

MINICORSI

ROMA, 24 Giugno 2026

ECG nell'Atleta

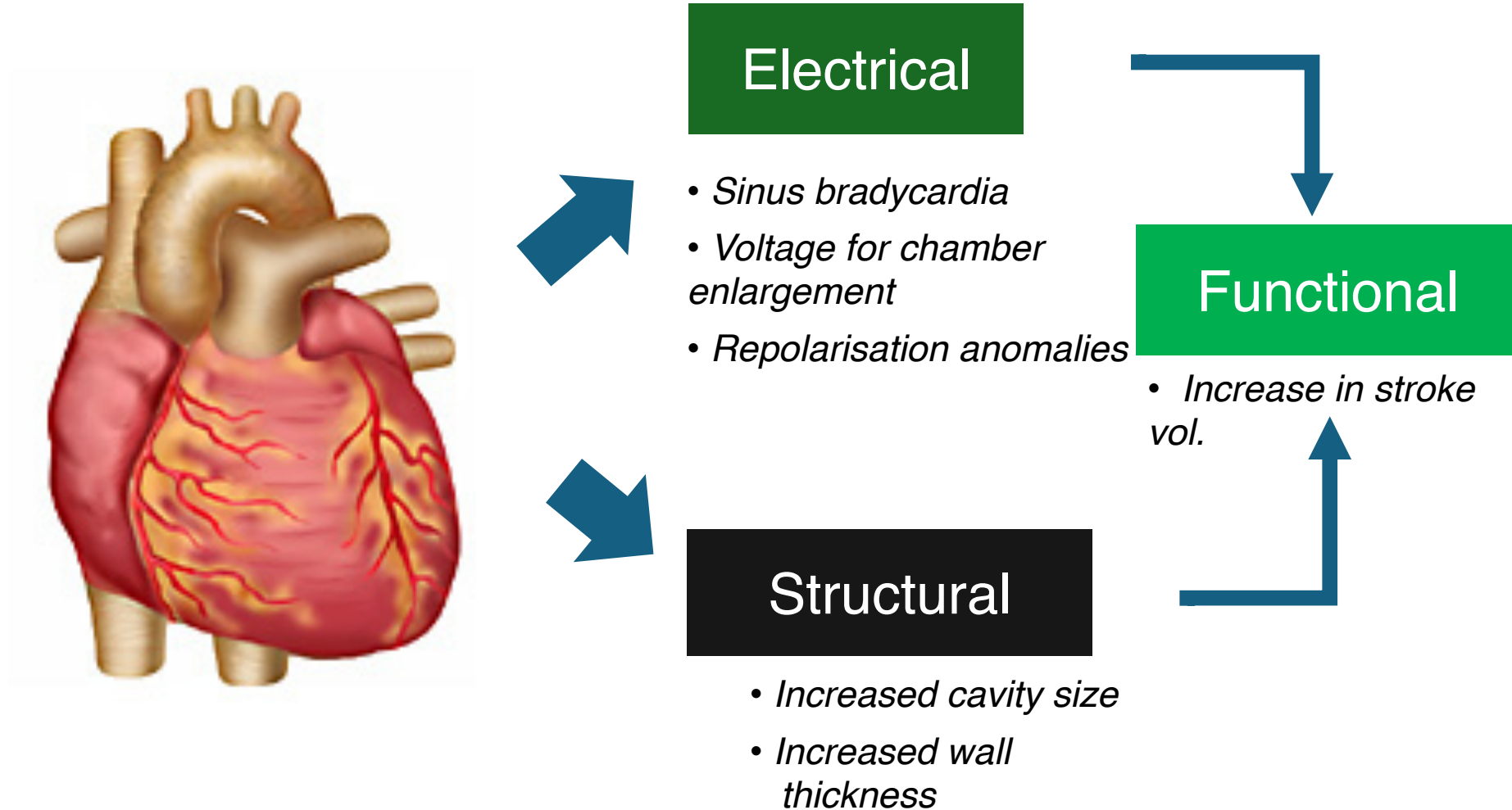
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SEDE DEI LAVORI

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Via Giorgio Zoega 59, Roma

Cardiac Adaptation to Exercise – The “Athlete’s Heart”



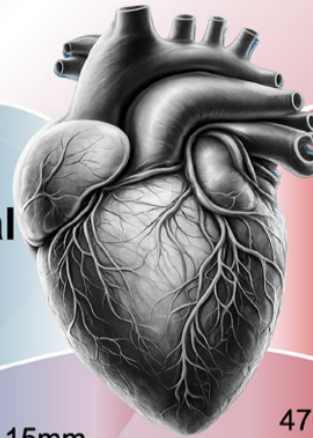
Physiological Adaptation

Features favoring physiology

- Isolated prominent QRS voltages
- Proportional chamber enlargement
- Mild symmetric LVH
- Normal/preserved systolic function
- Normal contractile response on exercise

Grey Zone Phenotypes

Assessing The Athletes Heart



Structural Overlap

LVH 13-15mm

LV/RV Dilatation

Electrical Overlap

QTc
470-500ms
Brugada pattern type I and II

Frequent PVCs
TWI V1-V3

Grey Zone

Cardiac Disease

Features favoring pathology

- TWI
- Asymmetrical hypertrophy
- Disproportional enlargement of RV or LV
- LVEF < 45% with impaired contractile reserve
- Uncommon PVCs/arrhythmias
- Presence of LGE

HCM

- Symptoms; FH
- Inferolateral TWI
- Pathological Q waves
- ST depression
- Impaired diastolic dysfunction
- VT,
- Low peak VO₂ on exercise
- Gene +ve



DCM

- Symptoms; Family history
- LBBB,
- VT
- Mid-wall LGE
- ↓VO₂ or failure to ↑LVEF on exercise
- Gene +ve



Channelopathies

Long QT, Brugada, CPVT

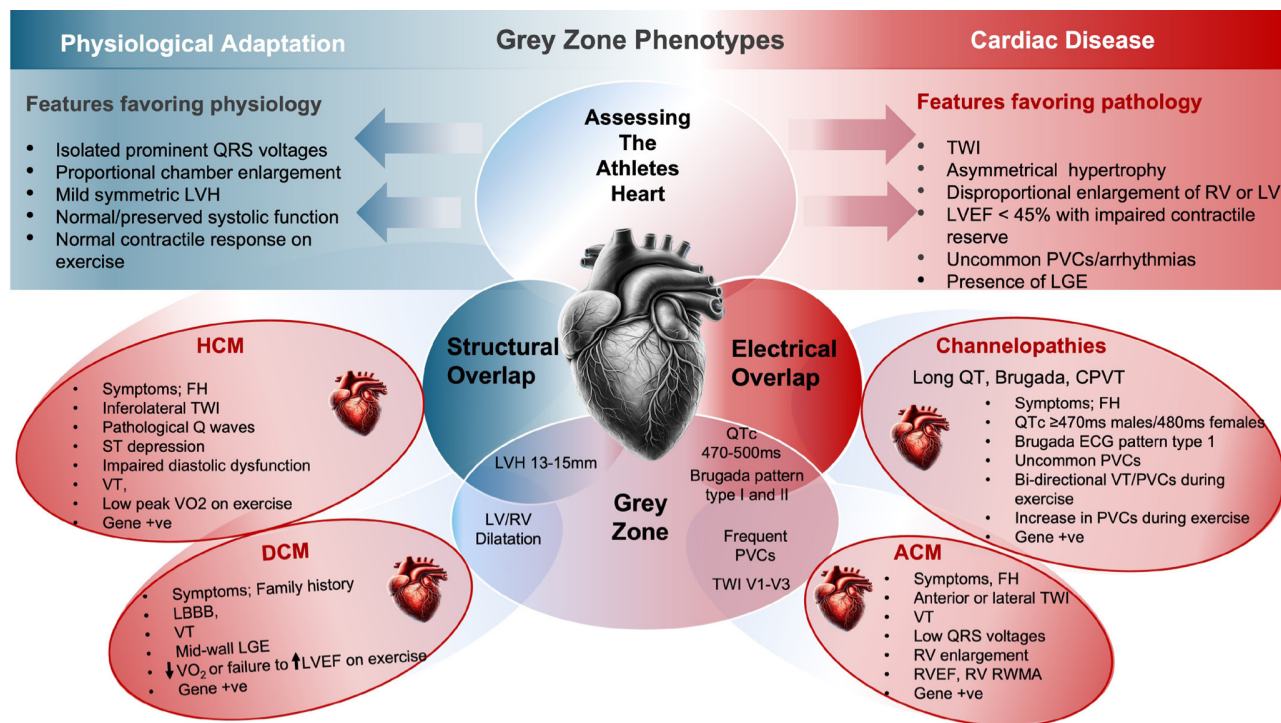


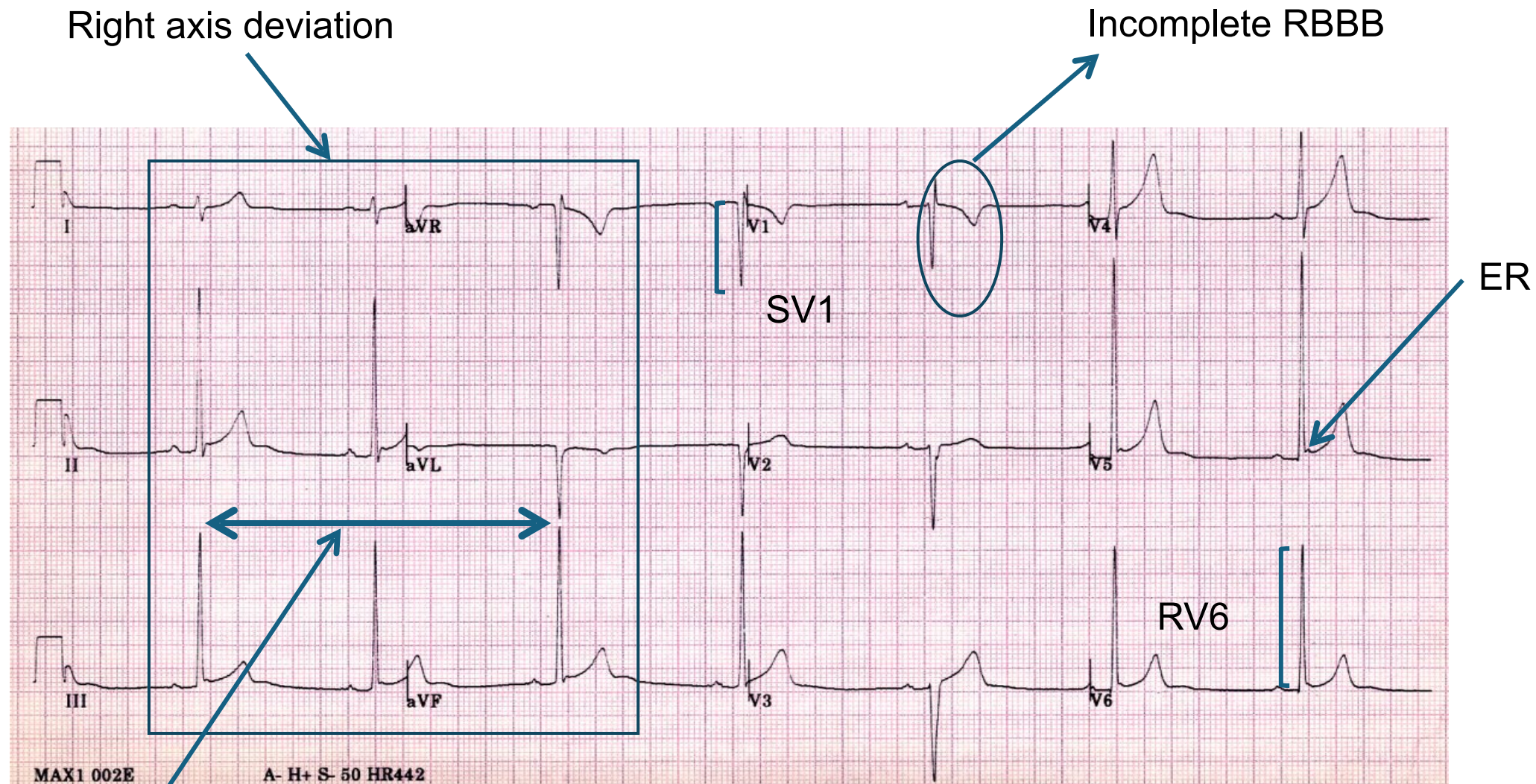
- Symptoms; FH
- QTc ≥470ms males/480ms females
- Brugada ECG pattern type 1
- Uncommon PVCs
- Bi-directional VT/PVCs during exercise
- Increase in PVCs during exercise
- Gene +ve

ACM

- Symptoms, FH
- Anterior or lateral TWI
- VT
- Low QRS voltages
- RV enlargement
- RVEF, RV RWMA
- Gene +ve



