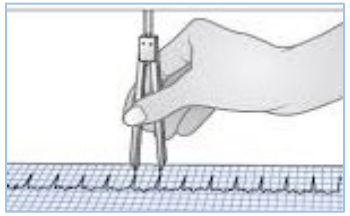
- AV Node (80-90%)

- **The AV node is fully integrated into the neurohormonal milieu**
- **Specific conduction properties of the AV node vary**

Type I block with a wide QRS

- AV Node (30–40%)

https://www.researchgate.net/figure/Fig-A5-Conducting-system-of-the-heart_fig48_43161158



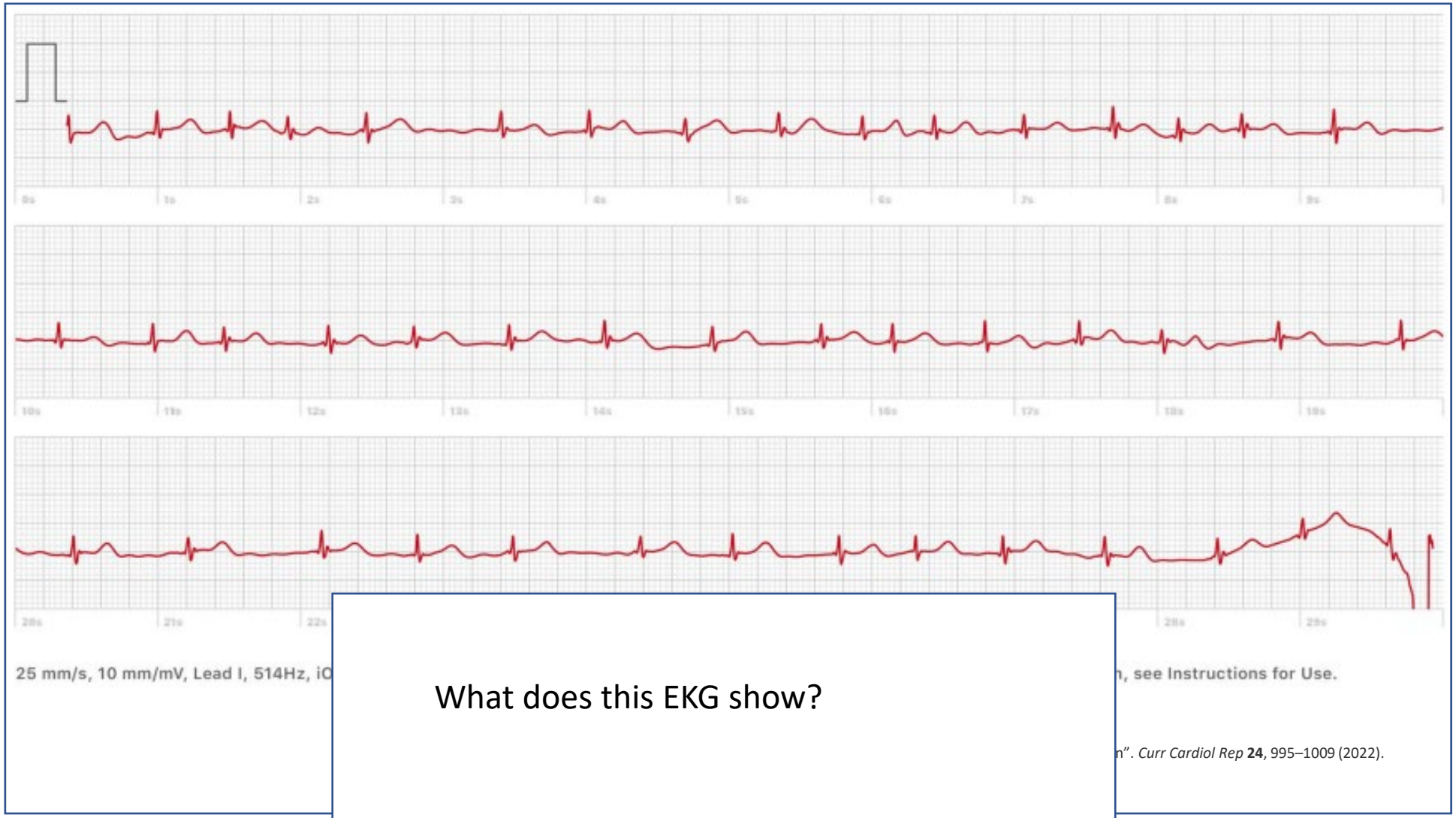
EKG Learning Points

1. Comparing **PR** intervals **before and after** the blocked P wave can help to differentiate Mobitz type I from type II block

2. 80-90% of Wenckebach block (with norm QRS) is benign; Mobitz type II is always a high risk.

Part 2

Case : 42y M history of moderate symptomatic COVID (10 m ago); fully recovered; no symptoms; submits an Apple watch (4) EKG recording



What does this EKG show?

1. PACs 2. Atrial Fibrillation 3. Atrial flutter 4. Other

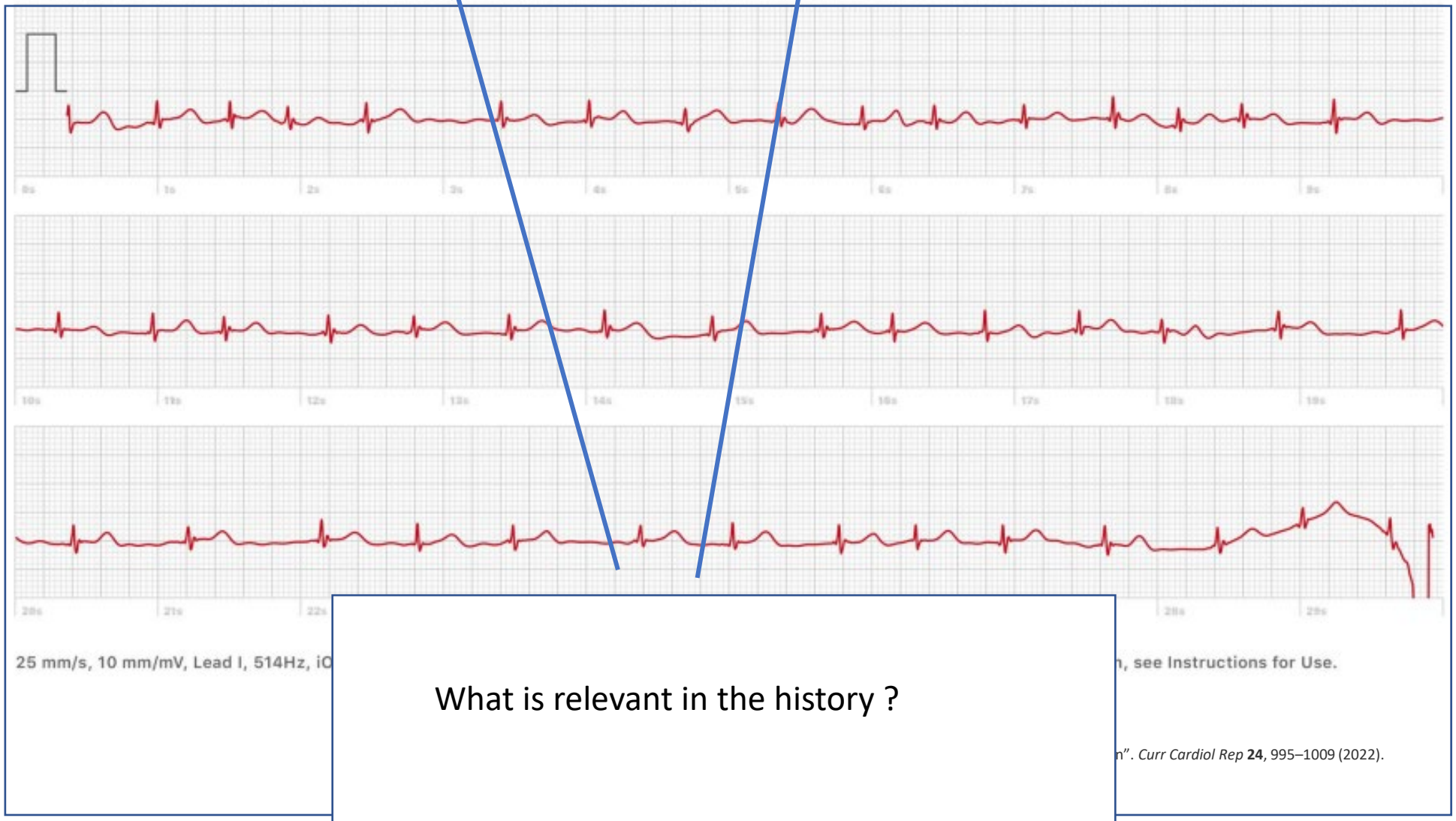
Case : 42y M history of mod symptomatic COVID (10 m ago); fully recovered; no symptoms; submits an Apple watch EKG recording

- Single lead recording
- No discernible repeating P waves
- Irregular QRS

What does this EKG show?

1. PACs 2. Atrial Fibrillation 3. Atrial flutter 4. Other

Case : 42y M history of mod COVID, fully recovered; no symptoms; submits an Apple watch EKG recording



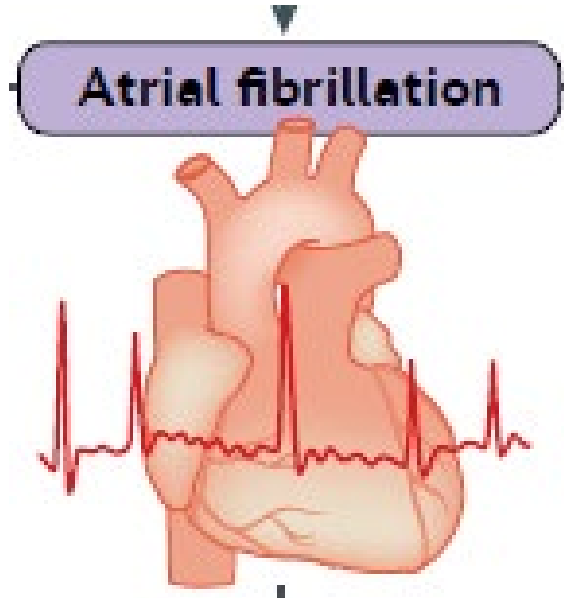
What is relevant in the history ?

1. PACs 2. Atrial Fibrillation 3. Atrial flutter 4. Other

AF *screening*: tools – sensitivity/specificity

considering 12-lead EKG as a gold standard

	Sensitivity	Specificity
Pulse taking	87–97%	70–81%
Automated BP monitors	93–100%	86–92%
Single lead ECG	94–98%	76–95%
Smartphone apps	91.5–98.5%	91.4–100%
Watches	97–99%	83–94%
CJC Oct/2022	69%	81%



Methods: PPG (Photo-Pletysmography) vs non-12 lead EKG recoding

pic; Herrmann Adverse cardiac effects of cancer therapies: cardiotoxicity and Arrhythmia doi: 10.1038/s41569-020-0348-1

2020 ESC Guidelines for the diagnosis and management of atrial fibrillation (European Heart Journal 2020-doi/10.1093/eurheartj/ehaa612)

https://doi.org/10.1093/ehjopen/oeac044 Esc AF guideline

AF SCREENING

Controversy of screening

NO RECOMMENDATION FOR SCREENING IN ASYMPTOMATIC ADULTS

United States Preventive Service Task Force, Draft Recommendation Statement, April 2021[1]

Population	Recommendation	Grade
Asymptomatic adults aged ≥50 years	The USPSTF concludes that the current evidence is insufficient to assess the balance of benefits and harms of screening for AF	I

2020 ESC recommendations[2]	Class*
Opportunistic screening for AF is recommended by pulse taking or ECG rhythm strip in patients aged ≥65 years	I
Systematic ECG screening should be considered to detect AF in individuals aged ≥75 years, or those at high risk of stroke	IIa

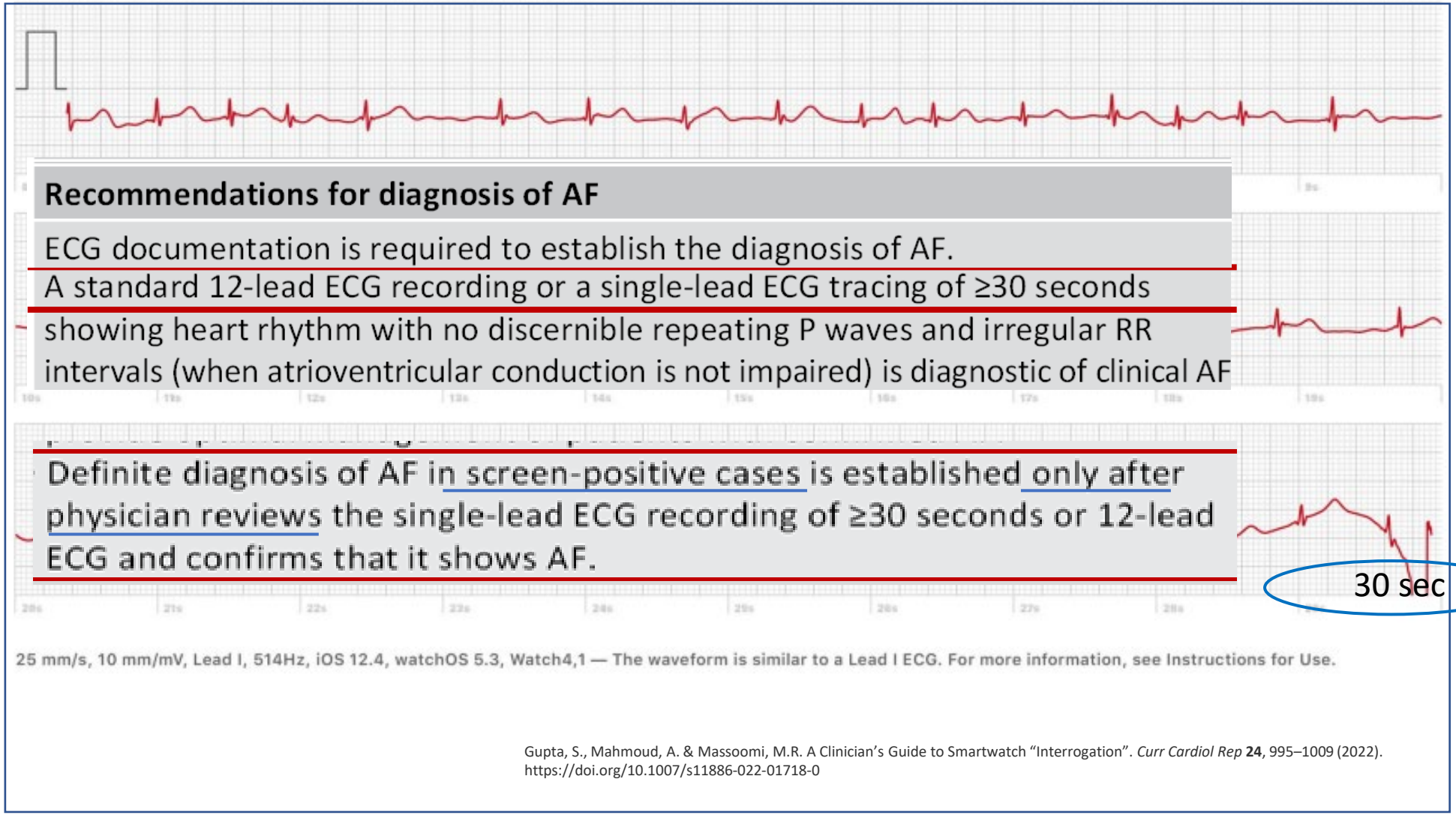
USPSTF, United States Preventive Service Task Force. 1. US Preventative Taskforce Draft Recommendation Statement. April 2021. Available at: https://www.uspreventiveservicestaskforce.org/uspstf/draft-recommendation/screening-atrial-fibrillation [Last accessed June 2021]; 2. Hindricks G, et al. Eur Heart J 2020;00:1–126.

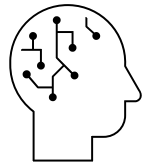
Case: 42y M history of mod COVID, fully recovered; no symptoms;
submits an Apple watch EKG recording

Is the atrial fibrillation a firm diagnosis now?

1. PACs 2. Atrial Fibrillation 3. Atrial flutter 4. Other

Case : 42y M history of mod COVID; fully recovered; no symptoms;
submits an Apple watch EKG recording





Gupta, S., Mahmoud, A. & Massoomi, M.R. A Clinician's Guide to Smartwatch "Interrogation". *Curr Cardiol Rep* **24**, 995–1009 (2022). https://doi.org/10.1007/s11886-022-01718-0

1. PACs 2. Atrial Fibrillation 3. Atrial flutter 4. Oth

2020 ESC Guidelines for the diagnosis and management of atrial fibrillation (European Heart Journal 2020-doi/10.1093/eurheartj/ehaa612)

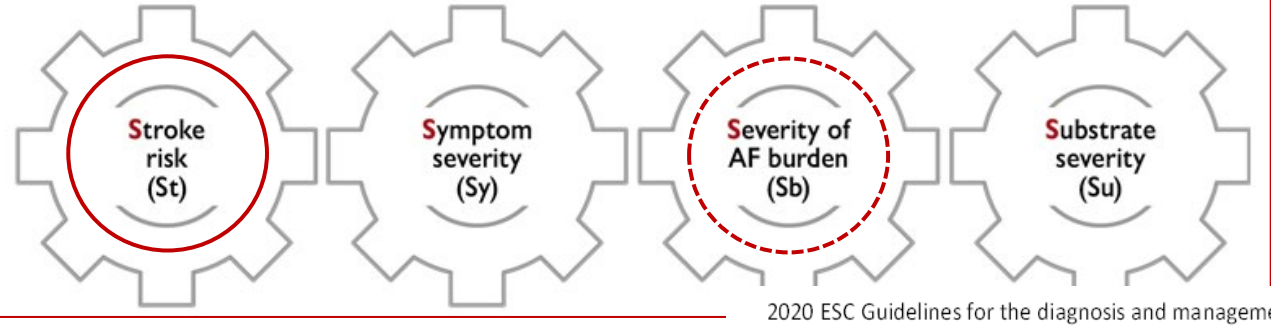
Case1 : 42y M history of mod COVID; fully recovered; no symptoms; submit an Apple watch EKG recording

Occult atrial fibrillation — Occult paroxysmal AF refers to asymptomatic paroxysmal AF in a patient **without a prior history** of AF, which is detected only by monitoring techniques (~**first detected**)

Subclinical AF: asymptomatic SILENT, detected by intracardiac/implantable or wearable devices (with& w/o hx)

Clinical AF: Symptomatic and Asymptomatic, detected by a 12 lead EKG / 30sec single lead (confirmed by MD)

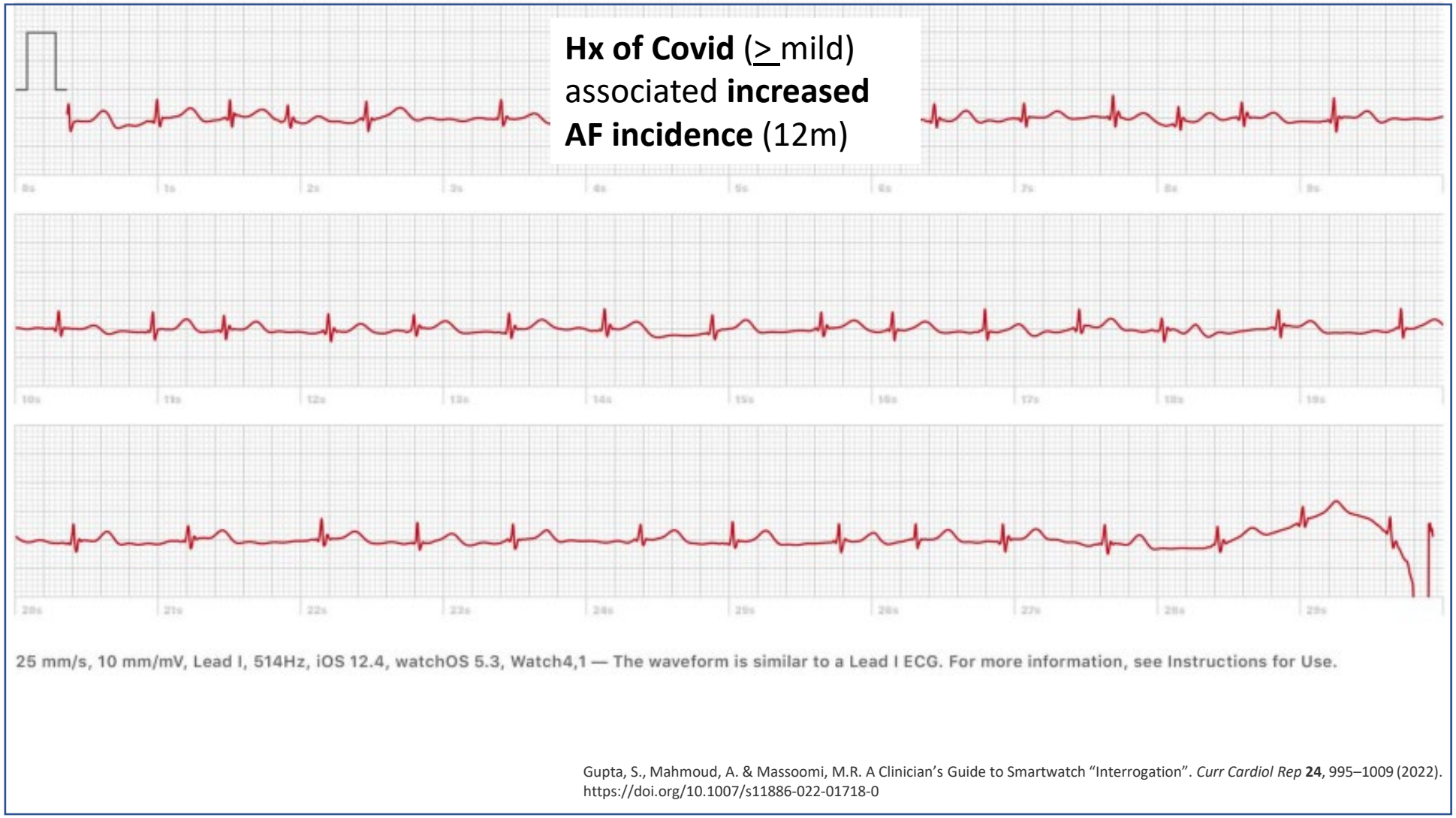
Needs Assessment:



995–1009 (2022).
2020 ESC Guidelines for the diagnosis and management of atrial fibrillation (European Heart Journal 2020-doi/10.1093/eurheartj/ehaa612)

1. PACs 2. Atrial Fibrillation 3. Atrial flutter 4. Other

Case1 : 42y M history of mod COVID (10 months ago); fully recovered; no symptoms; submit an Apple watch EKG recording



Gupta, S., Mahmoud, A. & Massoomi, M.R. A Clinician's Guide to Smartwatch "Interrogation". *Curr Cardiol Rep* **24**, 995–1009 (2022). https://doi.org/10.1007/s11886-022-01718-0

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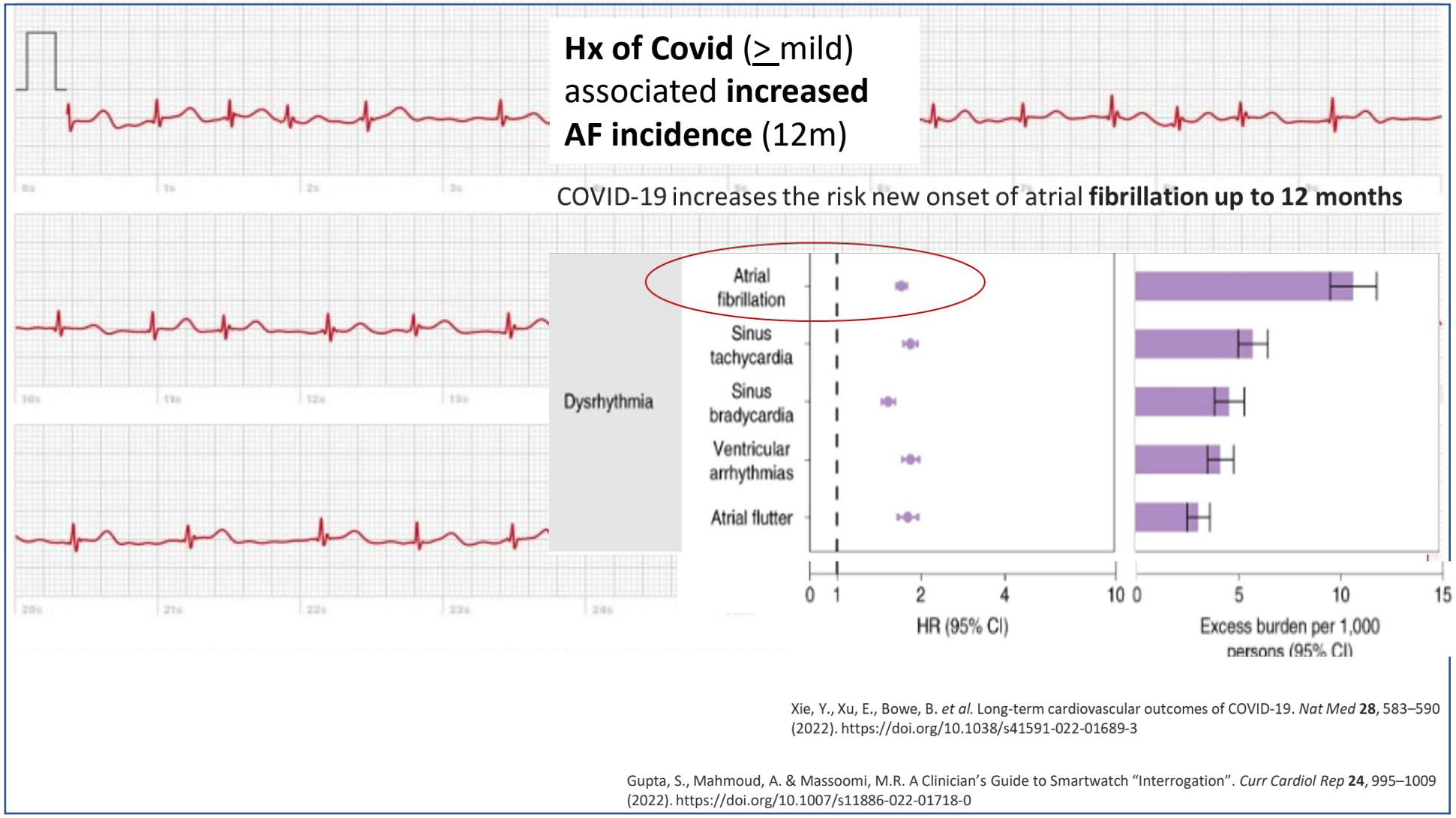
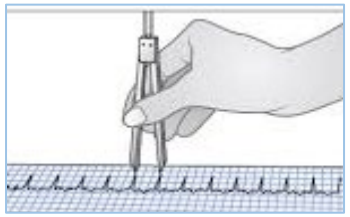