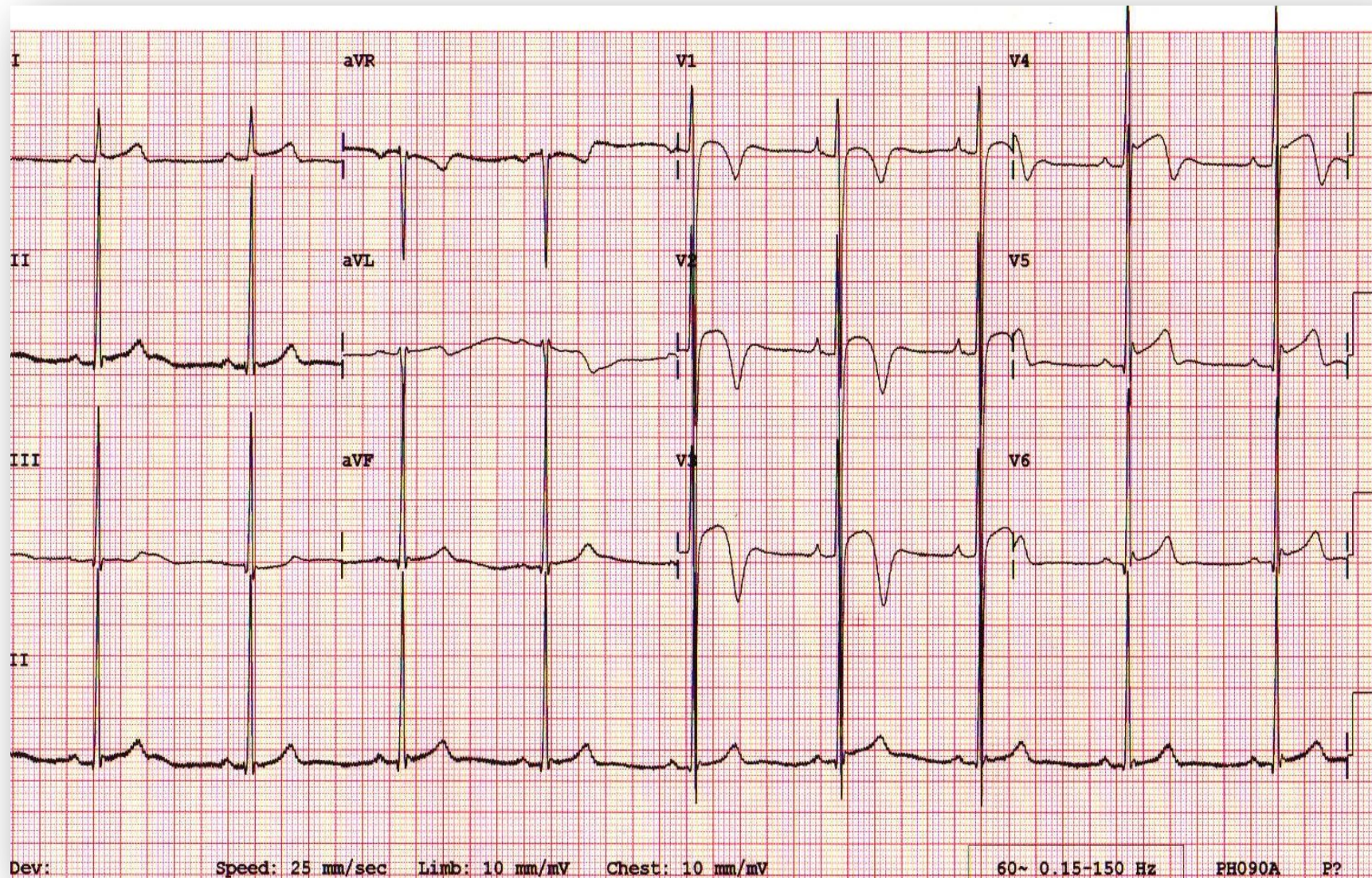




Sinus bradycardia 45 bpm

$SV1 + RV6 > 3.5 \text{ mV} = \text{LVH}$

Can this be attributed to exercise?



Normal ECG Findings

- Increased QRS voltage for LVH or RVH
- Incomplete RBBB
- Early repolarization/ST segment elevation
- **ST elevation followed by T wave inversion V1-V4 in black athletes**
- T wave inversion V1-V3 < age 16 years
- Sinus bradycardia or arrhythmia
- Ectopic atrial or junctional rhythm
- 1° AV block
- Mobitz Type I 2° AV block

Abnormal ECG Findings

- T wave inversion
- ST segment depression
- Pathologic Q waves
- Complete LBBB
- QRS ≥ 140 ms duration
- Epsilon wave
- Ventricular pre-excitation
- Prolonged QT interval
- Brugada Type 1 pattern
- Profound sinus bradycardia < 30 bpm
- PR interval ≥ 400 ms
- Mobitz Type II 2° AV block
- 3° AV block
- ≥ 2 PVCs
- Atrial tachyarrhythmias
- Ventricular arrhythmias

Borderline ECG Findings

- Left axis deviation
- Left atrial enlargement
- Right axis deviation
- Right atrial enlargement
- Complete RBBB

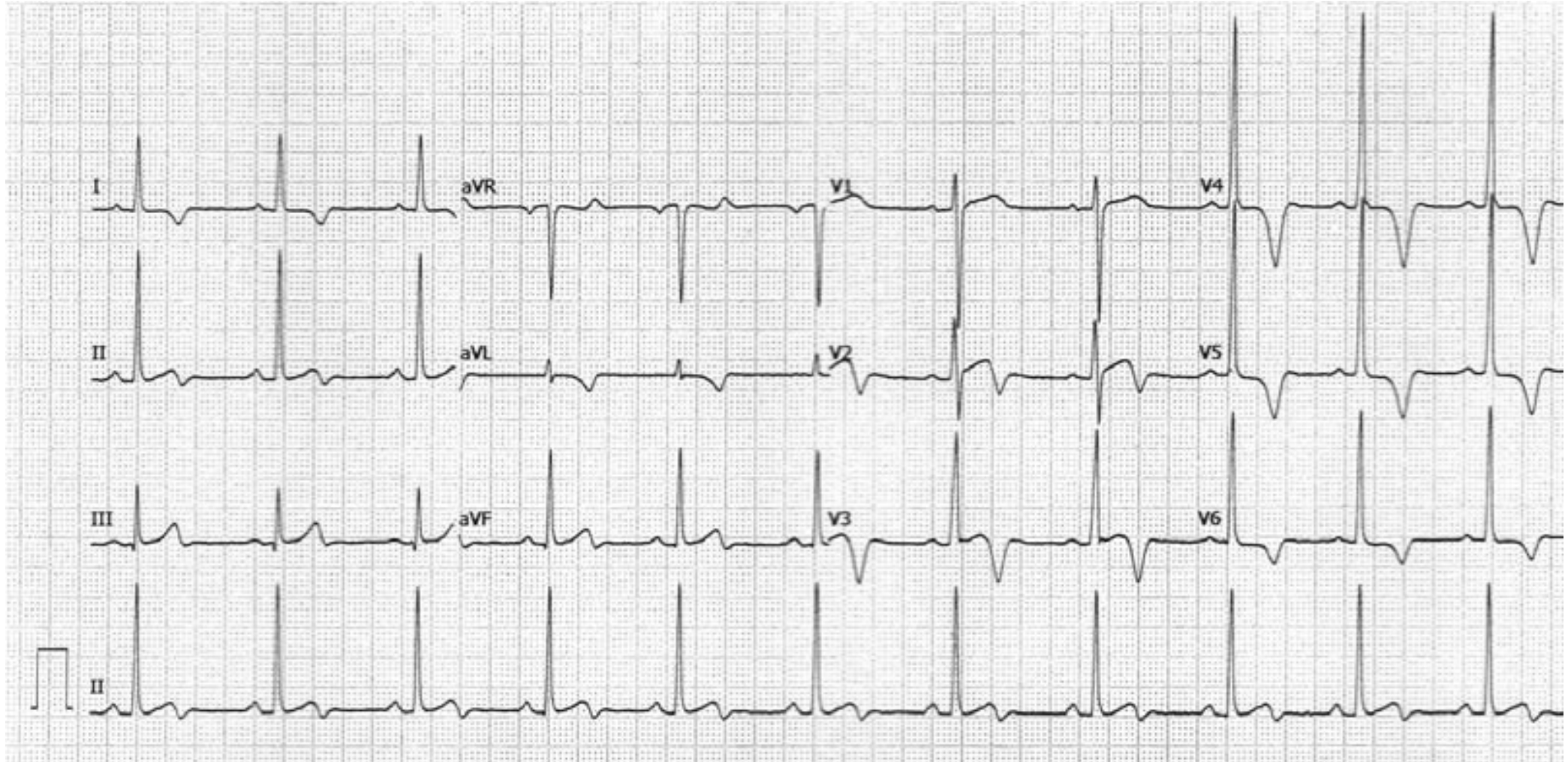
No further evaluation required
in asymptomatic athletes with no family history of inherited cardiac disease or SCD

In isolation

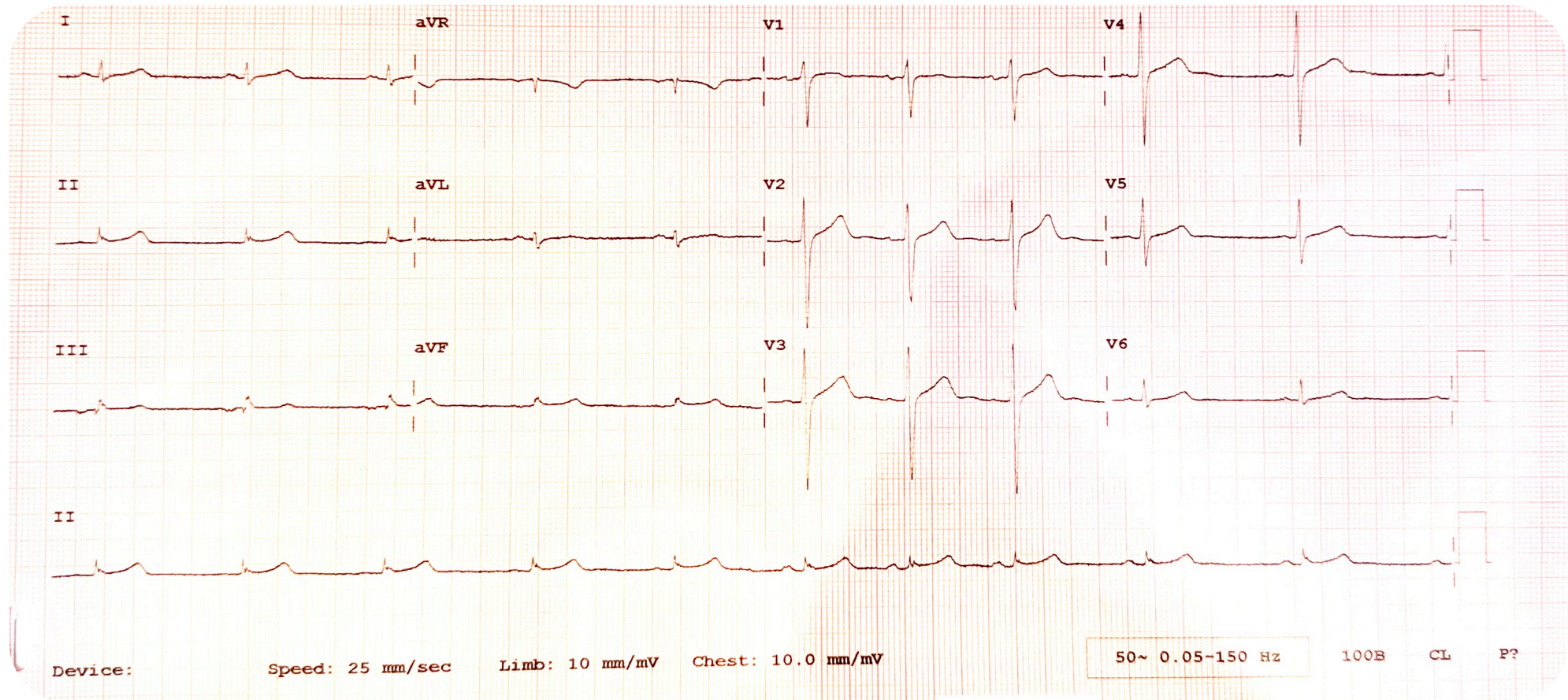
2 or more

Further evaluation required
to investigate for pathologic cardiovascular disorders associated with SCD in athletes

Can this be attributed to exercise?



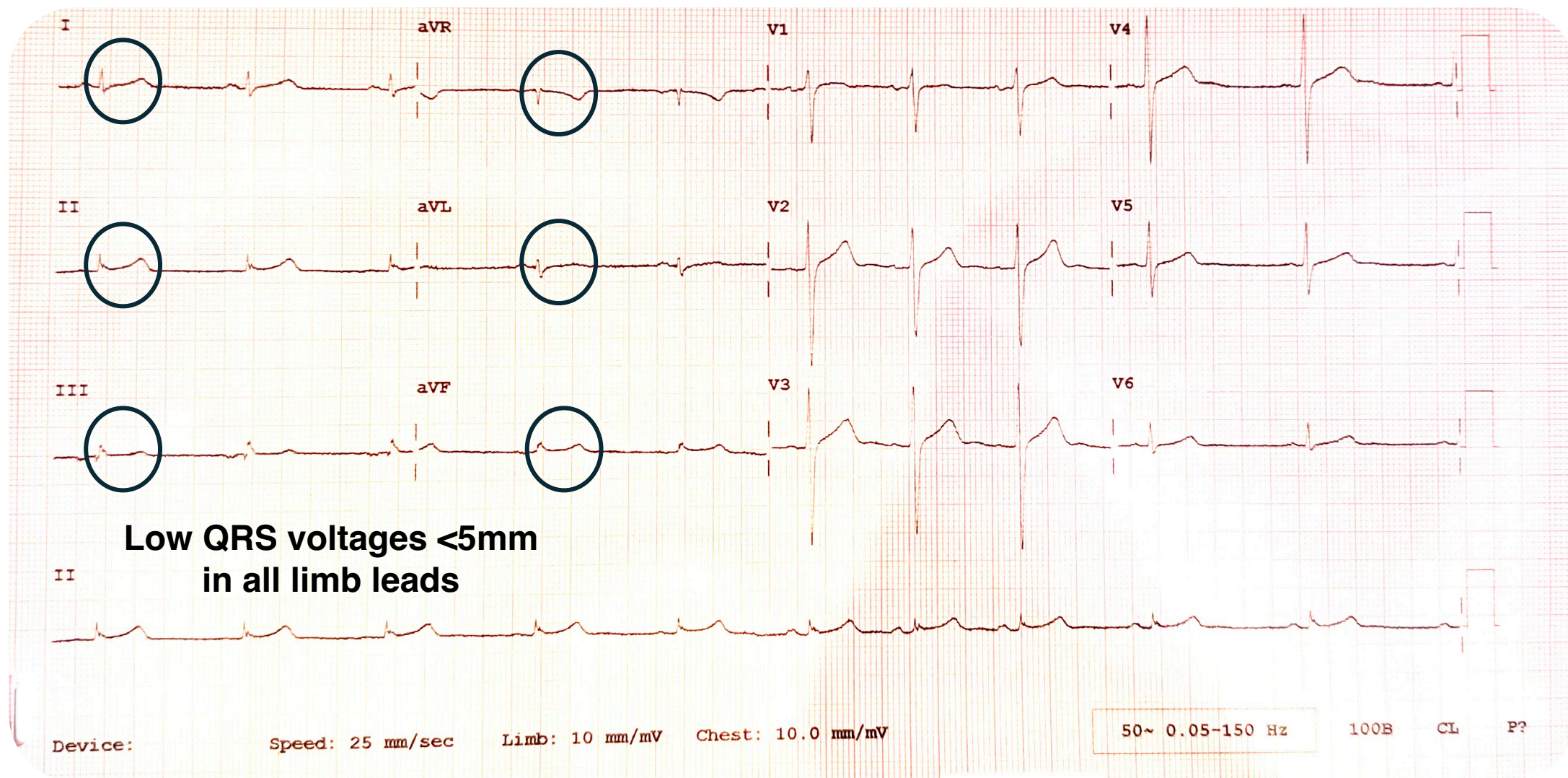
27-year-old male, bodybuilder, competitive for the last 2 years





What would you do next:

- A. Nothing. All clear.
- B. Transthoracic echocardiogram. If normal, all clear.
- C. Referral.
- D. Repeat screening in 2 years.



- **Over the last 2 years, he has been on testosterone for performance enhancement:**

Testosterone Enanthate 175mg per week, plus

- Metformin 400mg daily
- Telmisartan 40mg daily

Low QRS voltages

International Recommendations for Electrocardiographic Interpretation in Athletes



Sanjay Sharma, MD,^{a,*} Jonathan A. Drezner, MD,^{b,*} Aaron Baggish, MD,^c Michael Papadakis, MD,^a Mathew G. Wilson, PhD,^d Jordan M. Prutkin, MD, MHS,^e Andre La Gerche, MD, PhD,^f Michael J. Ackerman, MD, PhD,^g Mats Björjesson, MD, PhD,^h Jack C. Salerno, MD,ⁱ Irfan M. Asif, MD,^j David S. Owens, MD, MS,^k Eugene H. Chung, MD, MS,^l Michael S. Emery, MD,^m Victor F. Froelicher, MD,ⁿ Hein Heidbuchel, MD, PhD,^o Carmen Adamuz, MD, PhD,^p Chad A. Asplund, MD,^q Gordon Cohen, MD,^r Kimberly G. Harmon, MD,^s Joseph C. Marek, MD,^t Silvana Molossi, MD,^u Josef Niebauer, MD, PhD,^v Hank F. Peltó, MD,^w Marco V. Perez, MD,^x Nathan R. Riding, PhD,^y Tess Saarel, MD,^z Christian M. Schmied, MD,^{aa} David M. Shipon, MD,^{ab} Ricardo Stein, MD, ScD,^{ac} Victoria L. Vetter, MD, MPH,^{ad} Antonio Pelliccia, MD,^{ae} Domenico Corrado, MD, PhD,^{af}

Ricardo Stein, MD, ScD,^{af} Alfonso L. Avelar, MD, MPH,^{ag} Antonio Pelliccia, MD,^{ah} Domenico Corrado, MD, PhD,^{ai} Nathan R. Riding, PhD,^{aj} Tess Saarel, MD,^{ak} Christian M. Schmied, MD,^{al} David M. Shipon, MD,^{am} Joseph C. Marek, MD,^{an} Silvana Molossi, MD,^{ao} Josef Niebauer, MD, PhD,^{ap} Hank F. Peltó, MD,^{aq} Marco V. Perez, MD,^{ar} Carmen Adamuz, MD, PhD,^{as} Chad A. Asplund, MD,^{at} Gordon Cohen, MD,^{au} Kimberly G. Harmon, MD,^{av} Hein Heidbuchel, MD, PhD,^{aw} Eugene H. Chung, MD, MS,^{ax} Michael S. Emery, MD,^{ay} Victor F. Froelicher, MD,^{az} Mats Björjesson, MD, PhD,^{ba} Jack C. Salerno, MD,^{bb} Irfan M. Asif, MD,^{bc} David S. Owens, MD, MS,^{bd} Eugene H. Chung, MD, MS,^{be} Michael S. Emery, MD,^{bf} Victor F. Froelicher, MD,^{bg} Hein Heidbuchel, MD, PhD,^{bh} Carmen Adamuz, MD, PhD,^{bi} Chad A. Asplund, MD,^{bj} Gordon Cohen, MD,^{bk} Kimberly G. Harmon, MD,^{bl} Joseph C. Marek, MD,^{bm} Silvana Molossi, MD,^{bn} Josef Niebauer, MD, PhD,^{bo} Hank F. Peltó, MD,^{bp} Marco V. Perez, MD,^{bq} Nathan R. Riding, PhD,^{br} Tess Saarel, MD,^{bs} Christian M. Schmied, MD,^{bt} David M. Shipon, MD,^{bu} Ricardo Stein, MD, ScD,^{bv} Victoria L. Vetter, MD, MPH,^{bw} Antonio Pelliccia, MD,^{bx} Domenico Corrado, MD, PhD,^{by}

FIGURE 1 International Consensus Standards for Electrocardiographic Interpretation in Athletes

Normal ECG Findings

- Increased QRS voltage for LVH or RVH
- Incomplete RBBB
- Early repolarization/ST segment elevation
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No further evaluation required in asymptomatic athletes with no family history of inherited cardiac disease or SCD

In isolation

2 or more

Further evaluation required to investigate for pathologic cardiovascular disorders associated with SCD in athletes



Low QRS voltages

Prevalence and clinical significance of isolated low QRS voltages in young athletes

Alessandro Zorzi¹, Natascia Bettella¹, Mario Tatangelo²,
Alvise Del Monte¹, Teresina Vessella³, Barbara Poscolieri³, Cinzia Crescenzi⁴,
Davide Pegorin¹, Flavio D'Ascenzi⁵, Valentina Pescatore⁶, Franco Giada⁶,
Patrizio Sarto³, Leonardo Calò⁴, Maurizio Schiavon⁷, Dario Gregori¹,
David M. Hadley⁸, Jonathan A. Drezner⁹, Antonio Pelliccia^{2†}, and
Domenico Corrado^{1*†}

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Davide Pegorin¹, Flavio D'Ascenzi⁵, Valentina Pescatore⁶, Franco Giada⁶,
Alvise Del Monte¹, Teresina Vessella³, Barbara Poscolieri³, Cinzia Crescenzi⁴

Prevalence and determinants of low QRS voltages and QRS fragmentation in children and adolescents undergoing sports pre-participation screening

Francesca Graziano^{1,2}, Oscar Edoardo Genta^{1,3}, Laura Manfrin^{1,4},
Domenico Corrado¹, Laura Brusamolini⁵, Franco Giada⁶, Luigi Gerbino⁶,
Silvia Compagno⁶, and Alessandro Zorzi^{1*}

Francesca Graziano¹, Oscar Edoardo Genta^{1,3}, Laura Manfrin^{1,4},
Domenico Corrado¹, Laura Brusamolini⁵, Franco Giada⁶, Luigi Gerbino⁶,
Silvia Compagno⁶, and Alessandro Zorzi^{1*}

ESC

Prevalence and clinical significance of low QRS voltages in healthy individuals, athletes, and patients with cardiomyopathy: implications for sports pre-participation cardiovascular screening

Antonio Pelliccia^{1*}, Jonathan A. Drezner², Alessandro Zorzi³,
and Domenico Corrado¹

Antonio Pelliccia¹, Jonathan A. Drezner², Alessandro Zorzi³,
and Domenico Corrado¹

ESC

Isolated low QRS voltages

Table 2 Diagnostic work-up of athletes with low QRS voltages in the limb leads and premature ventricular contractions

	Degree of recommendation
Among athletes with unexplained LQSV in the limb leads, further investigation, including a TTE, maximal ETT and ambulatory ECG monitoring comprising a training session, is advised. CMR should be performed in athletes displaying abnormalities on these preliminary tests.	
In athletes with LQSV and negative initial tests, a CMR to exclude an underlying non-ischemic LV scar may be appropriate.	

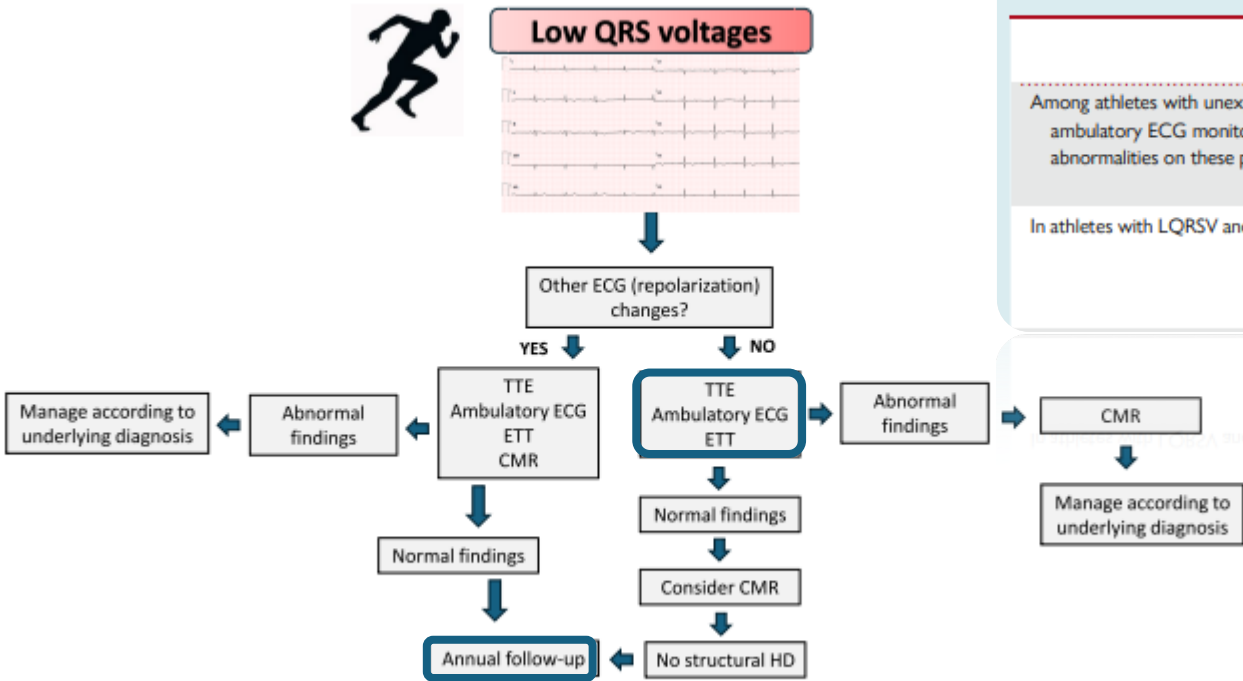
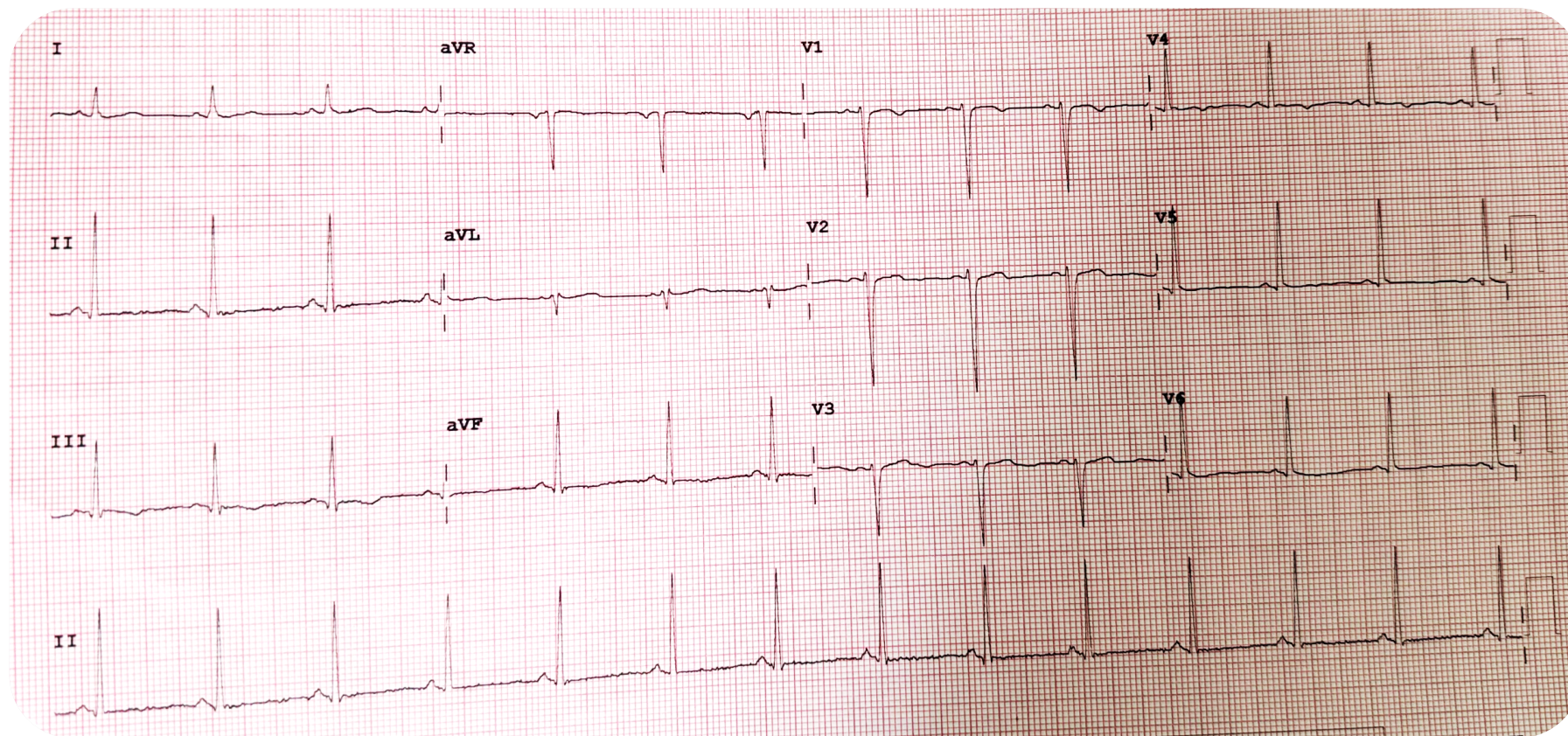


Figure 3 Management of athletes with isolated LQSV. CMR, cardiac magnetic resonance; ETT, exercise tolerance test; HD, heart disease; TTE, transthoracic echocardiogram

Finocchiaro G et al. Abnormal electrocardiogram findings in athletes. Eur Heart J. 2026 Jan 7;47(2):152-169.

25-year-old female, dancer



Flat T waves

ECG abnormality	Definition
T wave inversion • Anterior • ≥ 1 mm in depth in two or more contiguous leads; excludes leads aVR, III, and V₁ • V₂-V₄ - excludes: black athletes with J-point elevation and convex ST-segment elevation followed by TWI in V₂-V₄; athletes age <16 with TWI in V₁-V₃; and biphasic T waves in only V₃ • I and AVL, V₅ <u>and/or</u> V₆ (only one lead of TWI required in V₅ or V₆) • II and aVF, V₅-V₆, I and AVL • II and aVF • Lateral • Inferolateral • Inferior	

There are no data relating to the significance of flat or biphasic T-waves in athletes but similar to TWI, this panel would recommend further evaluation of biphasic T-waves where the negative portion is ≥ 1 mm in depth in ≥ 2 leads.