Xie, Y., Xu, E., Bowe, B. *et al.* Long-term cardiovascular outcomes of COVID-19. *Nat Med* **28**, 583–590 (2022). https://doi.org/10.1038/s41591-022-01689-3

Gupta, S., Mahmoud, A. & Massoomi, M.R. A Clinician's Guide to Smartwatch "Interrogation". *Curr Cardiol Rep* **24**, 995–1009 (2022). https://doi.org/10.1007/s11886-022-01718-0

1. PACs 2. Atrial Fibrillation 3. Atrial flutter 4. Other



EKG Learning Points

1. How to approach a screening EKG / single lead to make an AF diagnosis (and what do next)

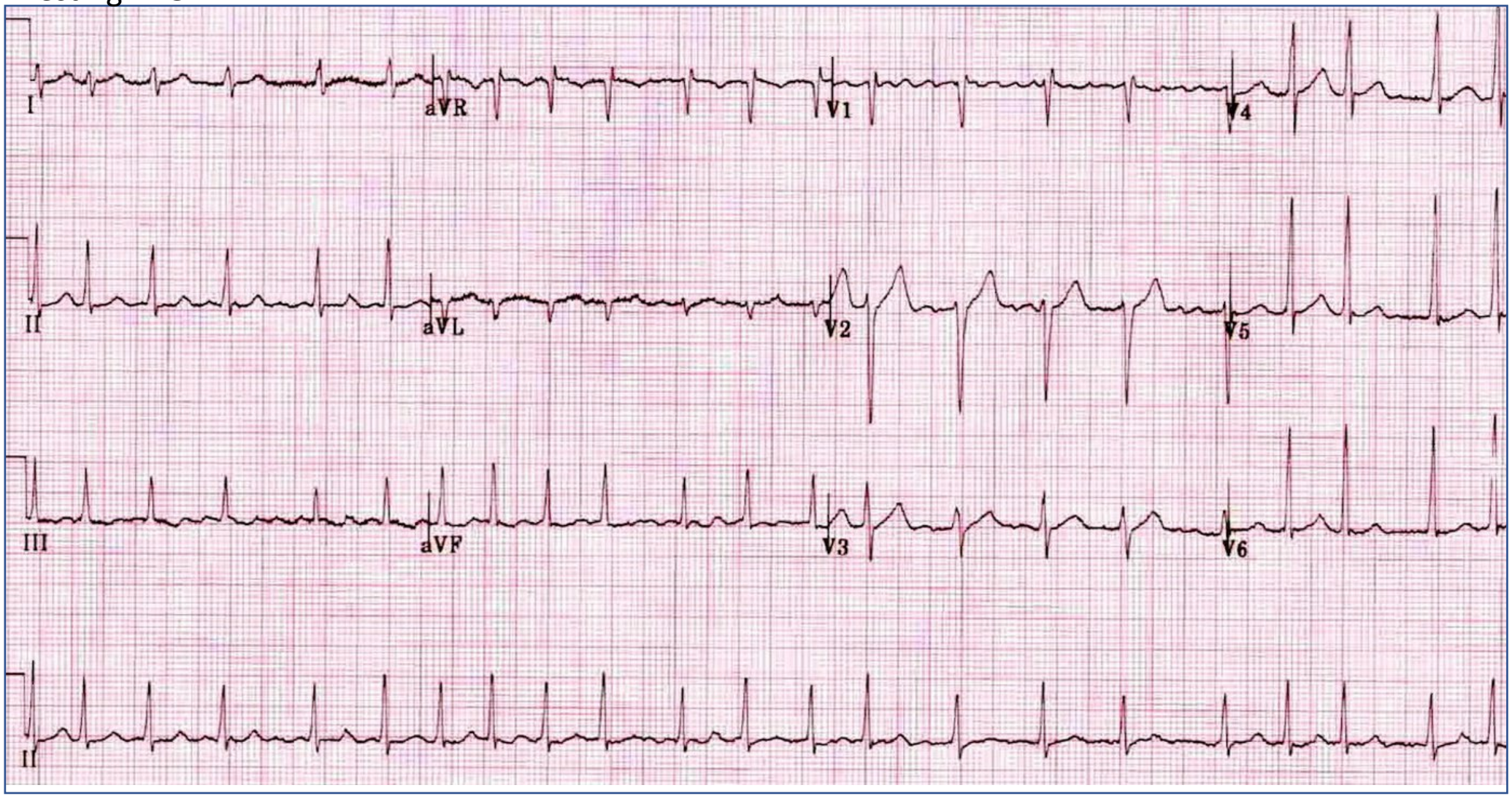
2. History is relevant

    1. All AF needs risk assessment (asymptomatic, symptomatic)
    2. Covid impact on AF incidence

60y M hx AFIB

Resting EKG

HR 140 bpm

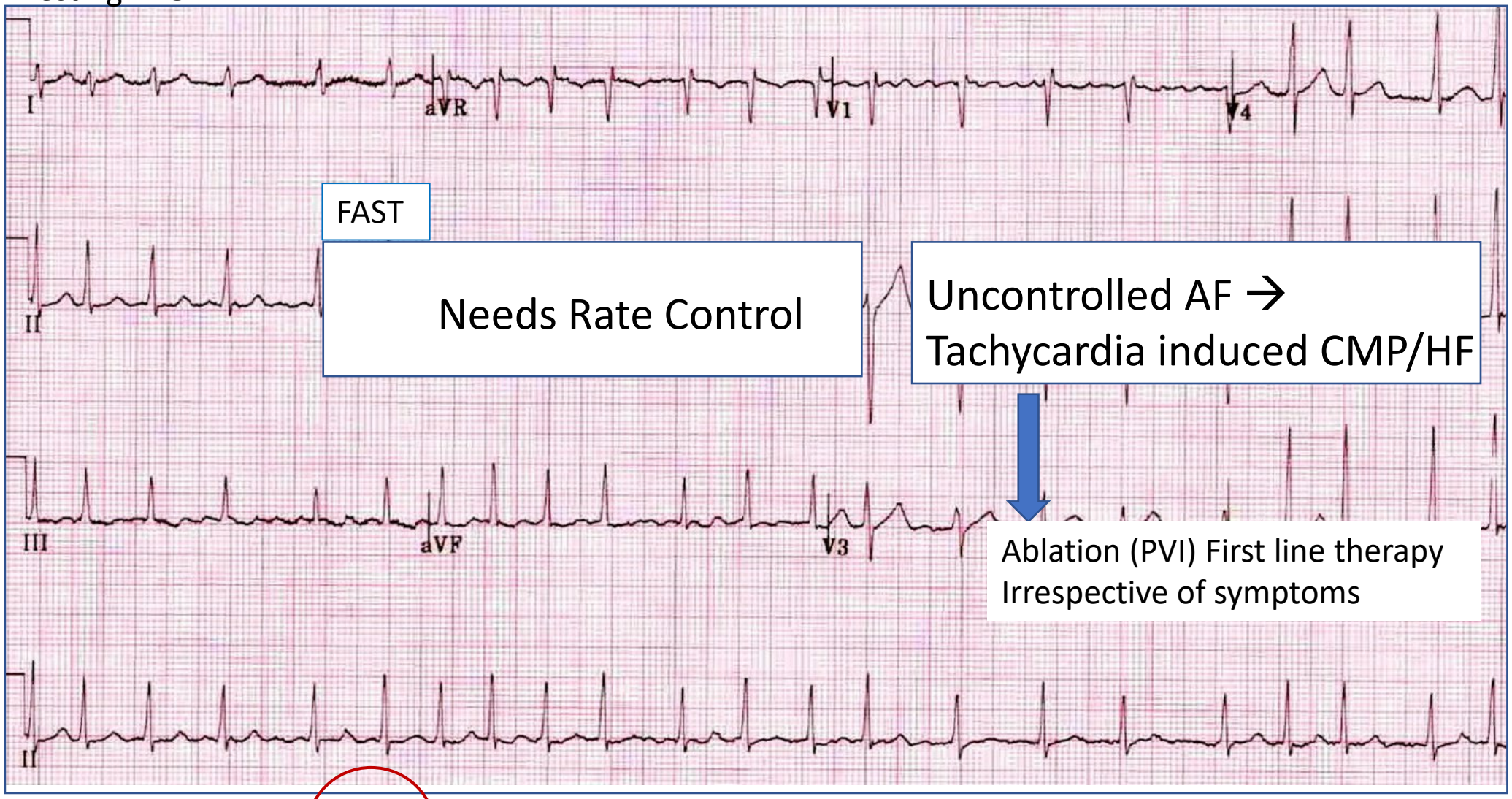


Worried? **A: Yes** **B: No** **C: Need more info**

60y M hx AFIB

Resting EKG

HR 140 bpm



FAST

Needs Rate Control

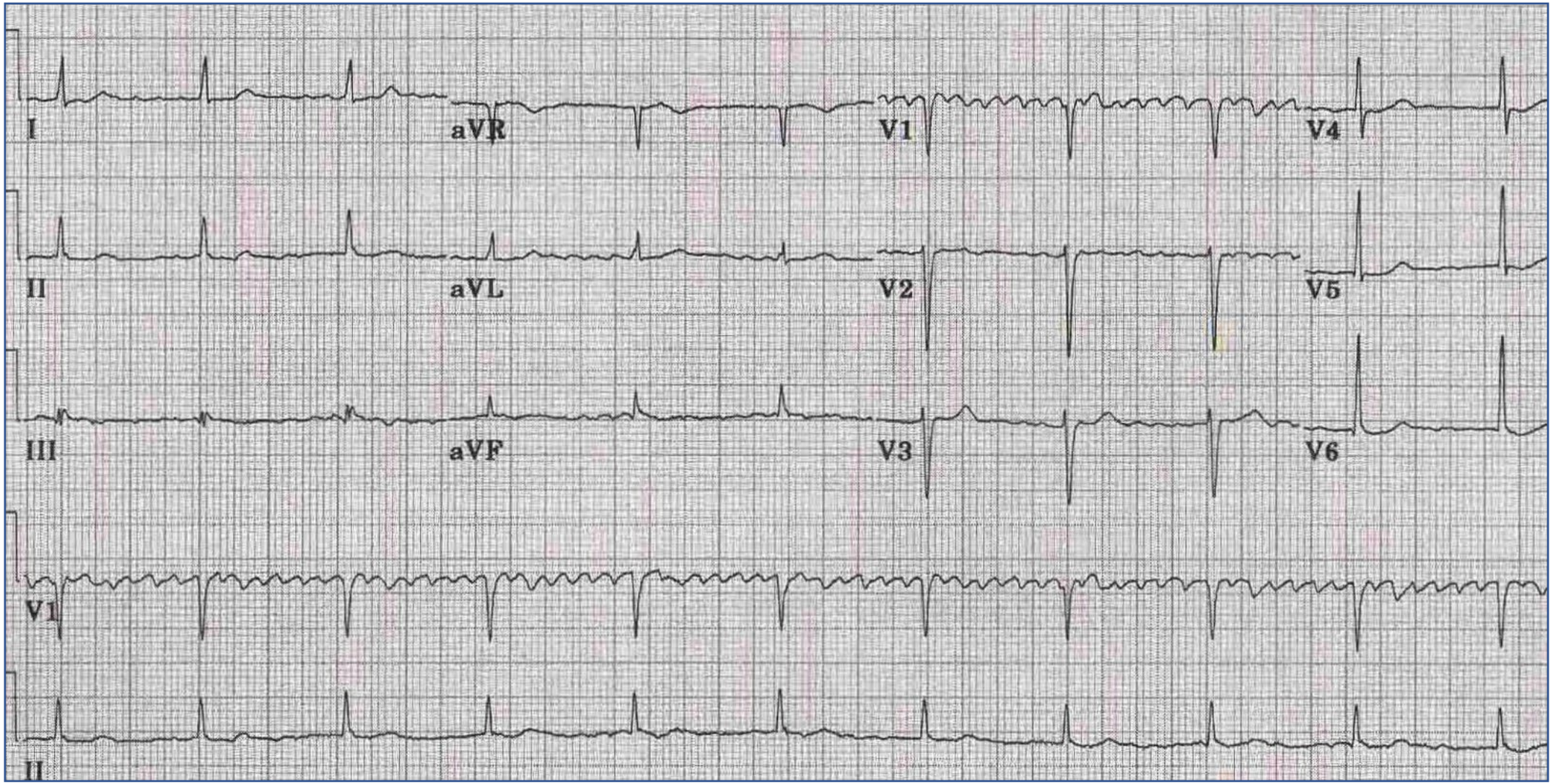
Uncontrolled AF →
Tachycardia induced CMP/HF