Flat T waves

Features of T wave inversion and diagnosis of cardiomyopathy: relevance for a cardiac screening programme in young individuals

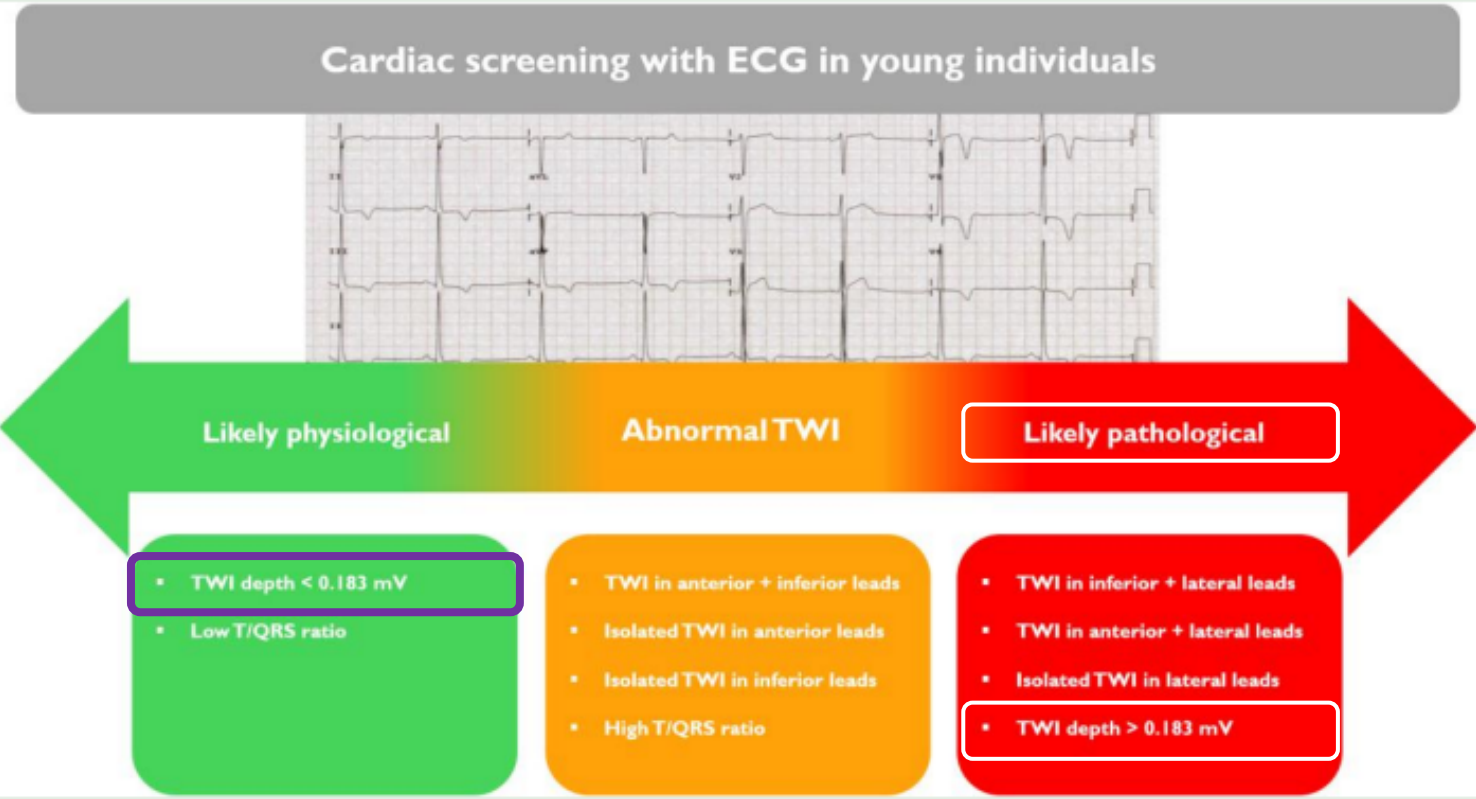
Ali Alzarka , Daniel Abioye, Hamish MacLachlan, Raghav Bhatia, Michael Papadakis, Sanjay Sharma , and Gherardo Finocchiaro *

Michael Papadakis¹, Sanjay Sharma² and Gherardo Finocchiaro³ *

Ali Alzarka¹, Daniel Abioye¹, Hamish MacLachlan¹, Raghav Bhatia¹

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Graphical Abstract

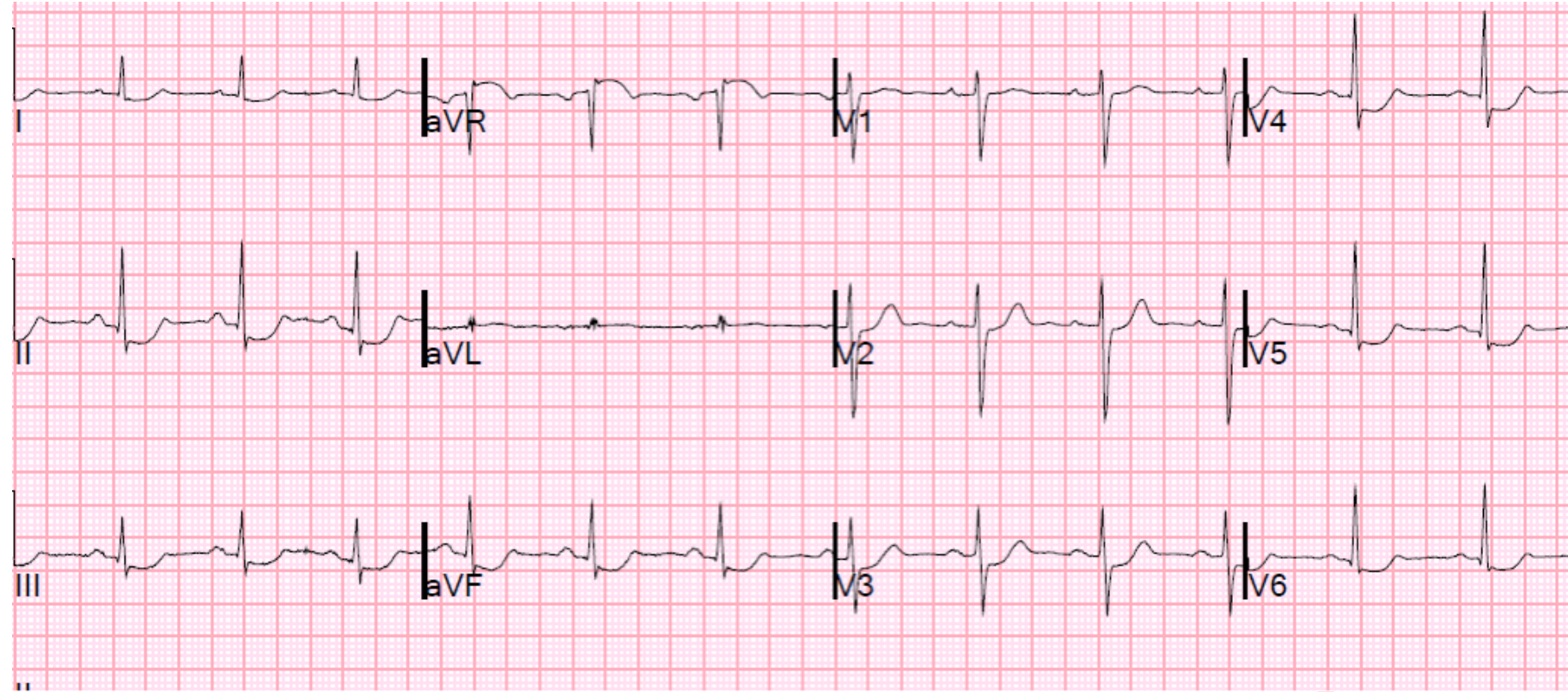


- 21 year-old female, former cyclist
- Shortness of breath in the last 3 months
- Treated with inhalers by the GP
- Asthma does not improve on inhalers

CRY screening 2015

Echocardiogram:

- Mild LVH
- Normal LVEF
- Restrictive filling pattern
- Dilated atria



2018 → on the heart transplant list

Woman undergoes heart transplant after doctors dismiss her symptoms as stress



Hattie Gladwell

Published Sep 6, 2018, 11:54am | **Updated** Sep 6, 2018, 12:53pm



Comment



Most Recent Post

I'm on the list!

February 10, 2018
10.02.2018

I am now officially listed on the heart transplant list! I am listed on the 'routine' or 'active' list, which means that hearts first go to people on the ...

SHARE POST A COMMENT

READ MORE



I'm in the paper!

January 15, 2018

15/01/01

Just a little catch up as I never wrote a post when I was discharged!

I was only in over night at Liverpool, my heart rate was stable and I felt much ...

SHARE POST A COMMENT

READ MORE



Another trip to Liverpool

January 10, 2018

10/01/18 Hello all!

Fancied a little trip to see my friends at Liverpool Heart and Chest today. Three weeks ago I had a cold and my chest was much worse and I was ...