Ablation (PVI) First line therapy
Irrespective of symptoms

Worried? **A: Yes** **B: No** **C: Need more info**

62y F hx Afib

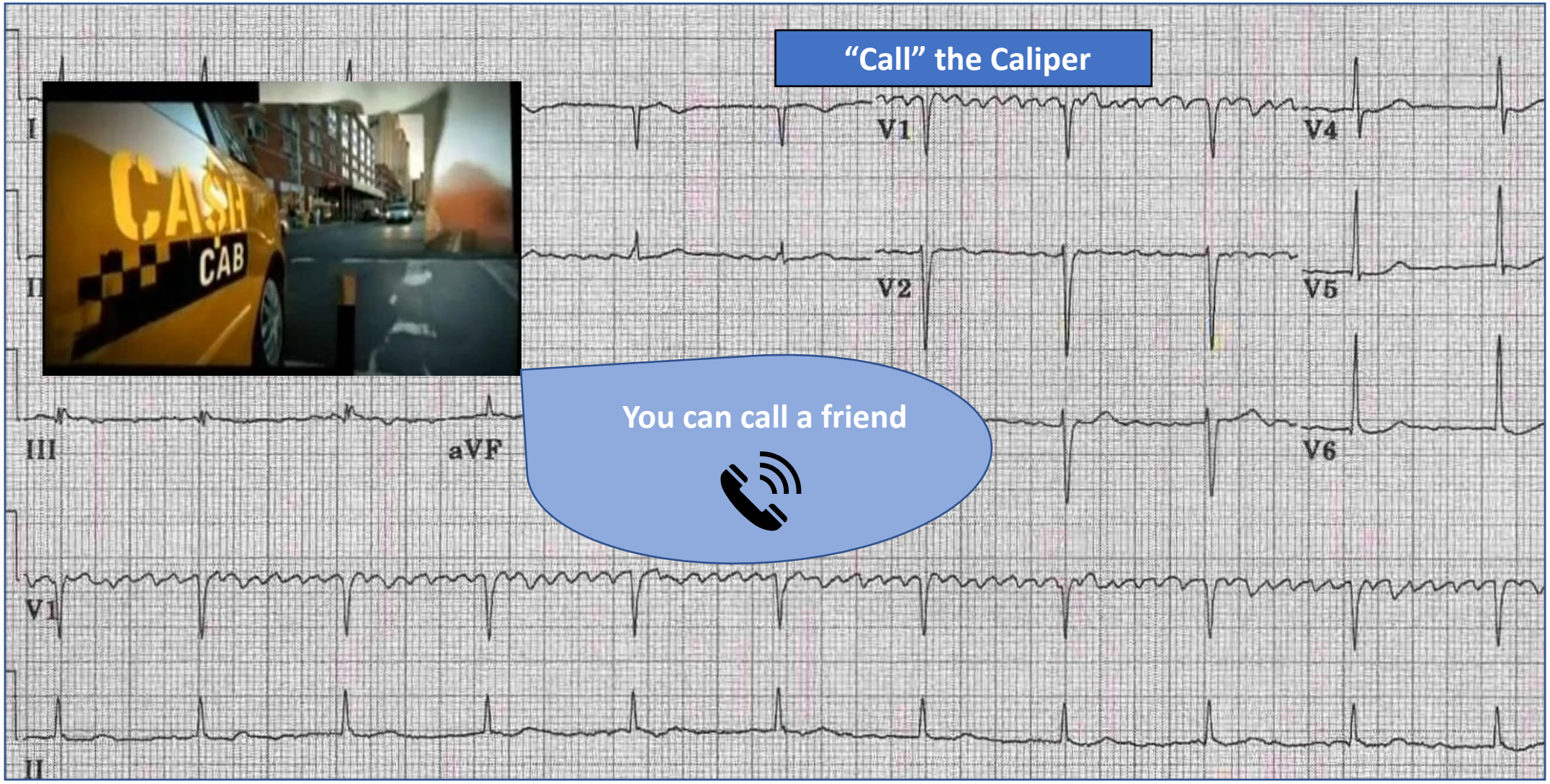
HR= 70 bpm



Worried? **A: Yes** **B: No** **C: Need more info**

62y F hx Afib

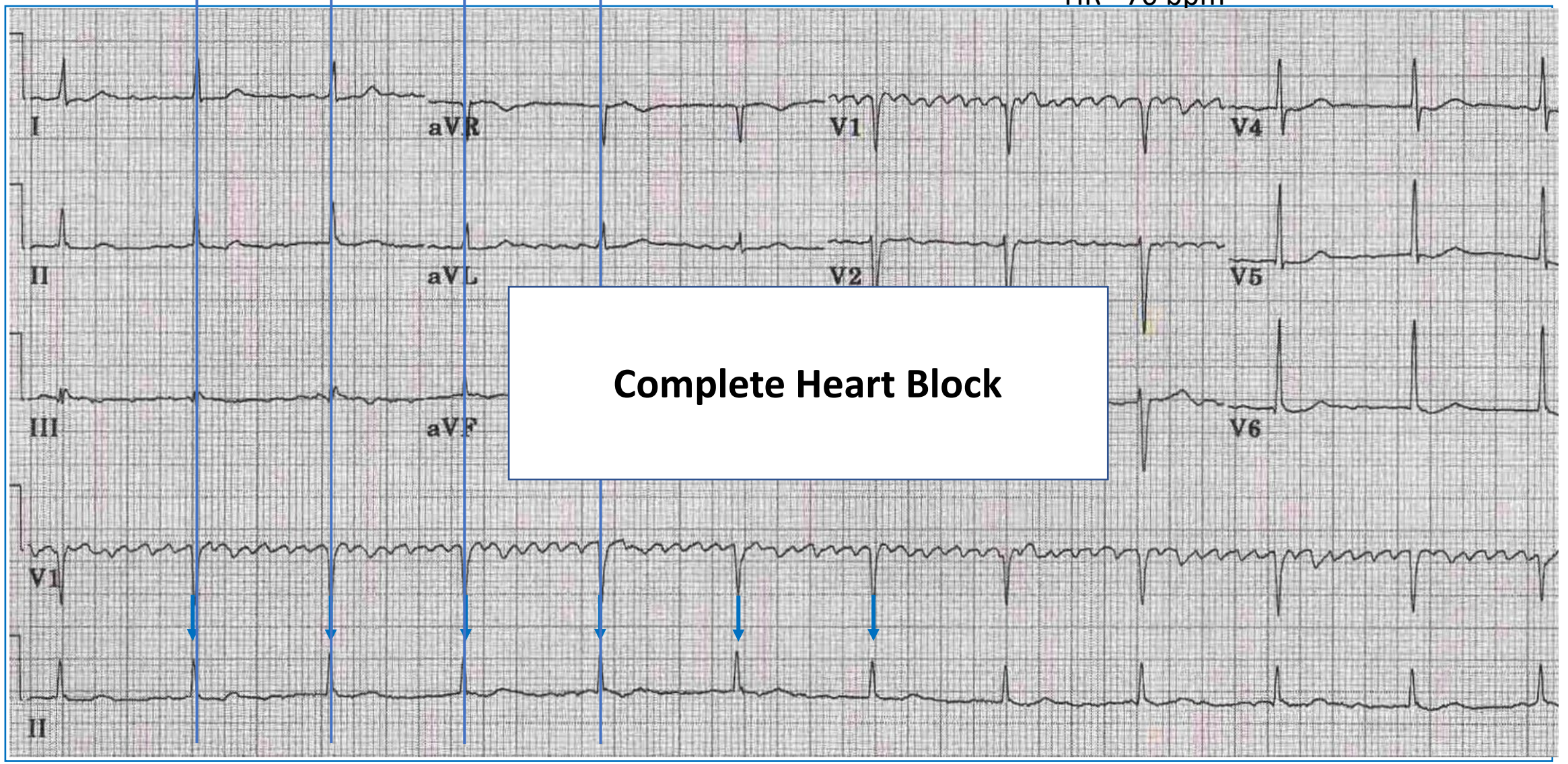
HR= 70 bpm



Worried? **A: Yes** **B: No** **C: Need more info**

62y F hx Afib,

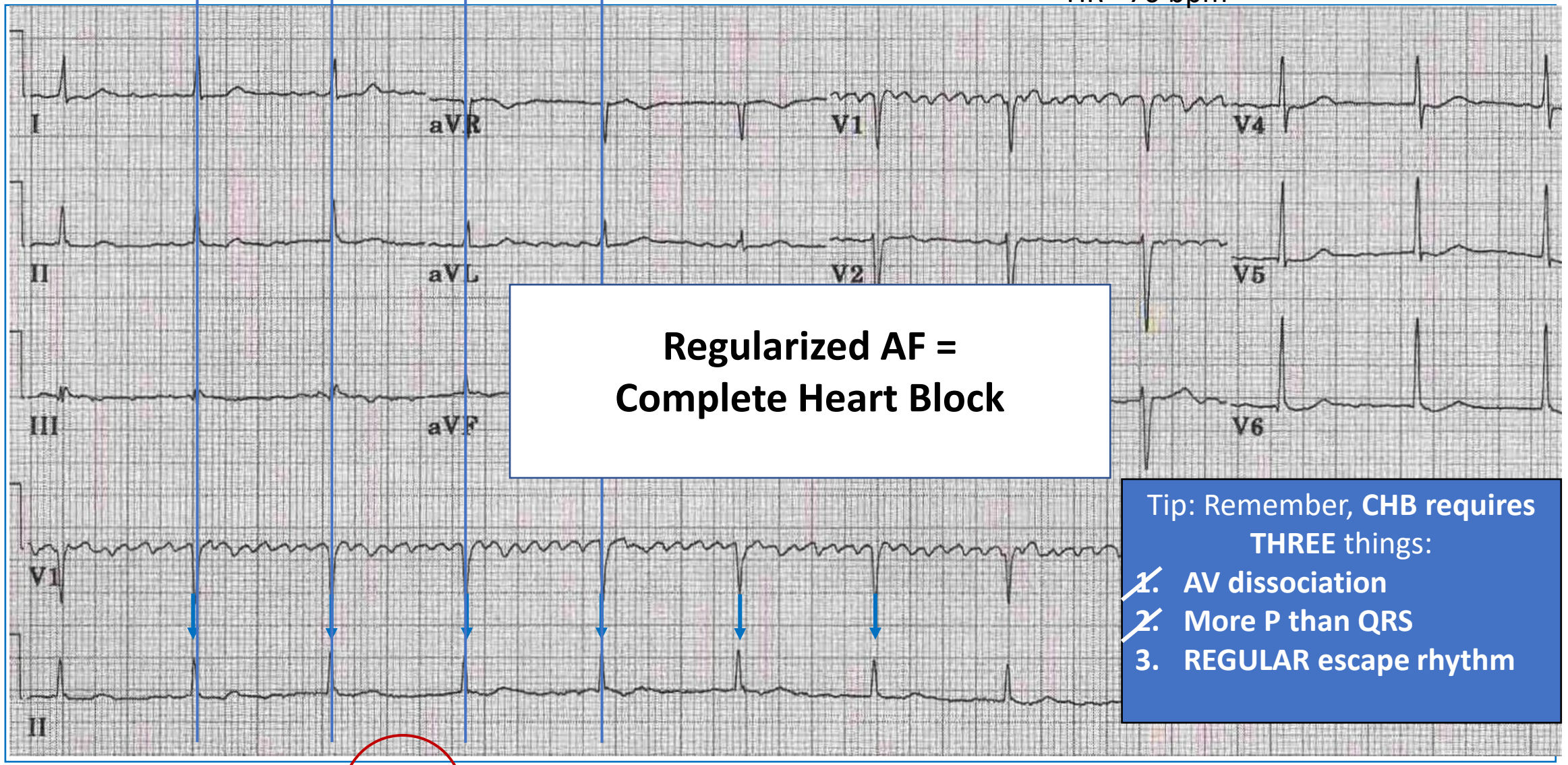
R-R → REGULAR
HR= 70 bpm



Complete Heart Block

62y F hx Afib,

R-R → REGULAR
HR= 70 bpm



Regularized AF =
Complete Heart Block

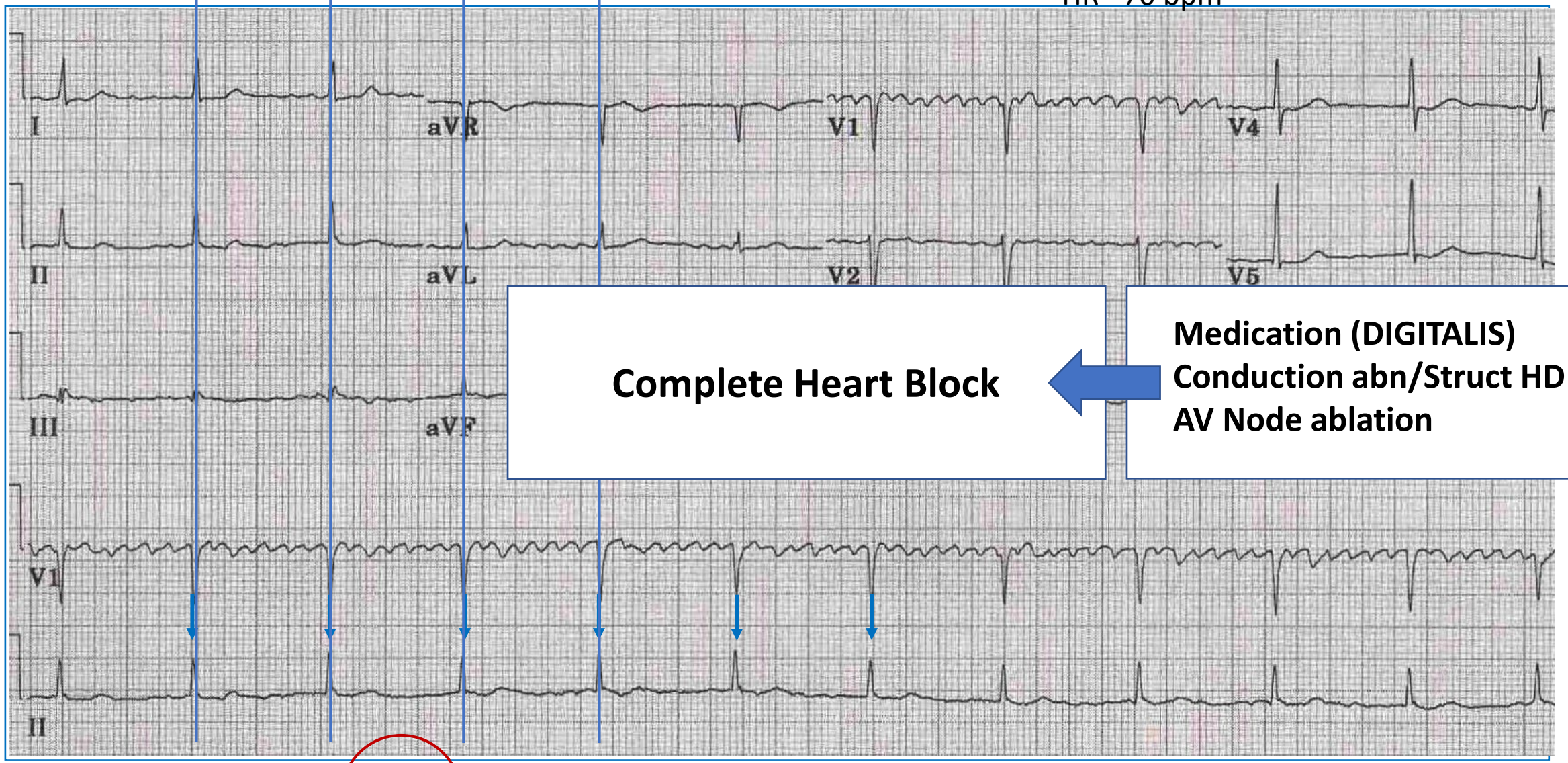
Tip: Remember, **CHB requires THREE** things:

1. ~~**AV dissociation**~~
2. ~~**More P than QRS**~~
3. **REGULAR escape rhythm**

Worried? **A: Yes** **B: No** **C: Need more info**

62y F hx Afib,

R-R → REGULAR
HR= 70 bpm



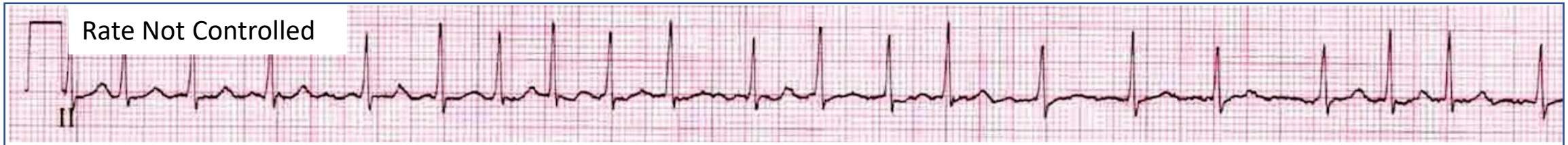
Complete Heart Block

Medication (DIGITALIS)
Conduction abn/Struct HD
AV Node ablation

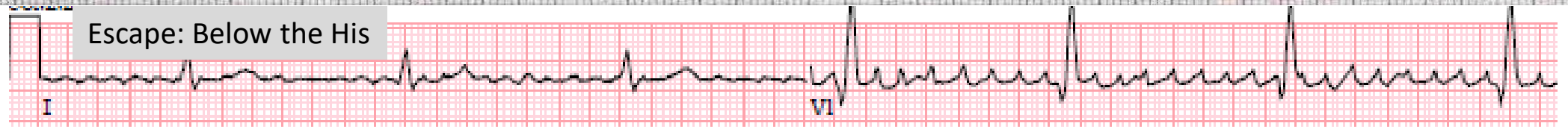
Worried? **A: Yes** **B: No** **C: Need more info**

Key learning points

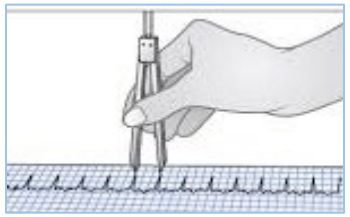
Atrial Fibrillation



QRS Irregular → **Conduction**



QRS Regular → **Complete Heart Block (escape rhythm)**



EKG Learning Points

1. Uncontrolled AF can cause Tachycardia induced Cardiomyopathy

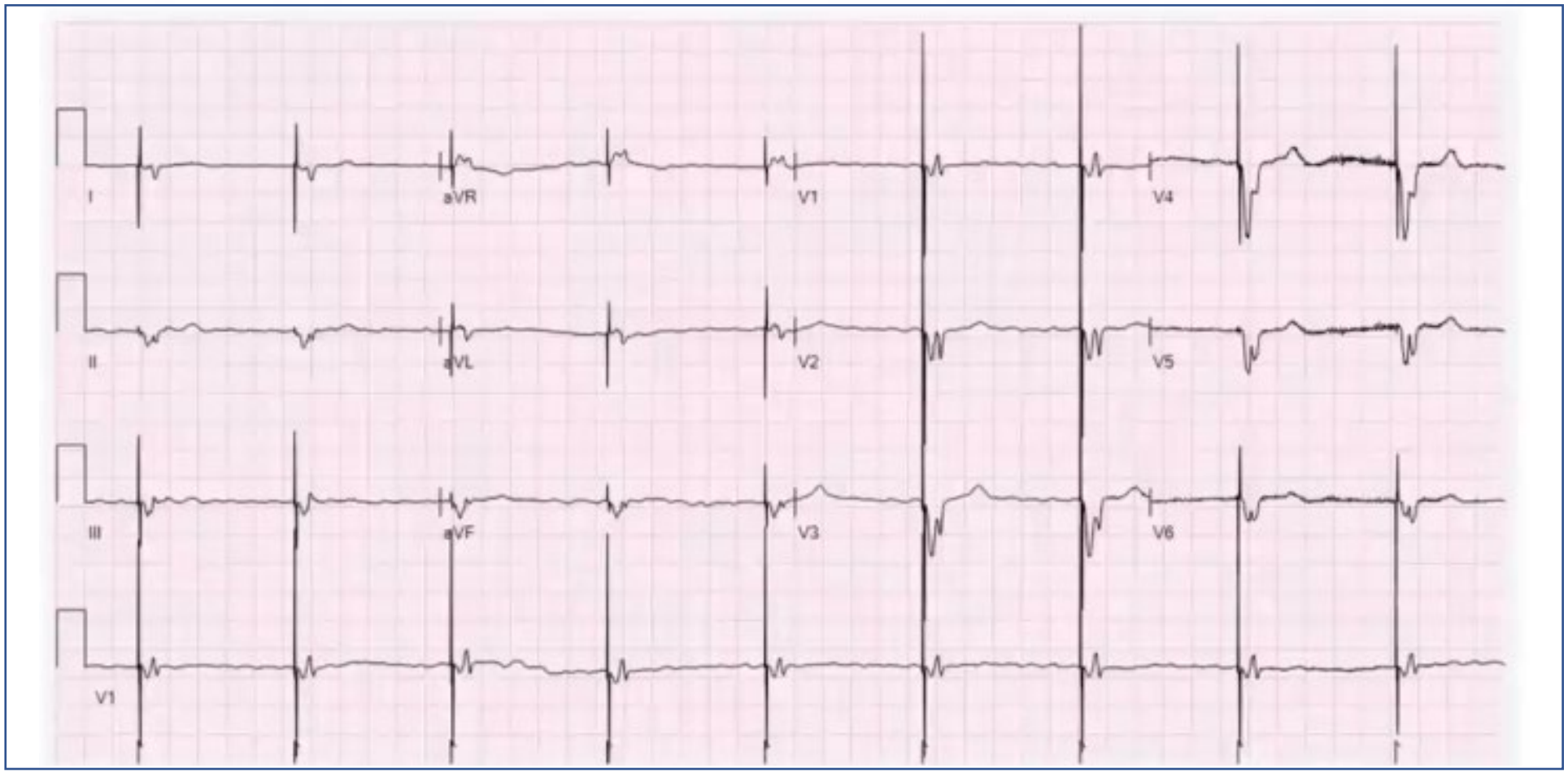
2. AF can present with Heart block. **Regularized AF is = CHB**

3. AF ablation:
   PVI (pulmonary vein isolation)
   Not to be mixed with AVNode ablation for AF (last resort)

Part 3

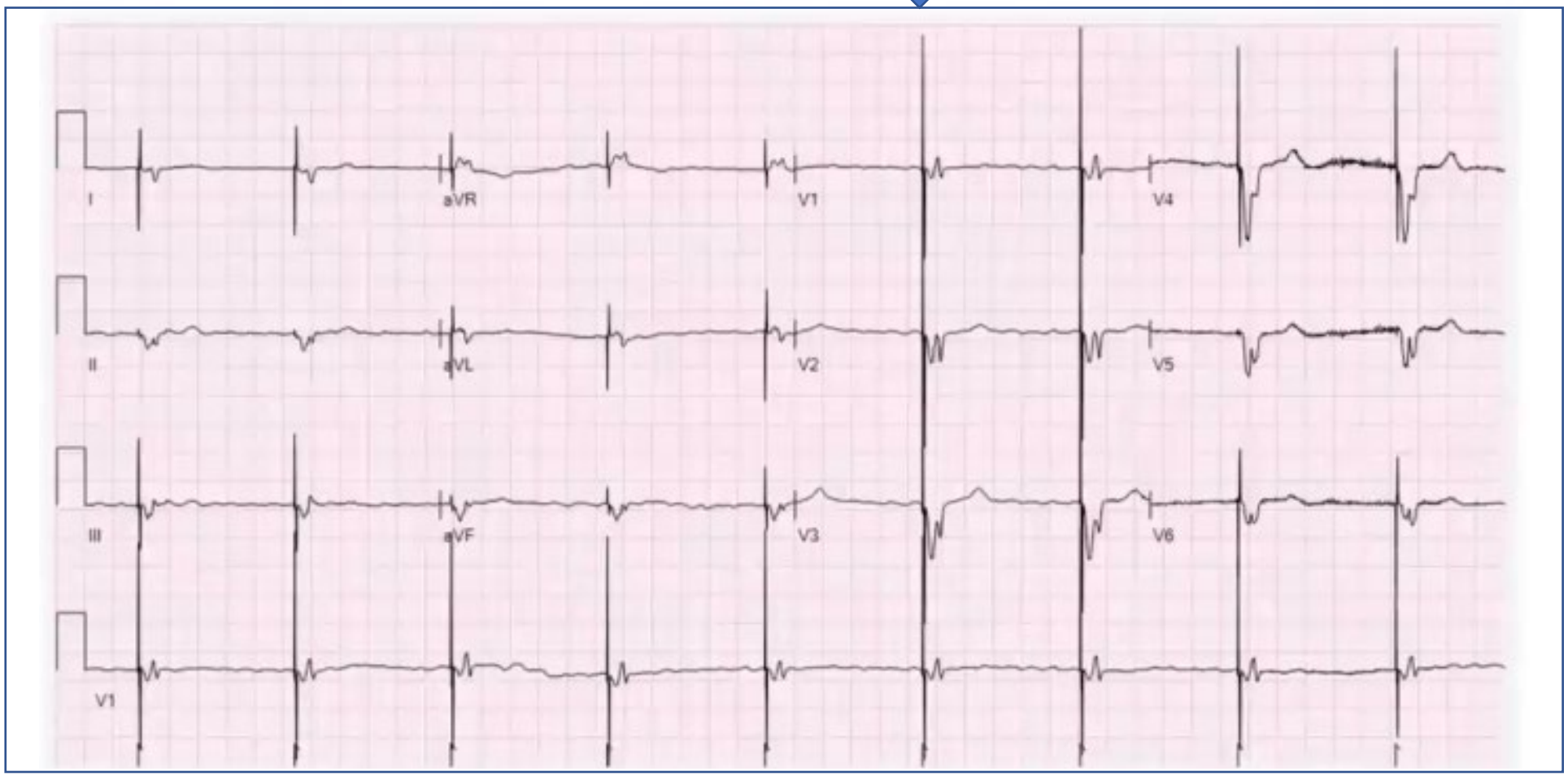
Case : 73y M no hx provided

What is the MIB code?