SHARE 1 COMMENT

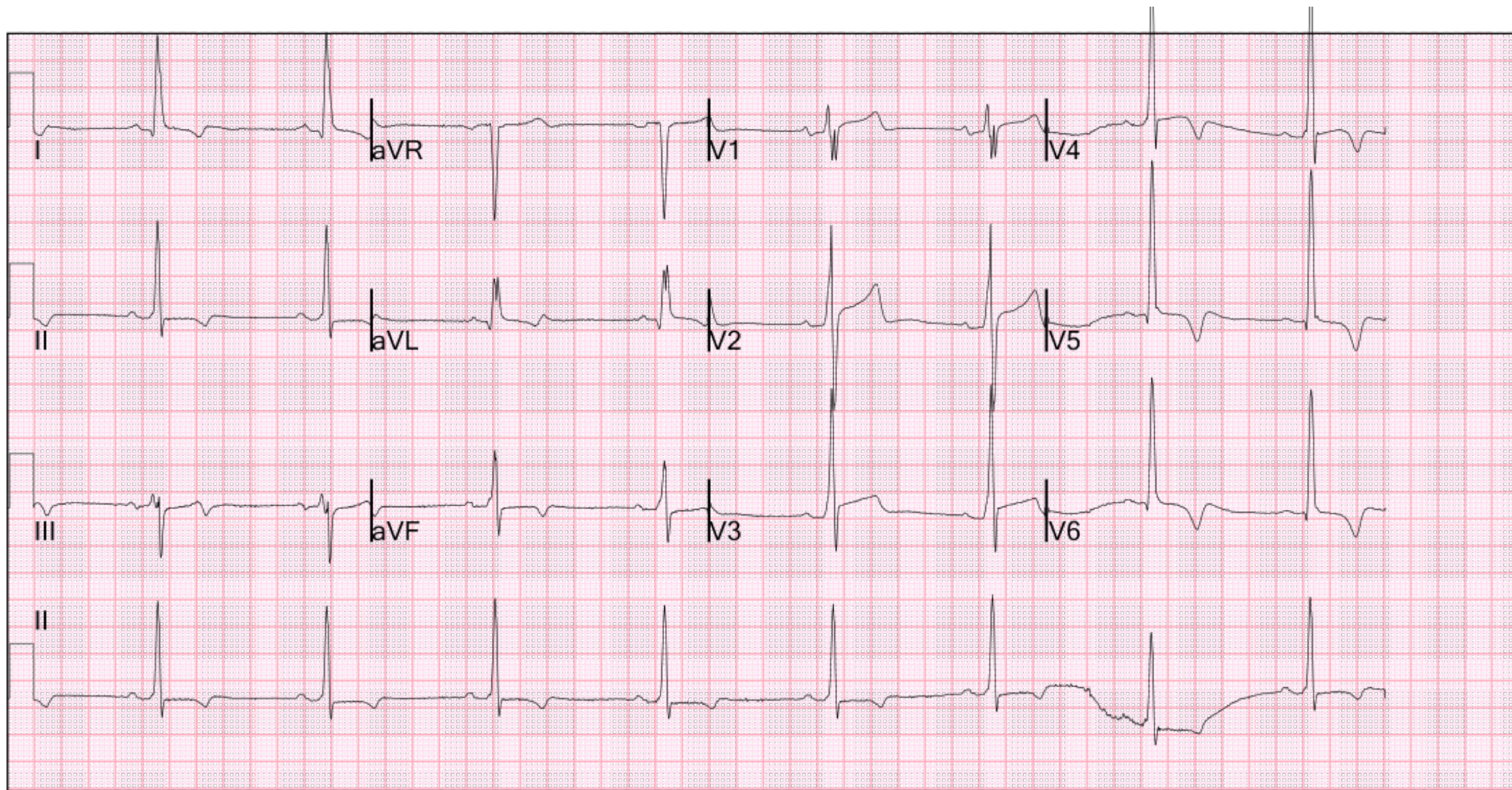
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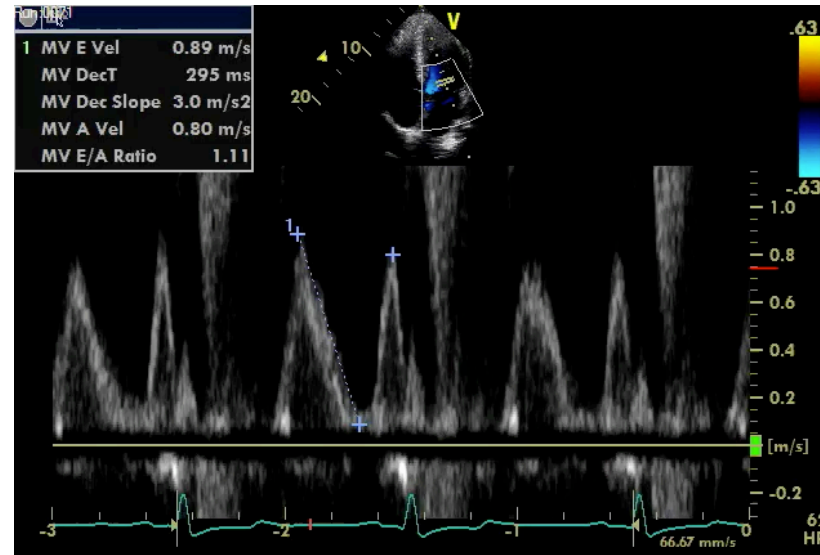
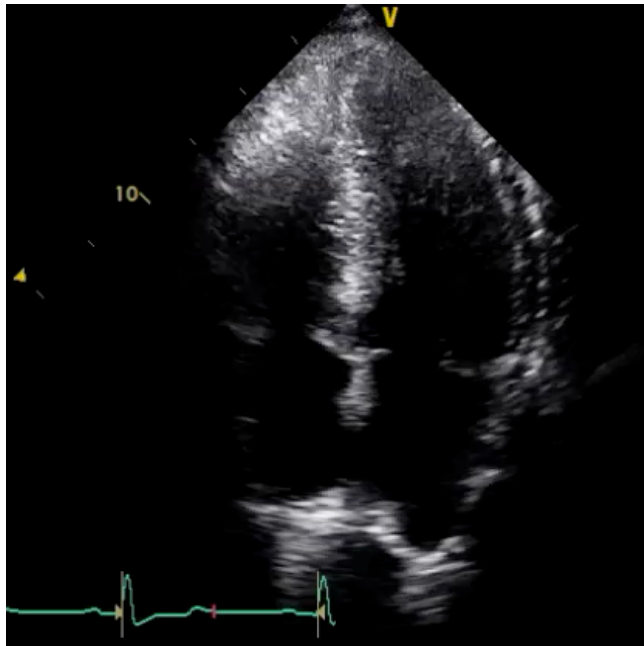
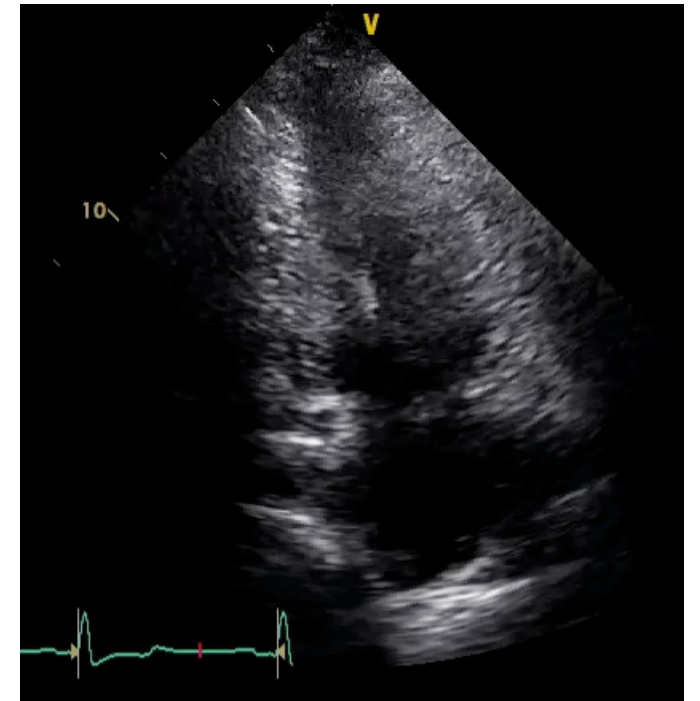
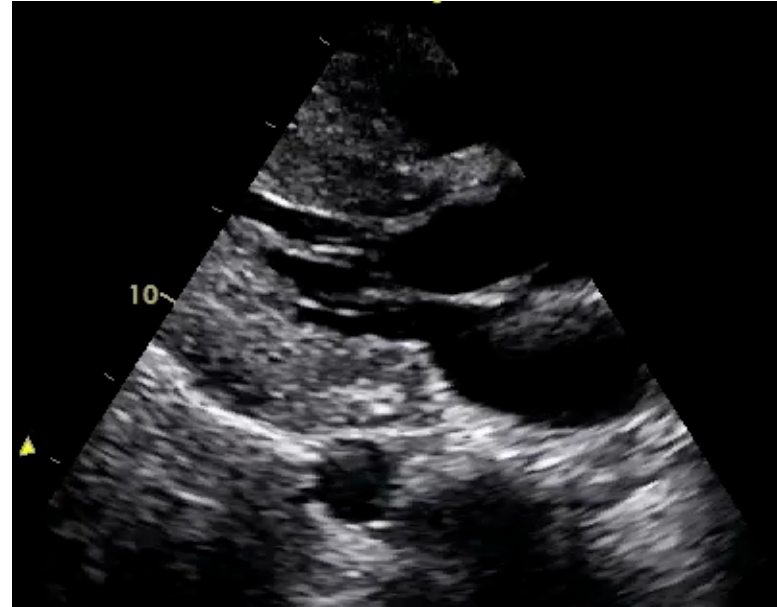
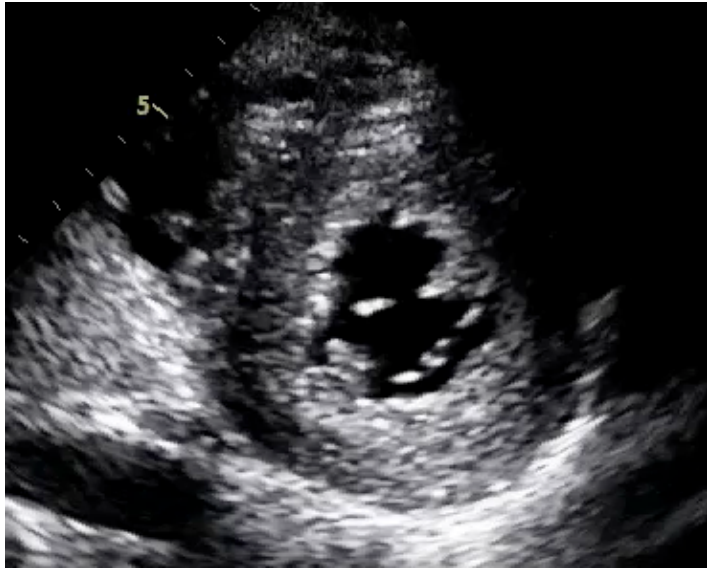


Mark, 42 years old



- ▷ Athlete
- ▷ Asymptomatic
- ▷ No history of chest pain, palpitation, syncope, dyspnea
- ▷ Family history of CV diseases in his mother and his brother (no further details)
- ▷ Screening for sport activity
 - ▷ ECG

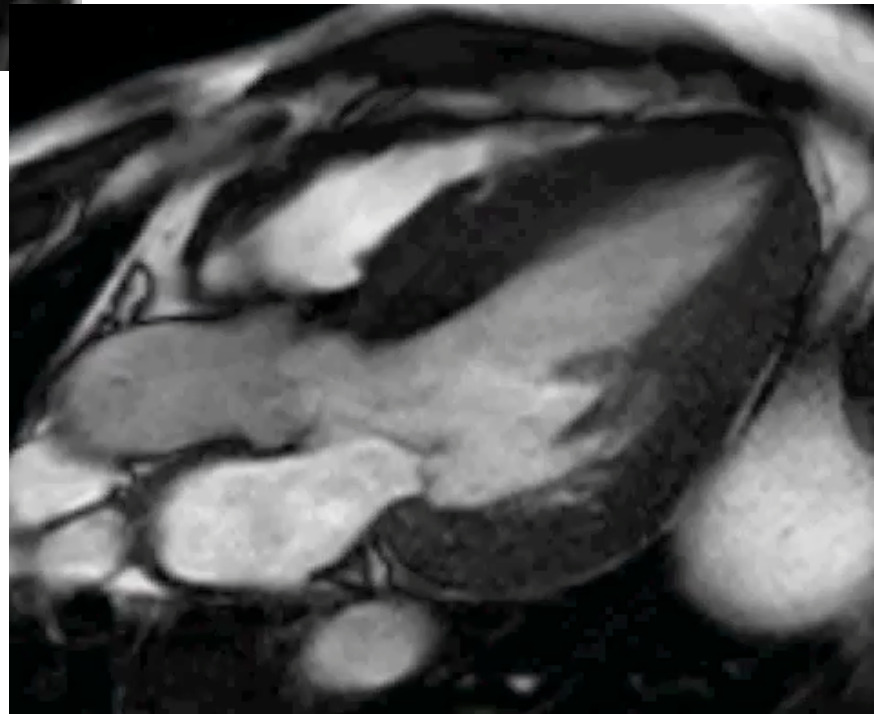
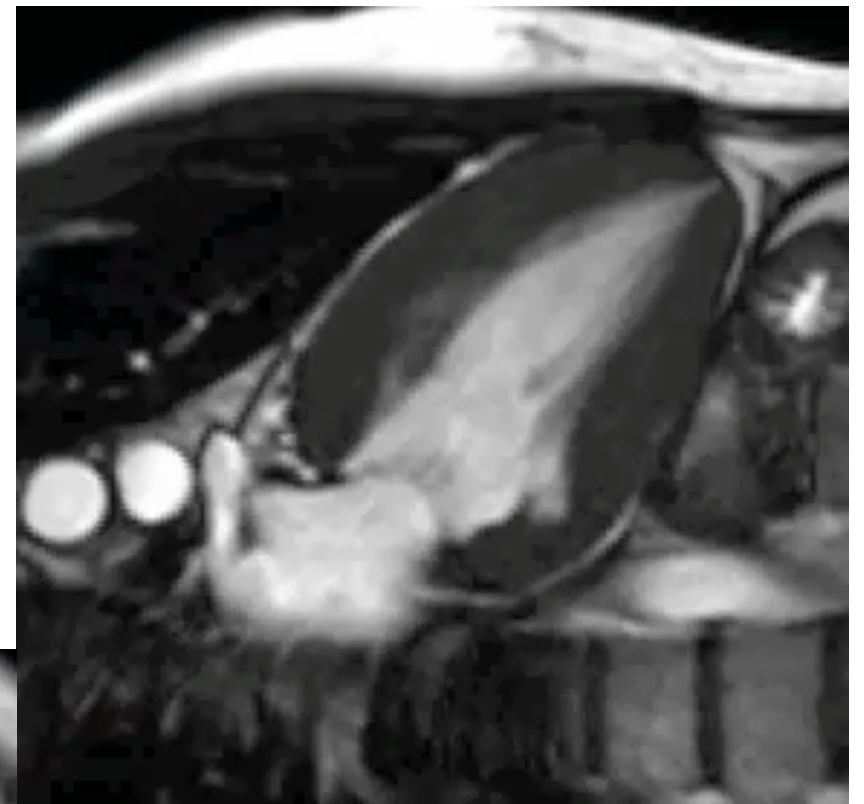
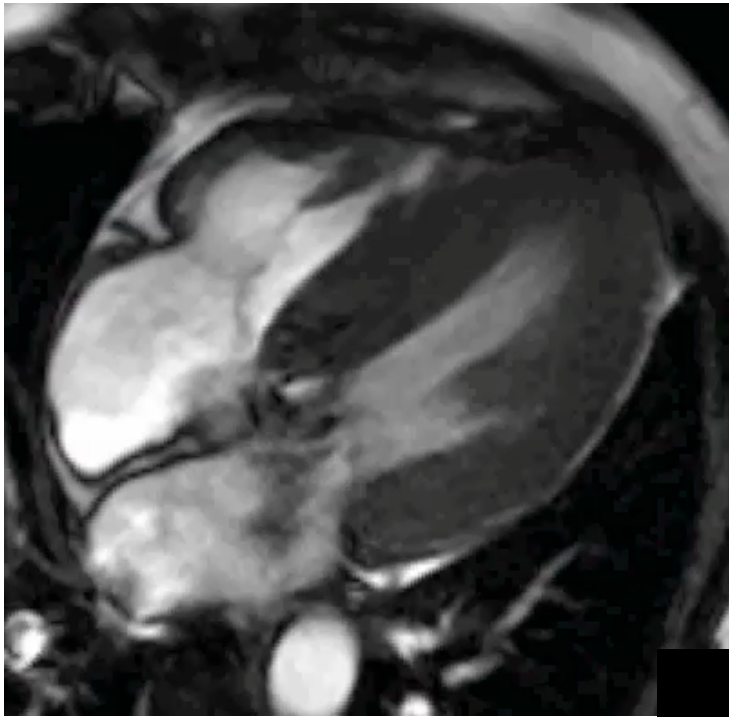


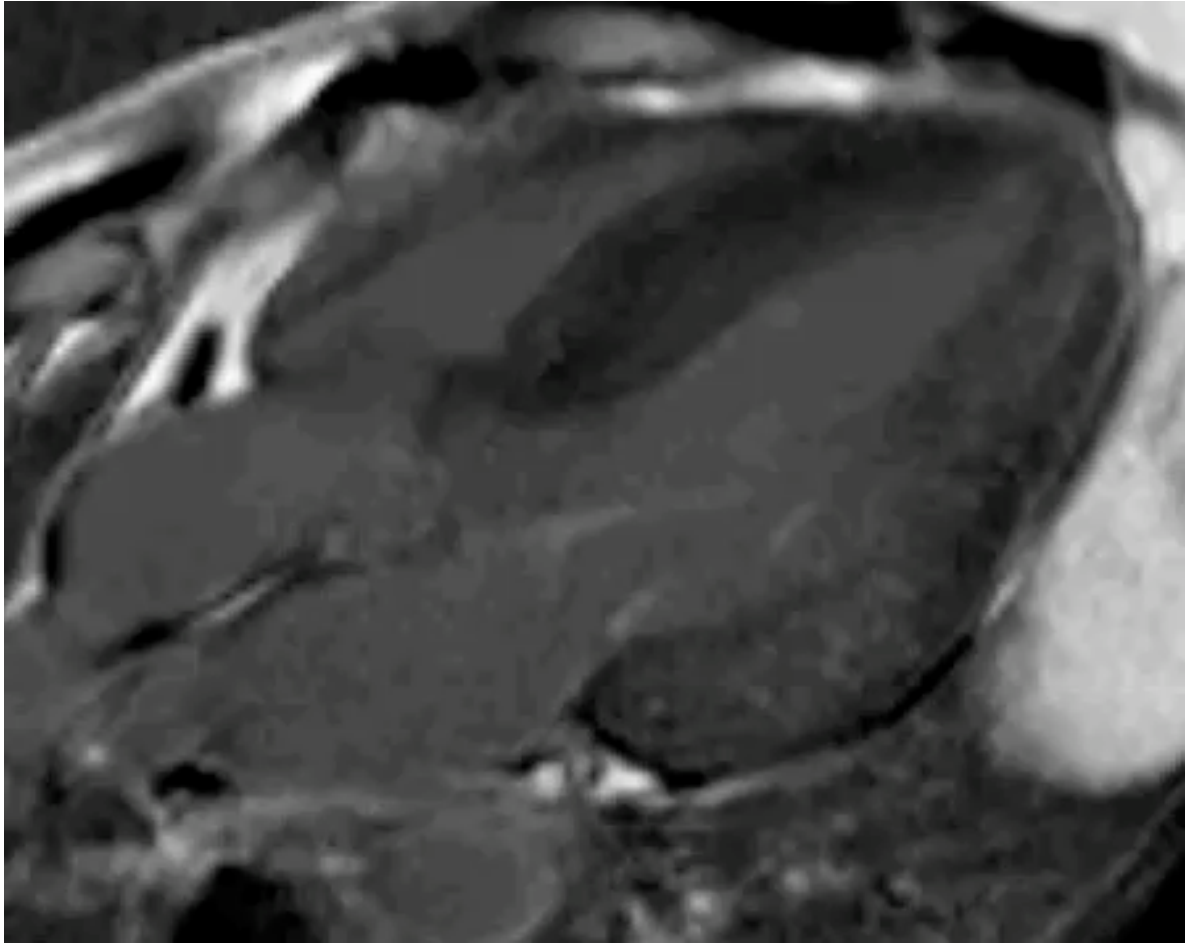


- Maximum wall thickness 23mm
- Complete apical obliteration
- No wall motion abnormalities
- LVOT obstruction with MV systolic anterior motion (SAM)
- Moderate posterior MR
- Bilateral dilatation
- Good RV function, moderate RVH

What would you do next?