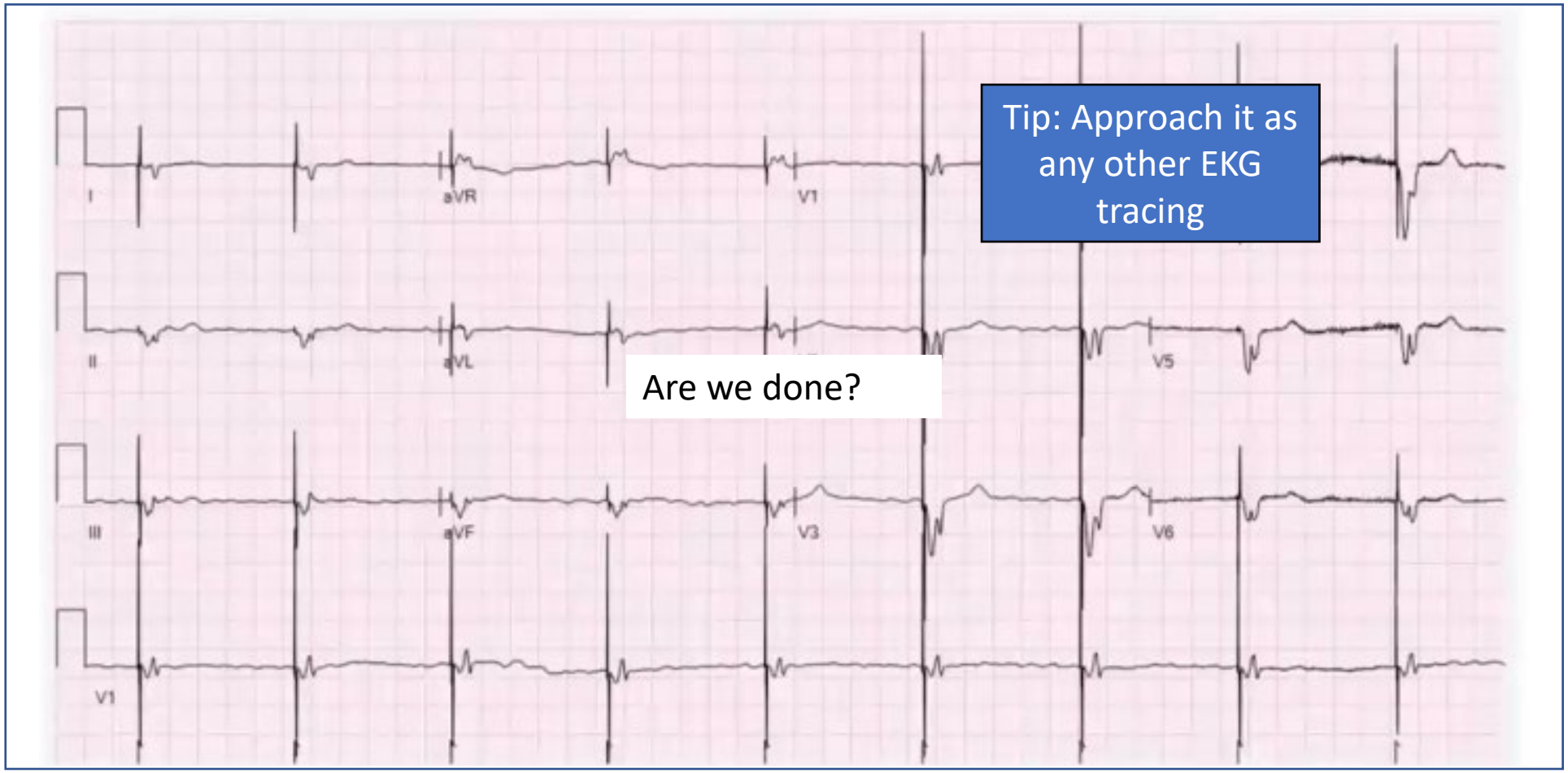
Case : 73y M no hx provided

What is the MIB code?



Case : 73y M no hx provided

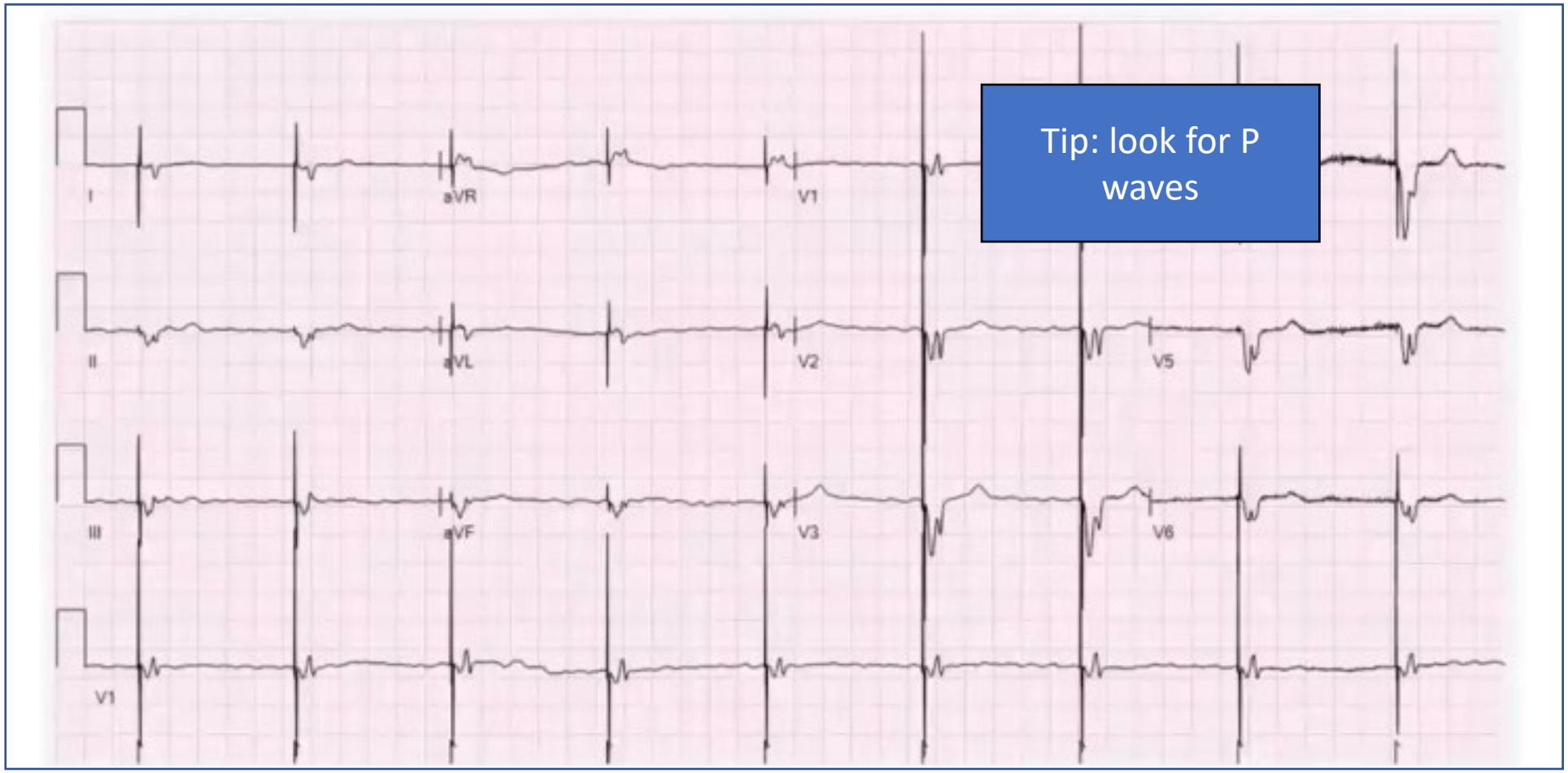
What is the MIB code? → 1 (PM)



1. Normal PM 2. Malfunction 3. Don't know

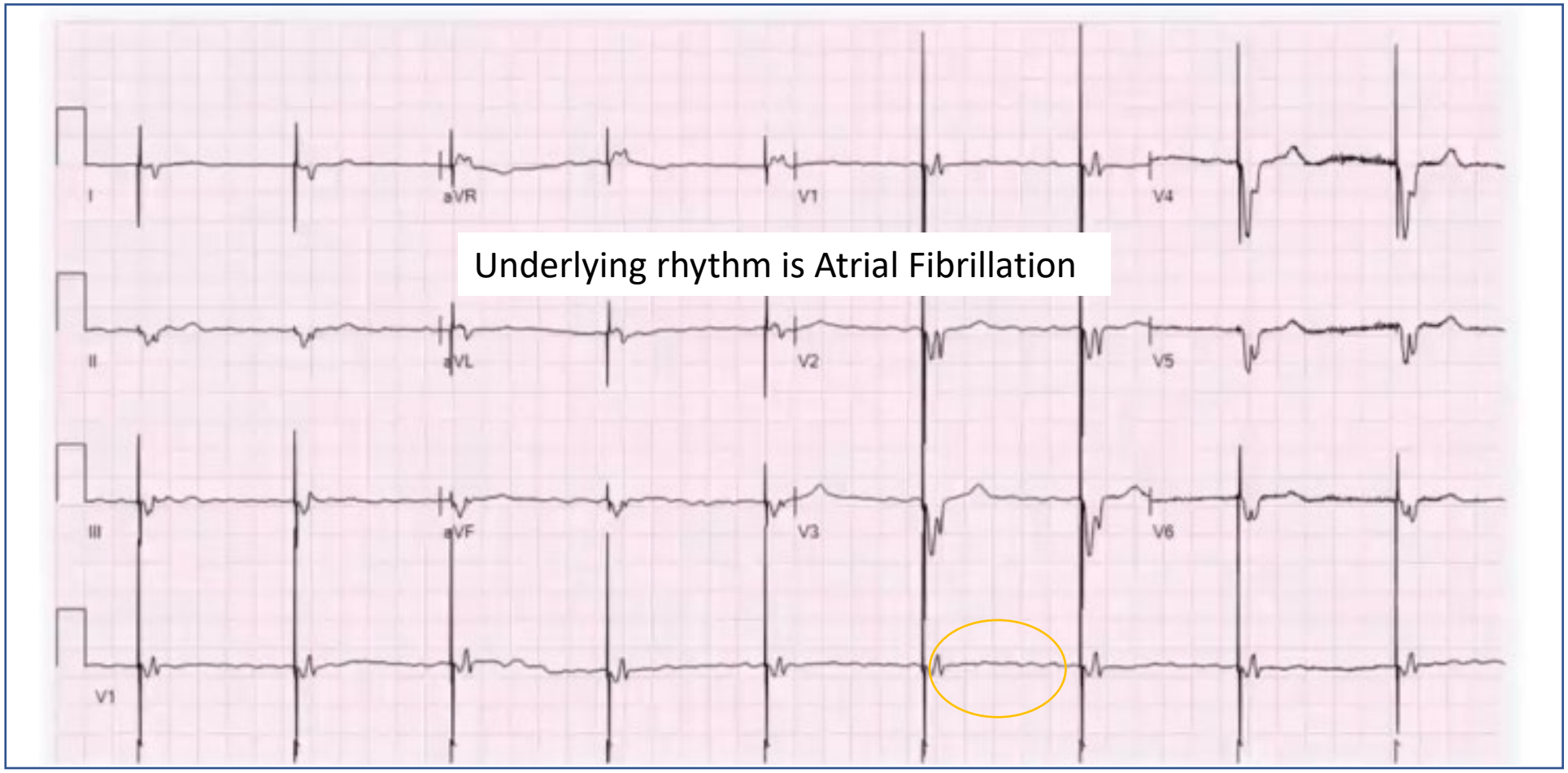
1. Dual chamber PM 2. Single chamber PM 3. Cannot tell