- A) No further tests, start medical treatment
- B) CMR
- C) ETT
- D) 24h Holter
- E) Genetic test



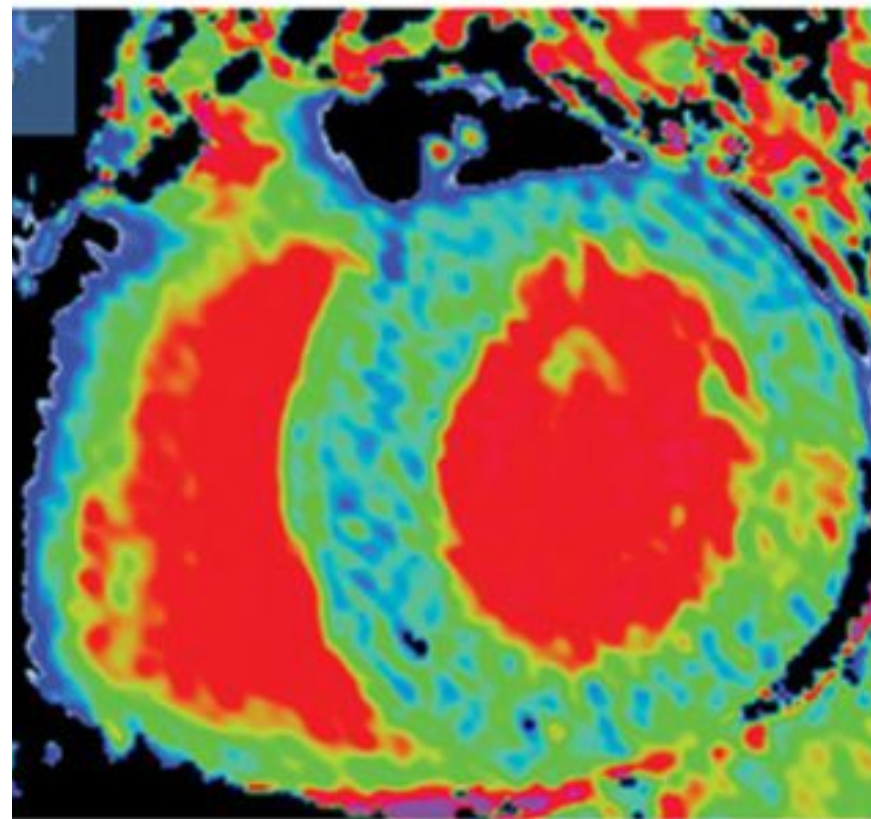
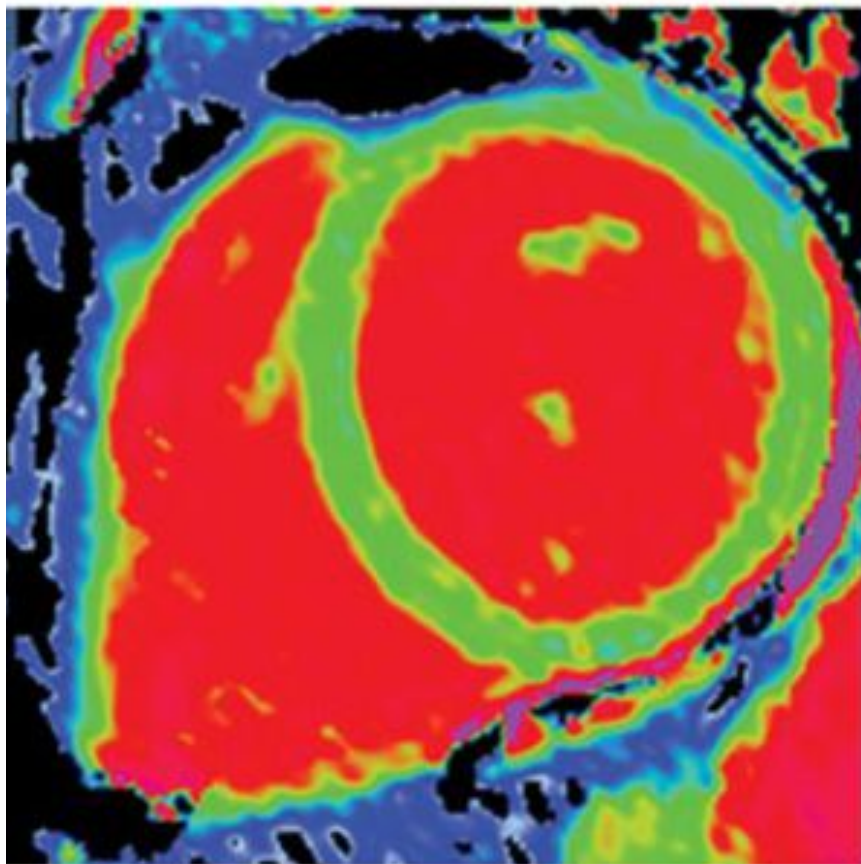