Case : 73y M no hx provided

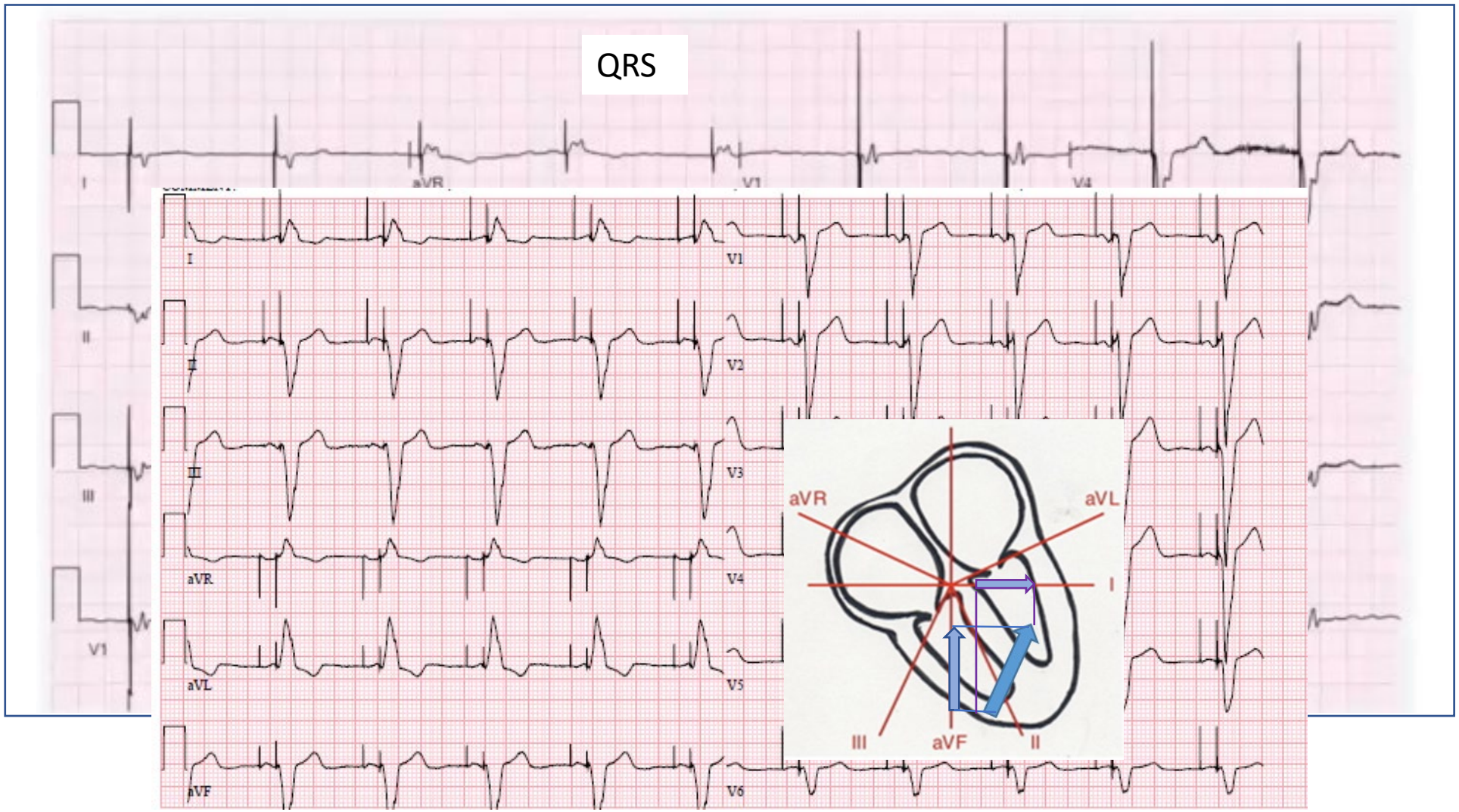


Case : 73y M no hx provided

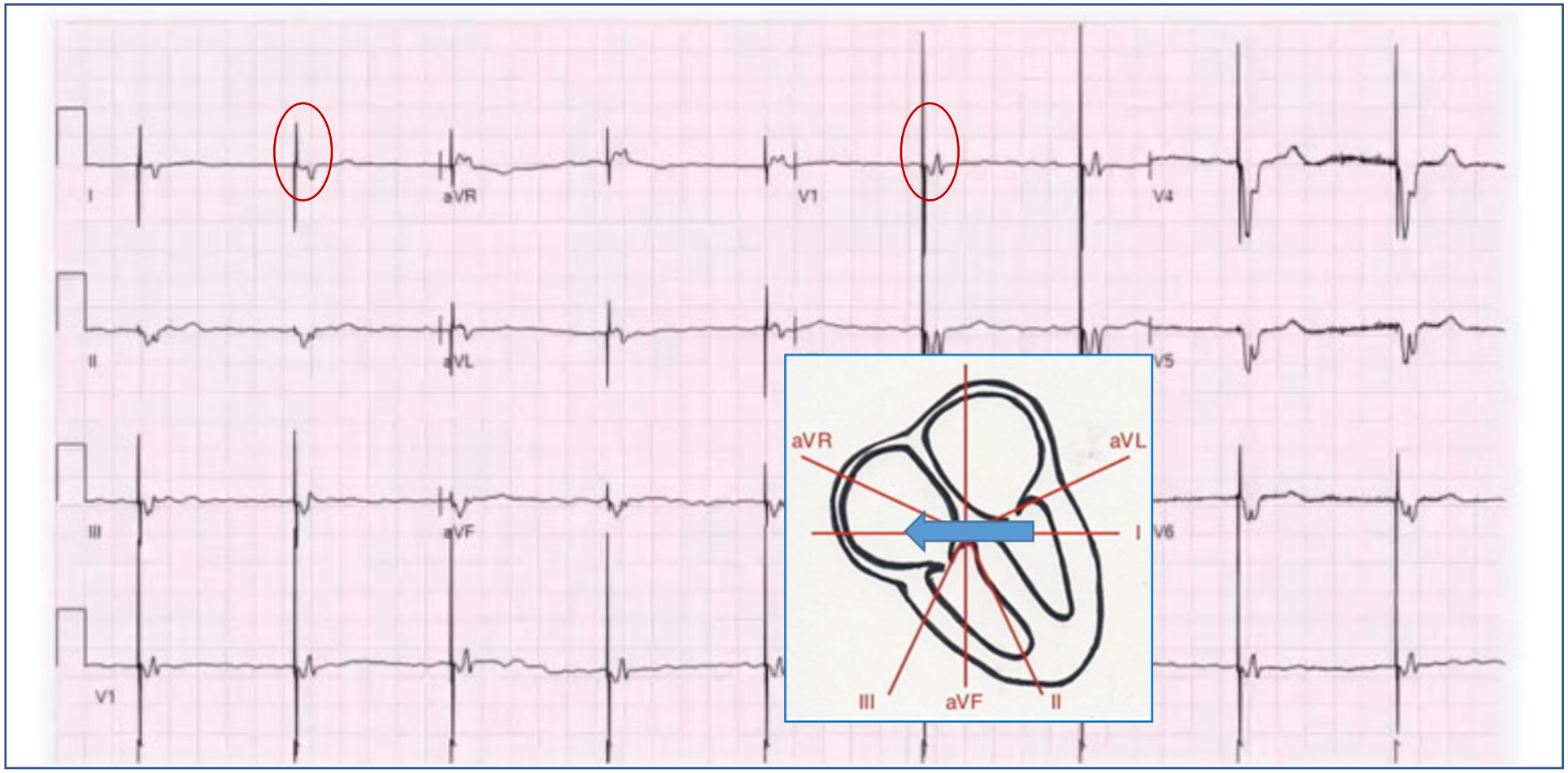
What is the MIB code? → 1,7



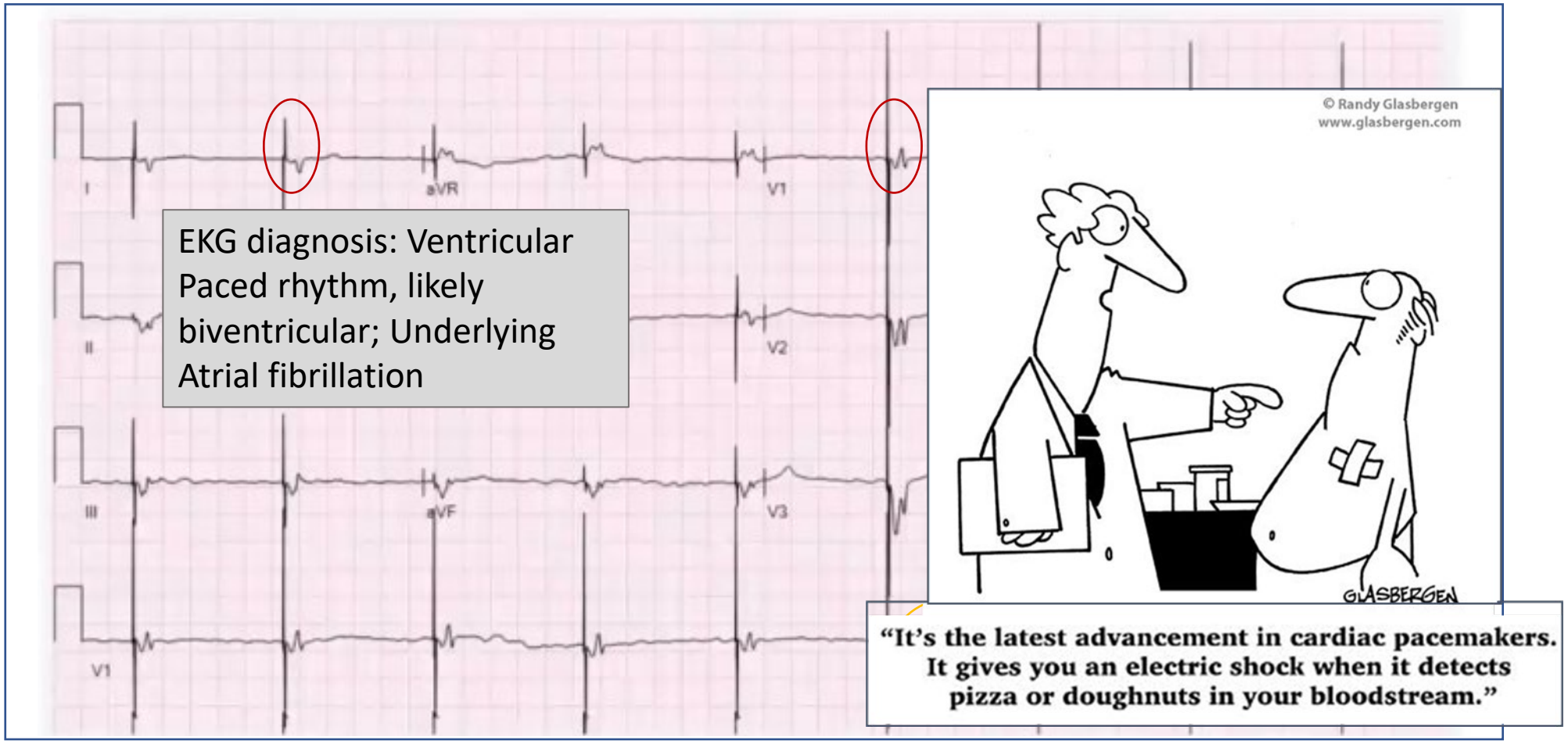
Case : 73y M no hx provided



Case : 73y M no hx provided



Case : 73y M no hx provided



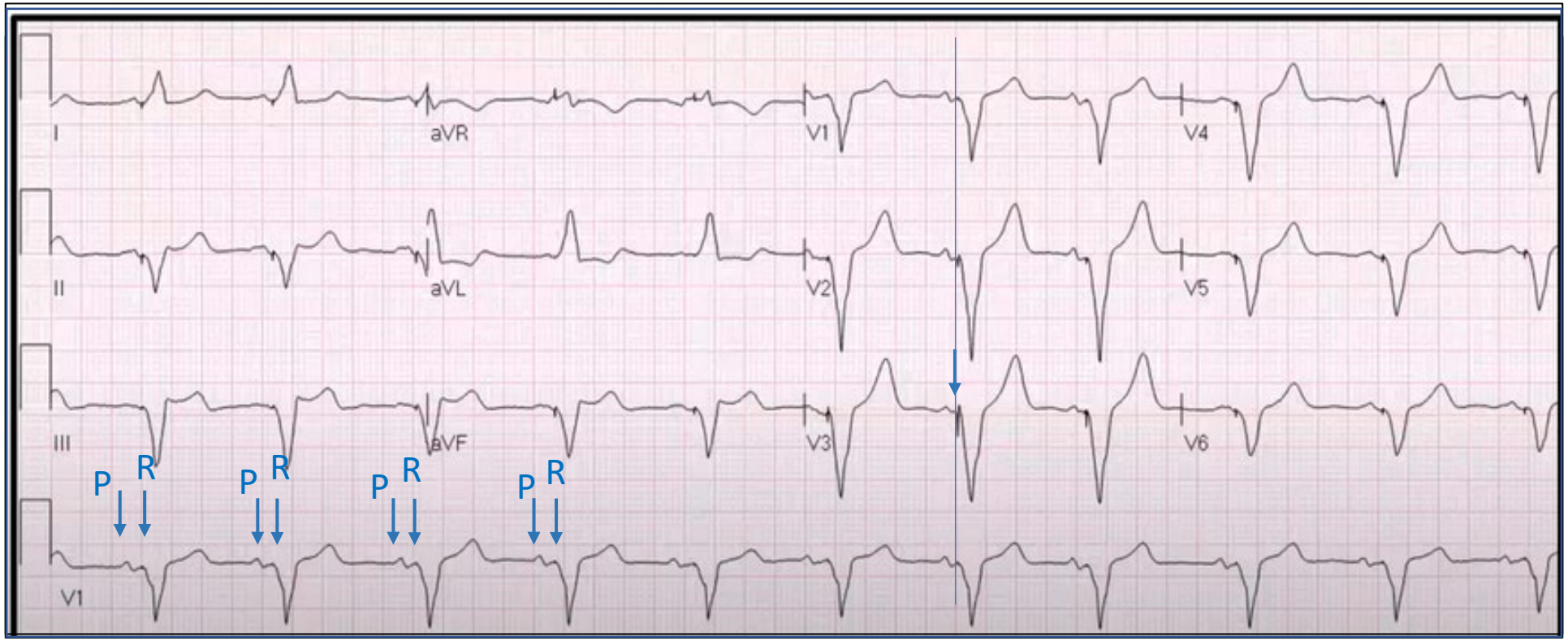
Case: 72y M Has a PM, no details

1. Dual chamber PM 2. Single chamber PM 3. Cannot tell

1. Normal PM 2. Malfunction 3. Don’t know

Case .. : 72y M

Has a PM, no details



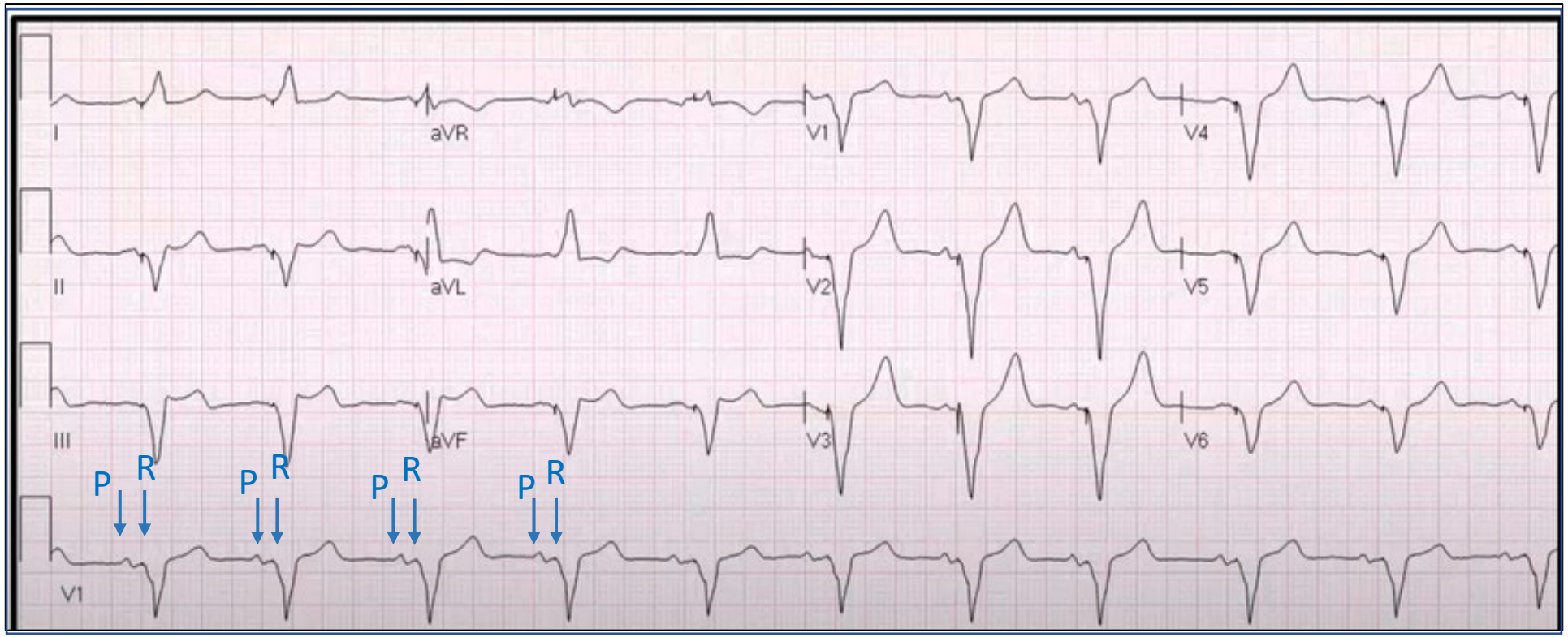
1. Dual chamber PM 2. Single chamber PM 3. Cannot tell