T1 mapping

3000ms

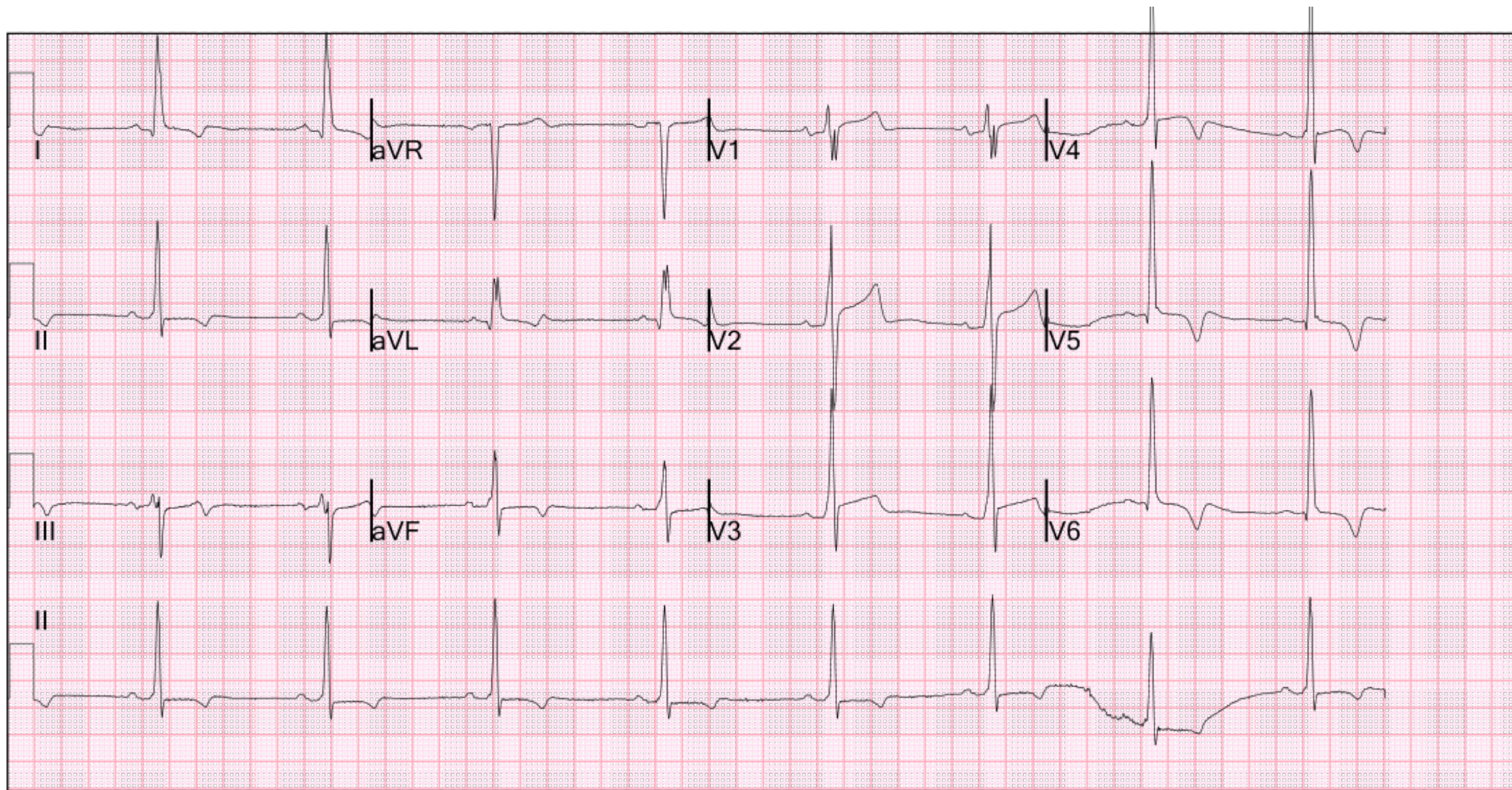
NORMAL

PATIENT

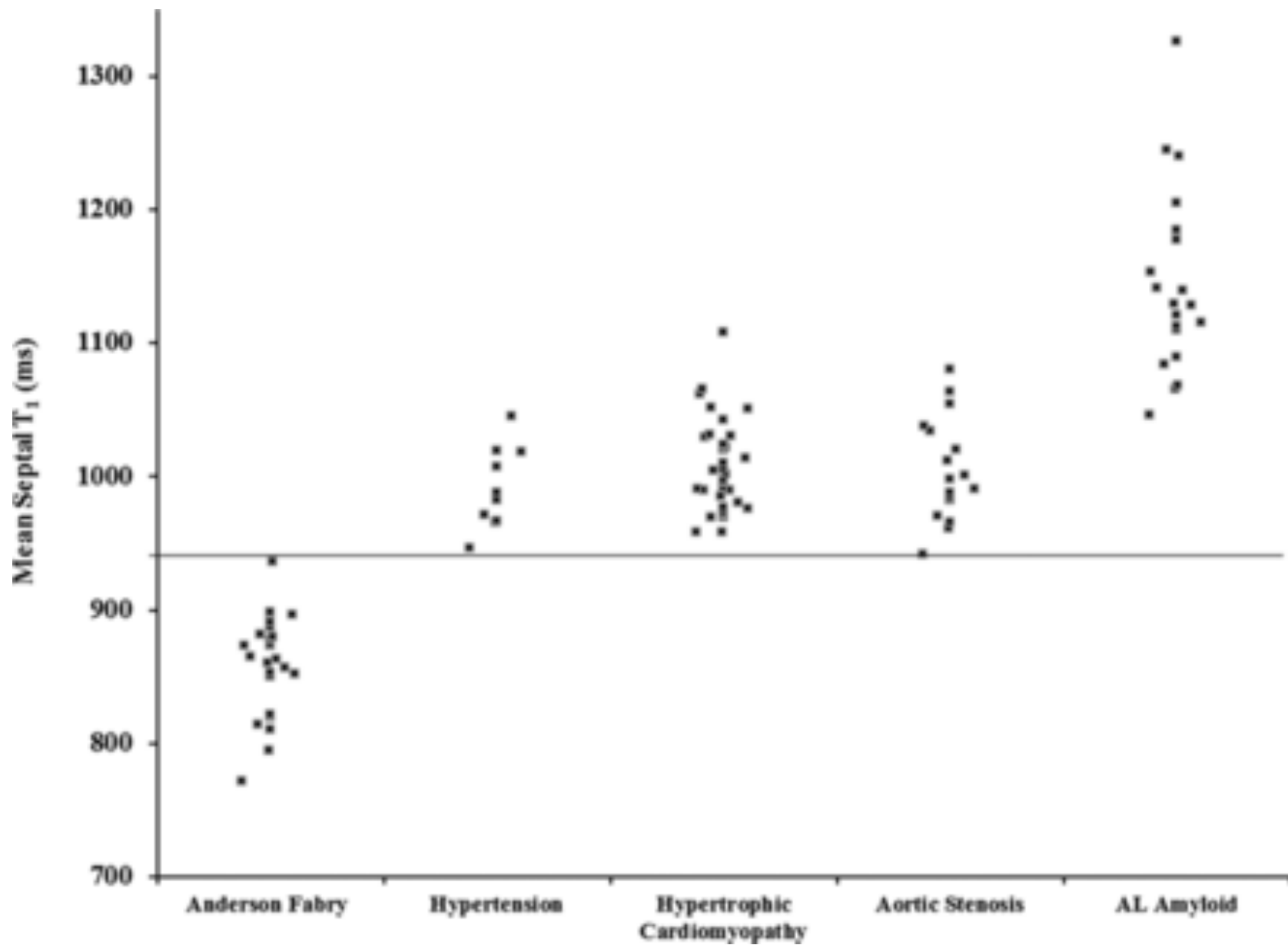


968ms (Normal
myocardial mean) →

200ms

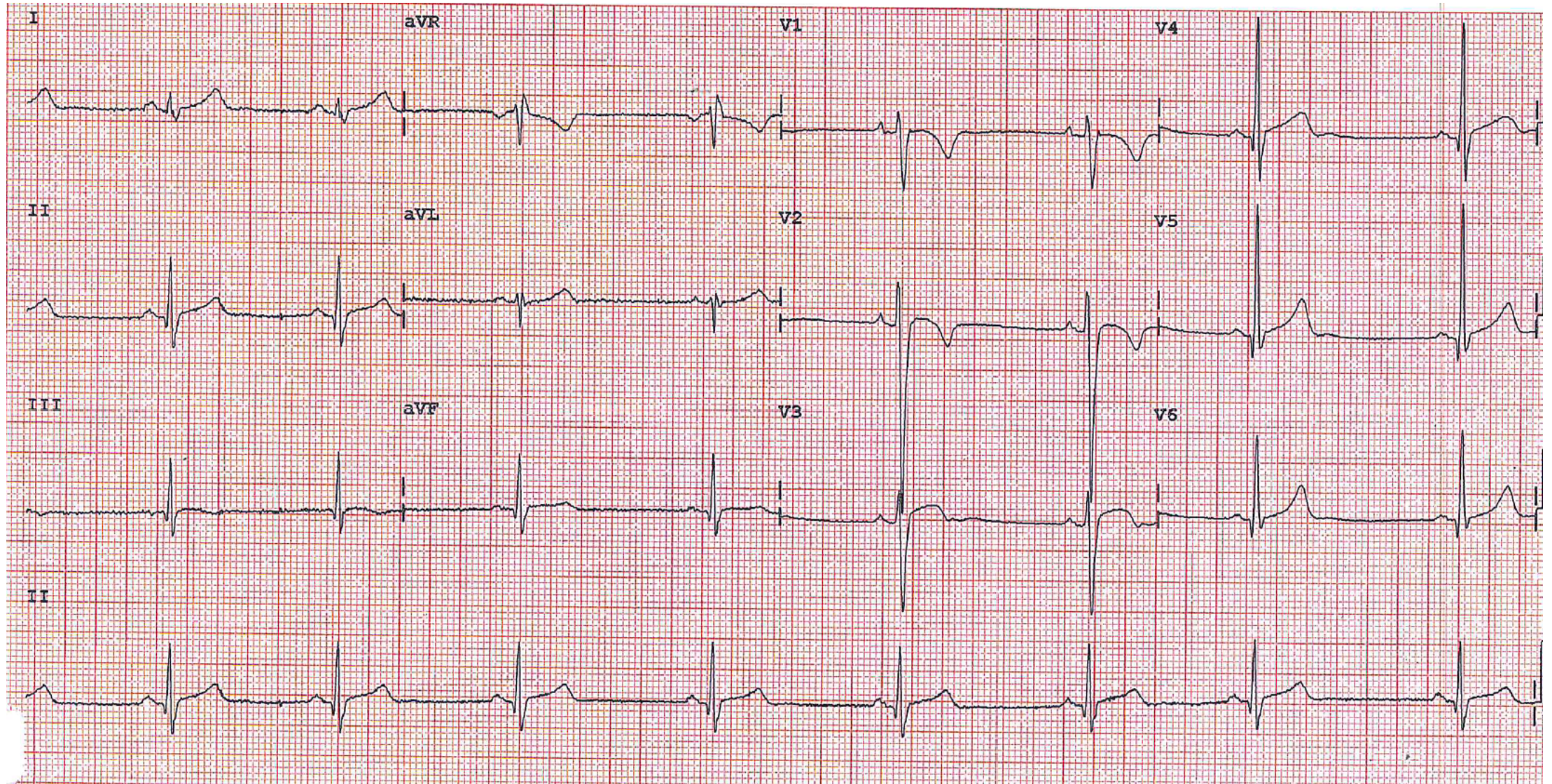


- ▷ Symmetric concentric LV hypertrophy
- ▷ Lateral LGE
- ▷ Reduced T1 mapping



- 16 years old Caucasian male**
- Cyclist at a national level**
- No FH of cardiac disease/sudden death**
- Asymptomatic**

ECG (2013) – CRY screening



What would you do next?

A) Echocardiogram

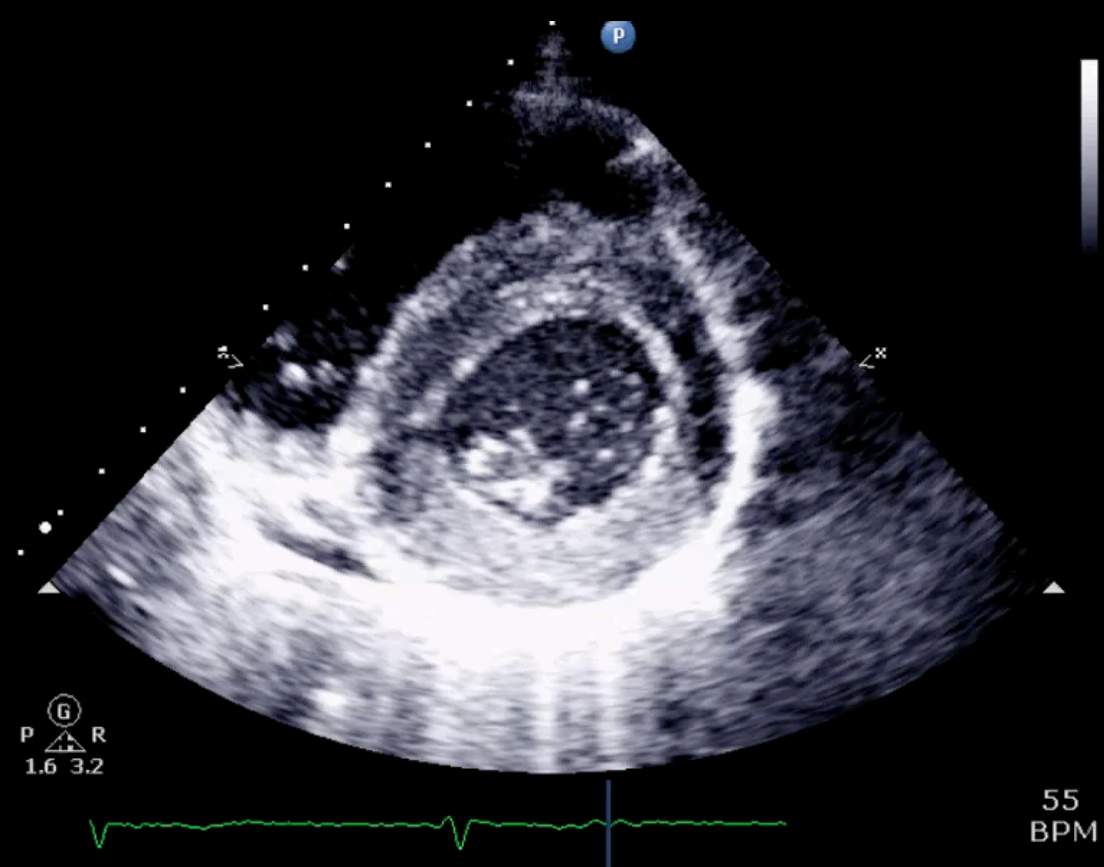
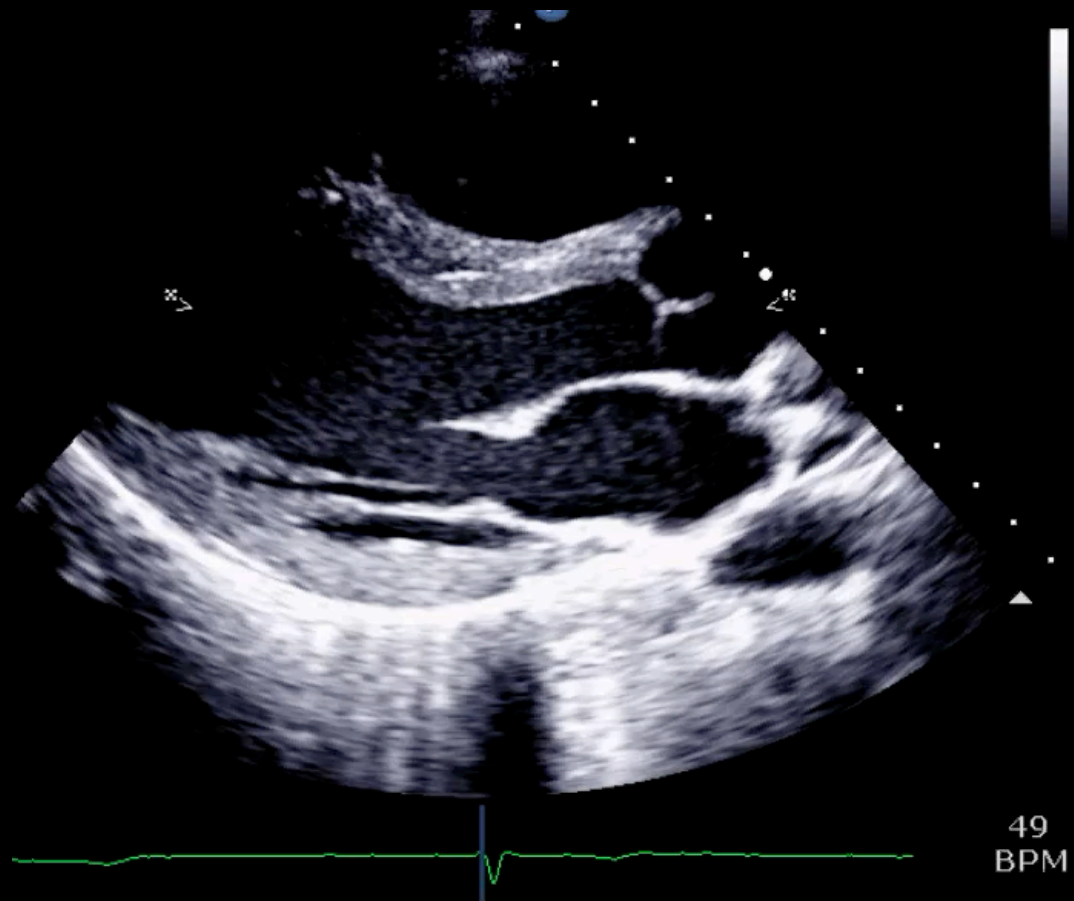
B) Cardiac MRI

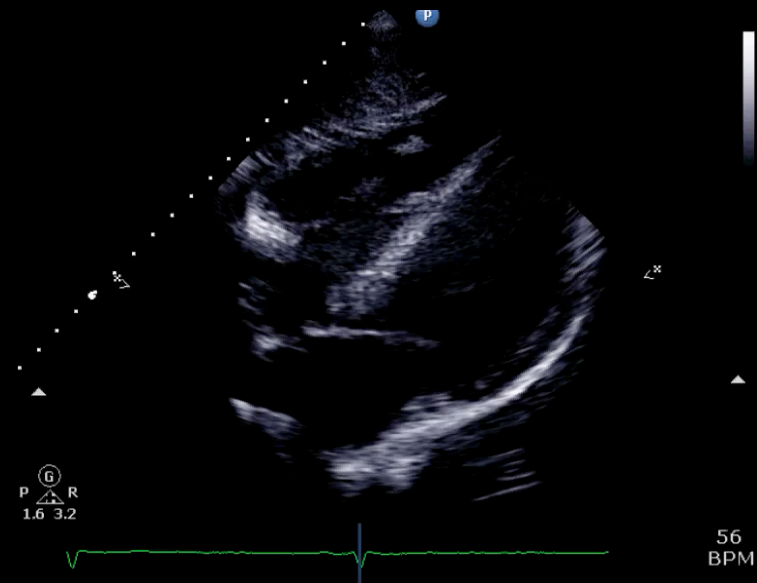
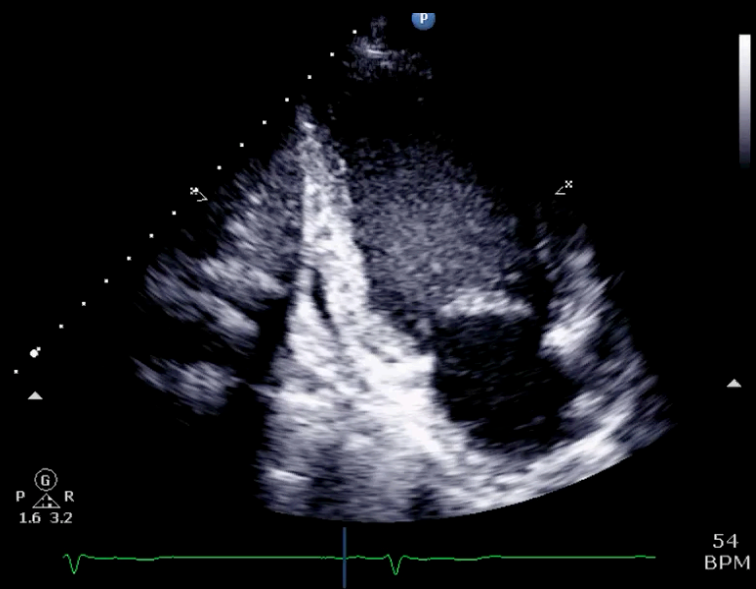
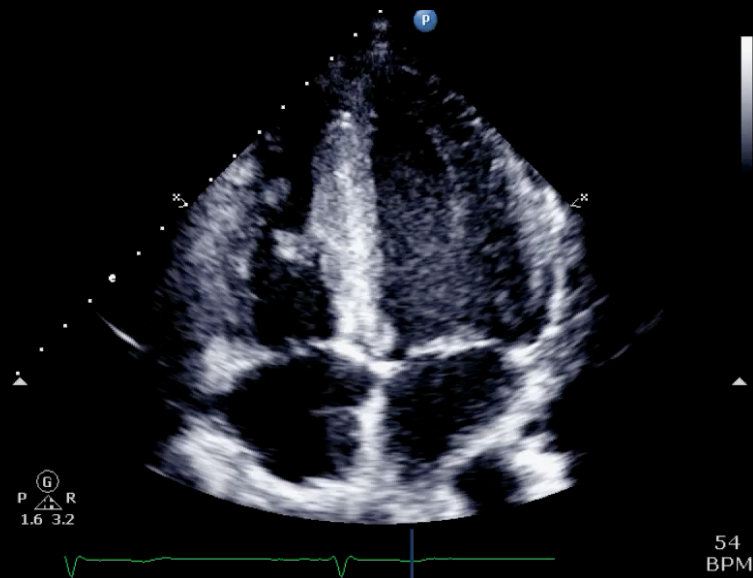
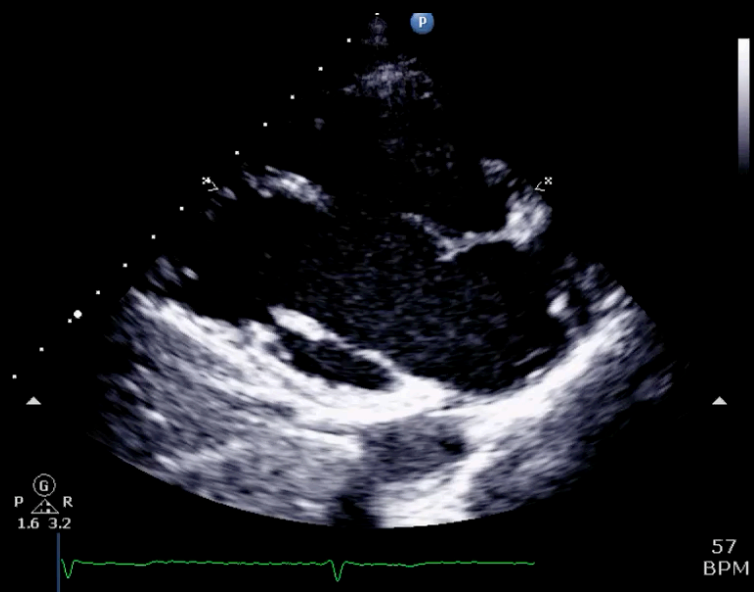
C) Exercise test

D) Restriction from competitive sport

E) No further test or restriction from competitive sport

Echocardiogram (2013)





What would you do next?