1. Normal 2. Malfunction 3. Don't know

CHRS/CCS Interpretation of ECGs Series

Case .. : 72y M

Has a PM, no details

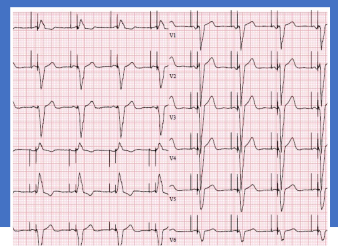


1. **Dual chamber PM** 2. Single chamber PM 3. Cannot tell

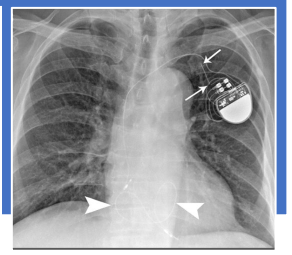
1. **Normal** 2. Malfunction 3. Don't know

APPROACH to PM / EKG

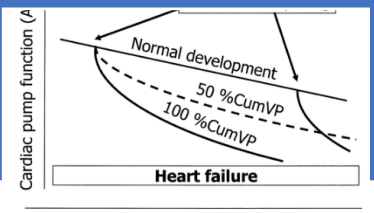
- Approach as any other EKGs
- Understand basics and what you see
- Recognizes 'red flags' (malfunction or 'higher risk' group)



- **Long-term Morbidity and mortality** implication of the device implant **hardware** → **complications**
- =>Evolution of PMs



- **Morbidity and mortality** implication / complications of **Programming**/Pacing) ie.→ AF , HF
- => Evolution

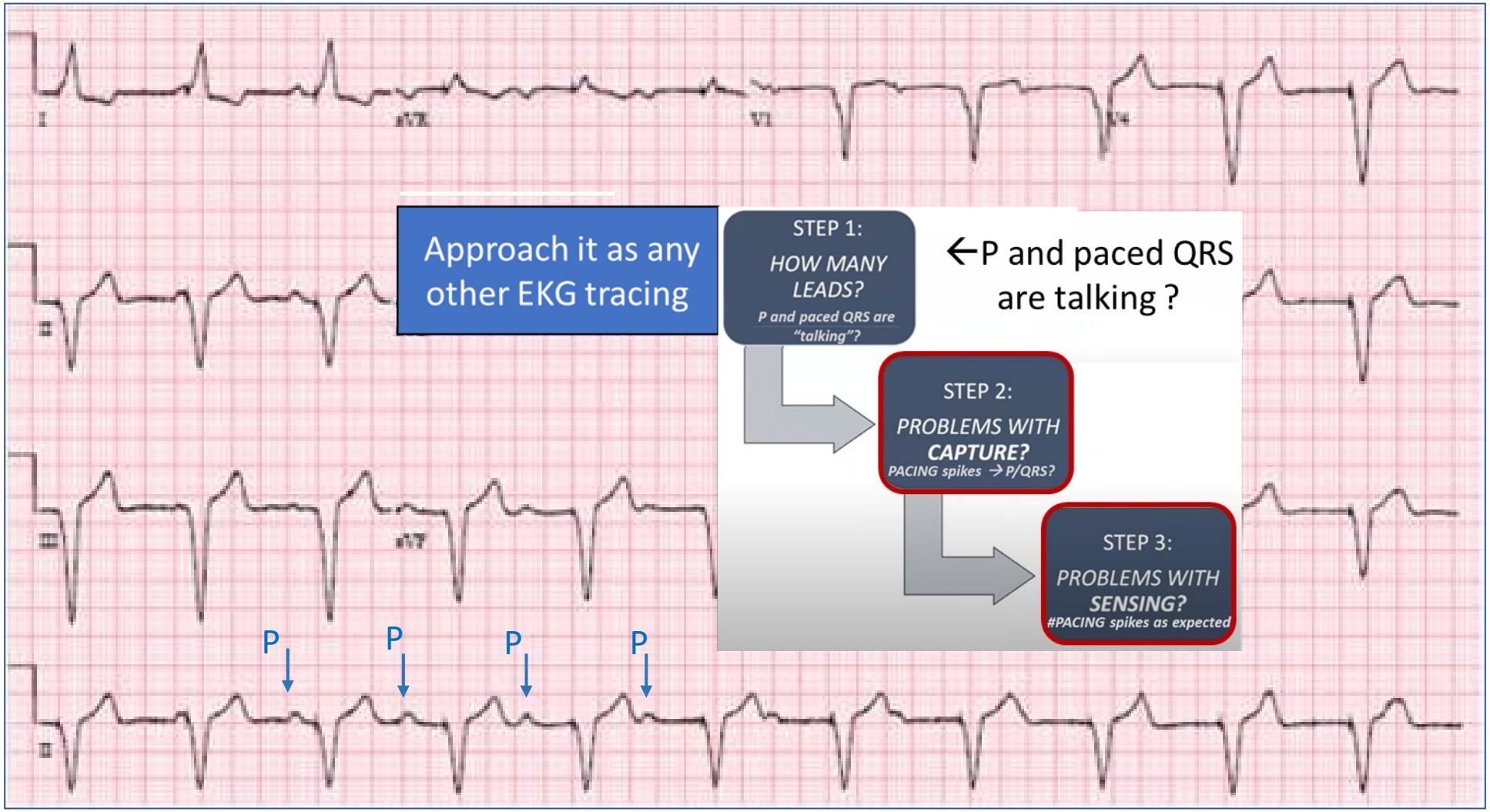


http://dx.doi.org/10.1016/j.jacc.2016.10.061

Sharma, Heart Rhythm, 2005; MADIT JCE 2005, Sweeney JACC 2006

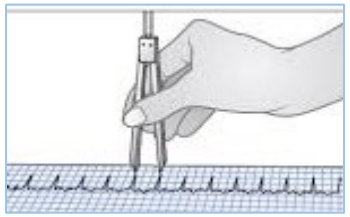
60 Y M hx PMx5y

NOTE

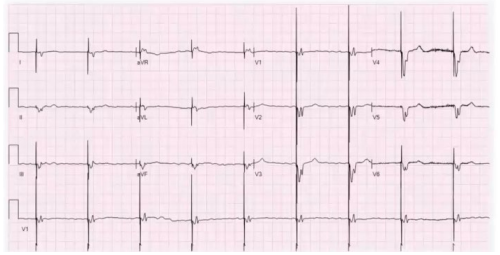


1. **Normal** 2. Malfunction 3. Don't know

1. Dual chamber PM 2. **Single chamber PM** 3. Cannot tell



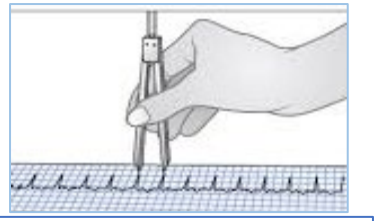
EKG Learning Points



1. Approach Paced EKGs as any other rhythm EKG

2. Don’t forget to check underlying rhythm and paced QRS configuration

Summary of EKG Learning Points



1. Break down complex EKG into smaller manageable parts

2. Look for hidden P waves
   - in ST /T waves/QRS
   - Look halfway in between P waves

3. Use tools: calipers, magnification etc
   → Check P-P/R-R/PR and if 'talking'
   → Work on a Hypothesis

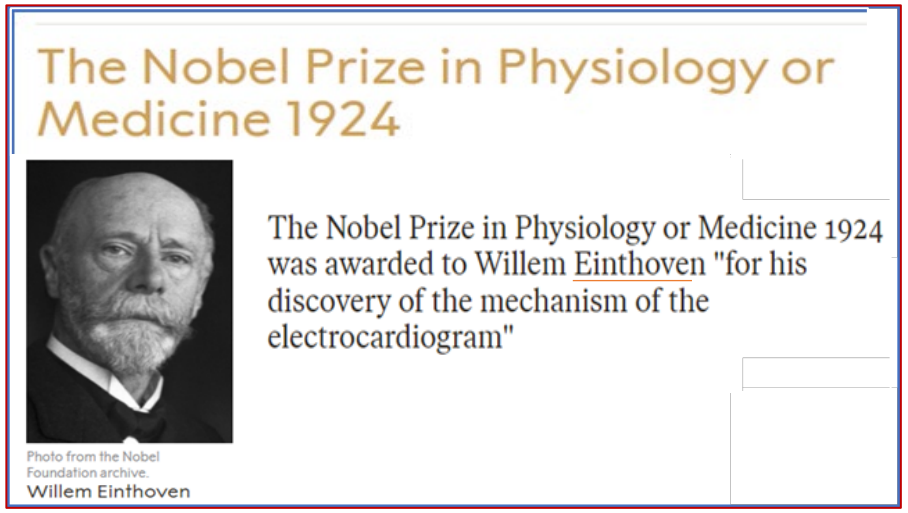
→ Pattern recognition vs 'inductive/deductive' mechanism

4. Wide QRS beat/tachycardia
- Look at the transitions (onset, end)
- Recognize Typical BBB

5. Heart Blocks:
   - Prognosis is based on the Level of block → infraNodal: high risk
   - Symptoms are Red flags
   - Look at first and last PR's (Mobitz I vs II
   - QRS is regular in CHB

6. Paced Rhythm
- Approach it as a usual rhythm EKG
- Don't forget QRS morphology and underlying rhythm

Unlocked potentials in EKG innovation



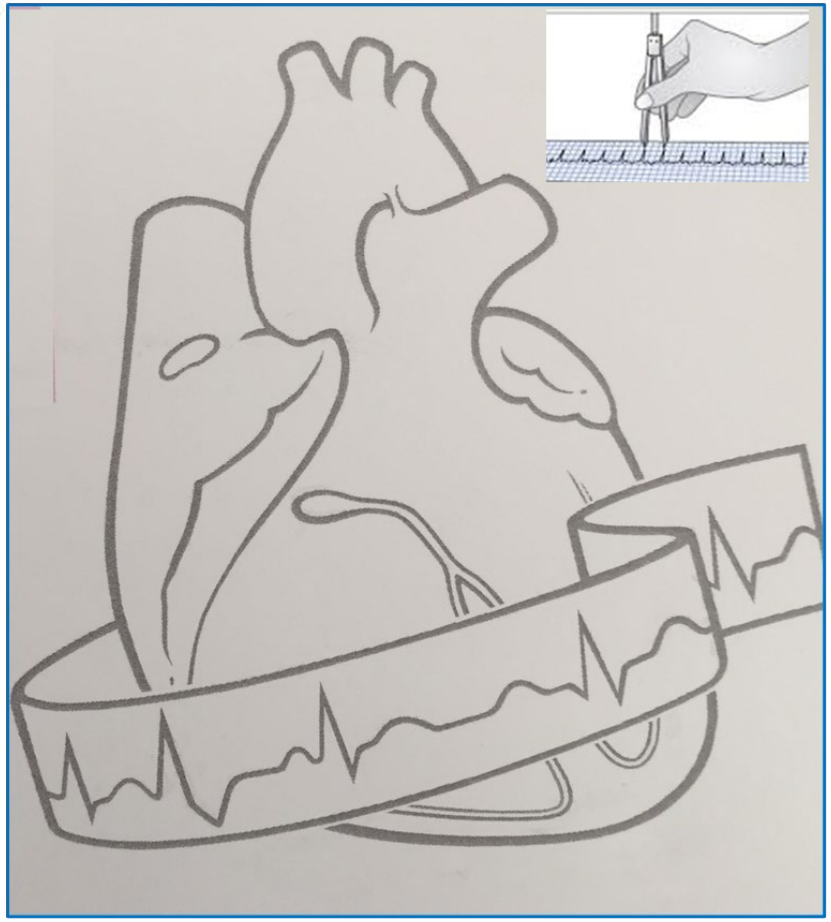
66 yr		Vent. rate	39	BPM	Marked sinus bradycardia with 1st degree A-V block
Male	Caucasian	PR interval	266	ms	Possible Left atrial enlargement
70in	302lb	QRS duration	96	ms	T wave abnormality, consider lateral ischemia
Room:		QT/QTc	512/412	ms	Abnormal ECG
Loc:207		P-R-T axes	36 7	81	

← Computer EKG reading

AI enhanced CVD management:

Future of EKG reading →

Estimated age:	37.3 yrs
Probability male:	98.6%
Estimated EF:	58.1%
Probability of low EF:	0.3%
Probability of undetected AF:	0.2%
Probability of HCM:	0.1%
Probability of aortic stenosis:	<0.01
Probability of cardiac amyloidosis:	0.02%



Thank you!