A) Repeat the ECG in one year

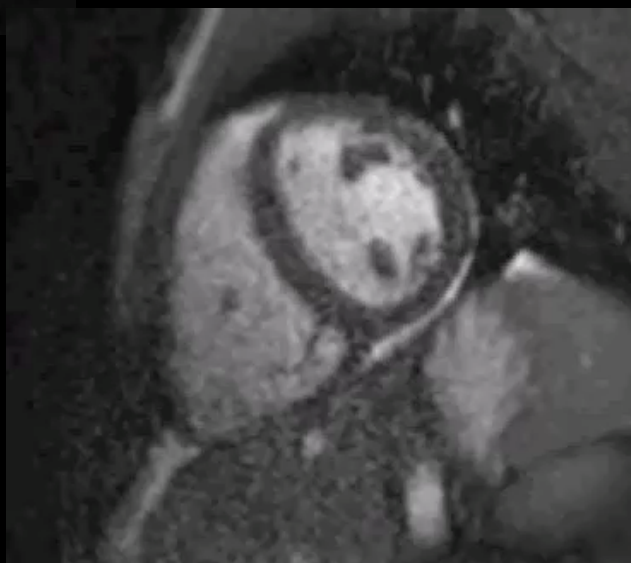
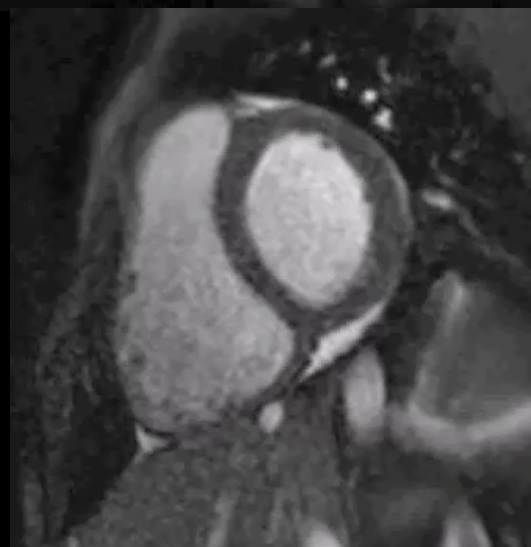
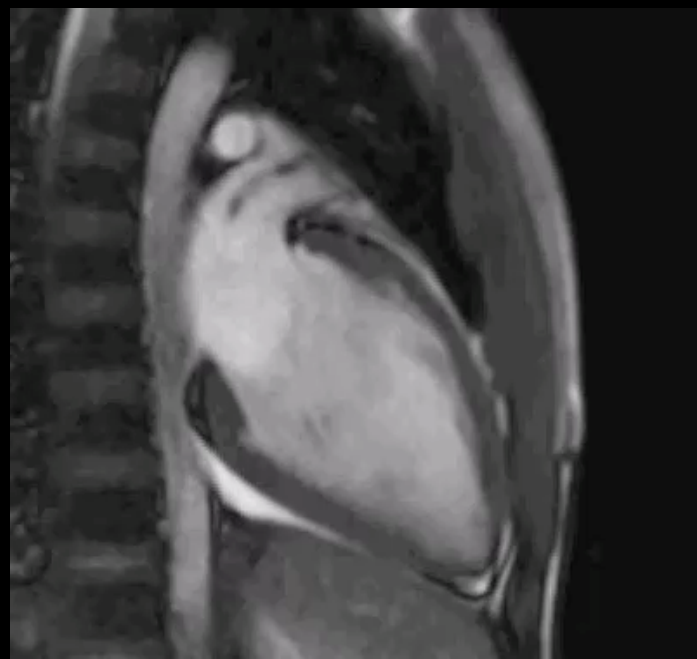
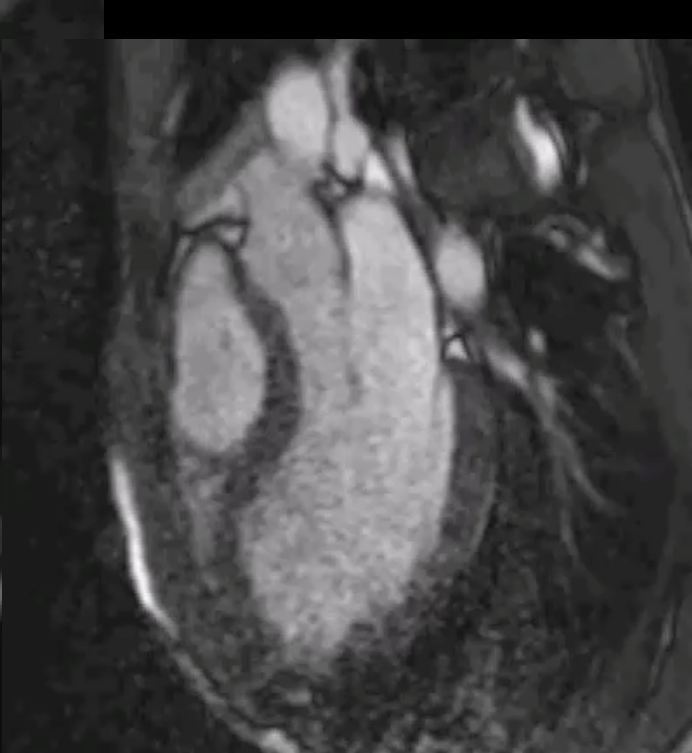
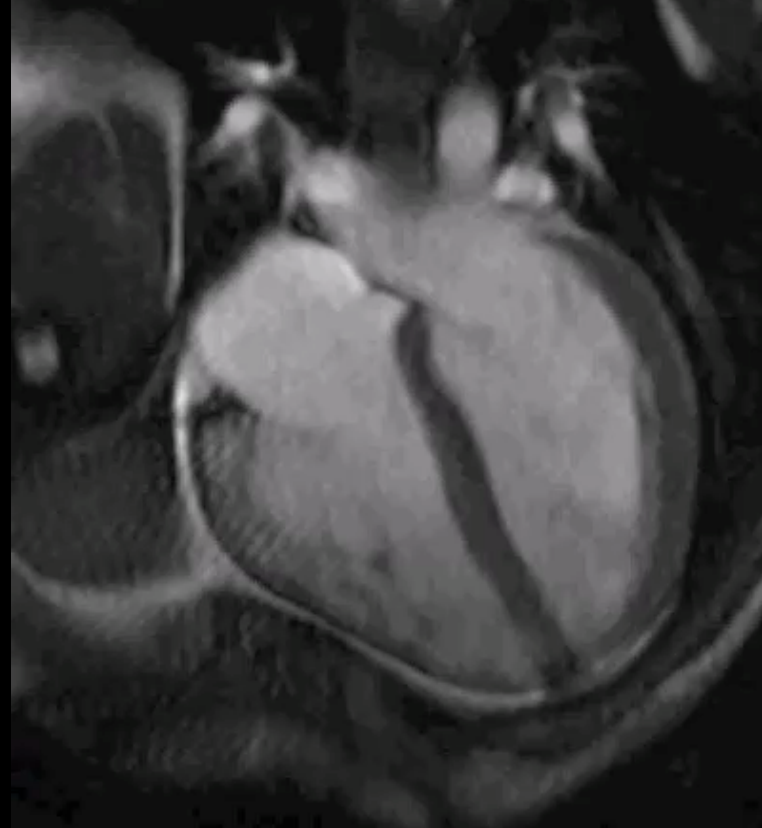
B) Further investigations including cardiac MRI

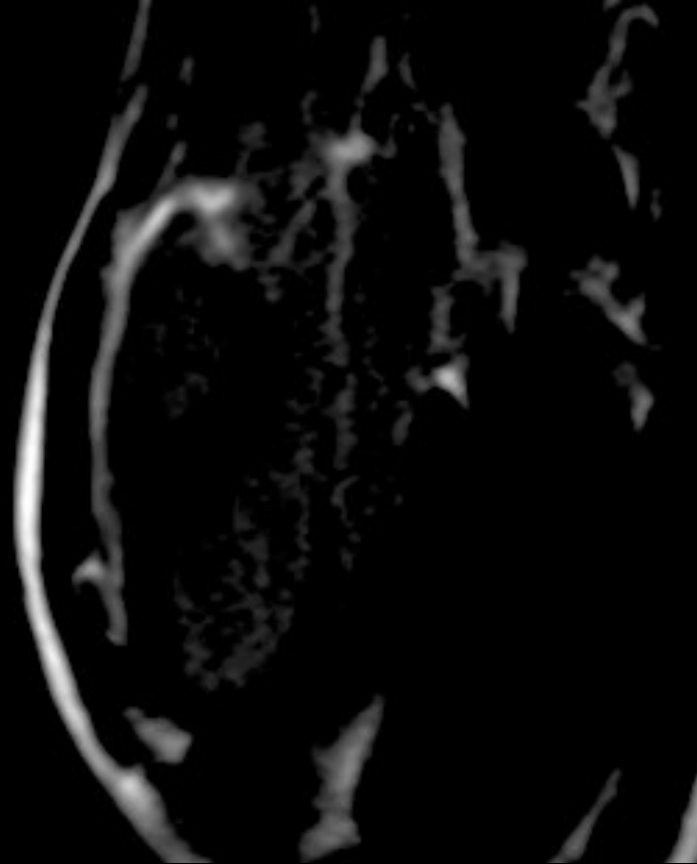
C) Restriction from competitive sport

D) No restriction from competitive sport

E) Detrain for 3 months and repeat ECG and echo

Cardiac MRI (11/2013)





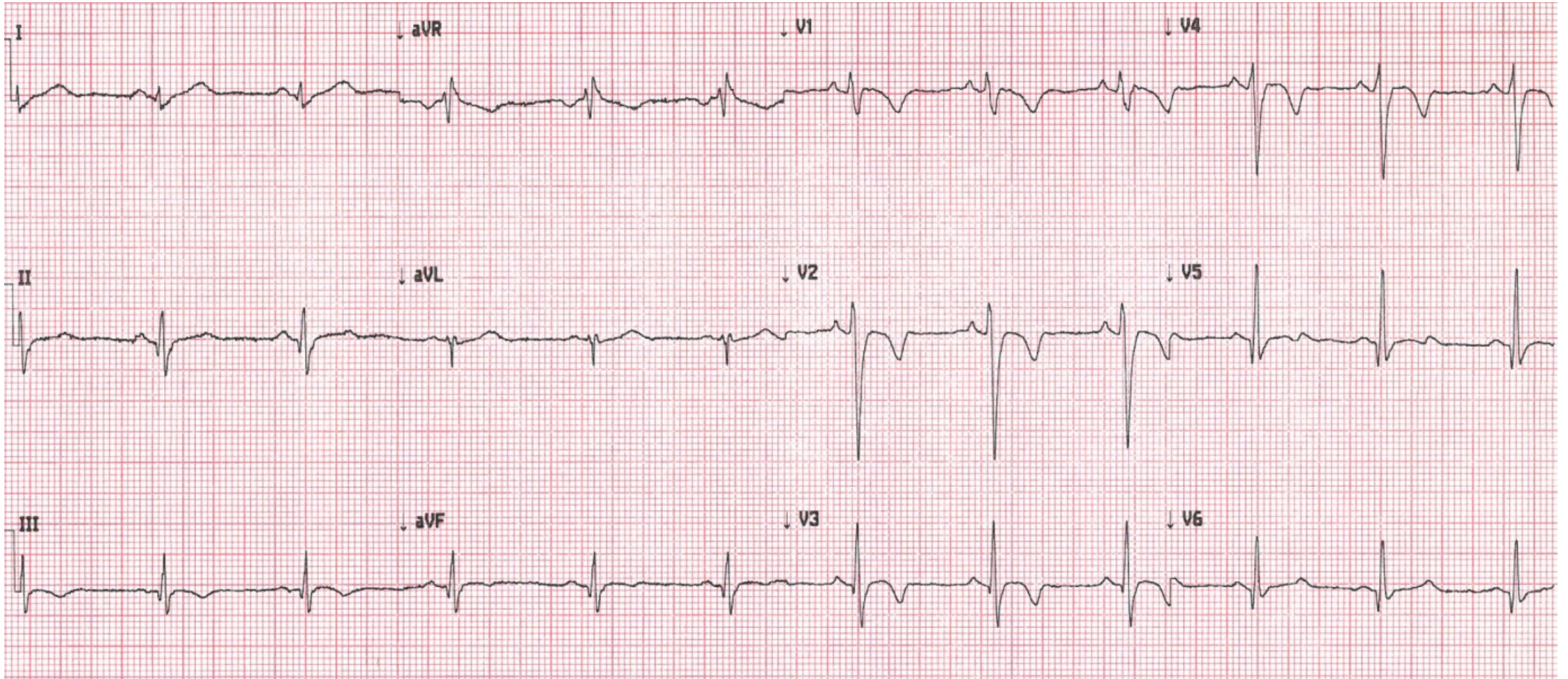
Cardiac MRI (11/2013)

- Normal biventricular size and function
- No valvular abnormalities

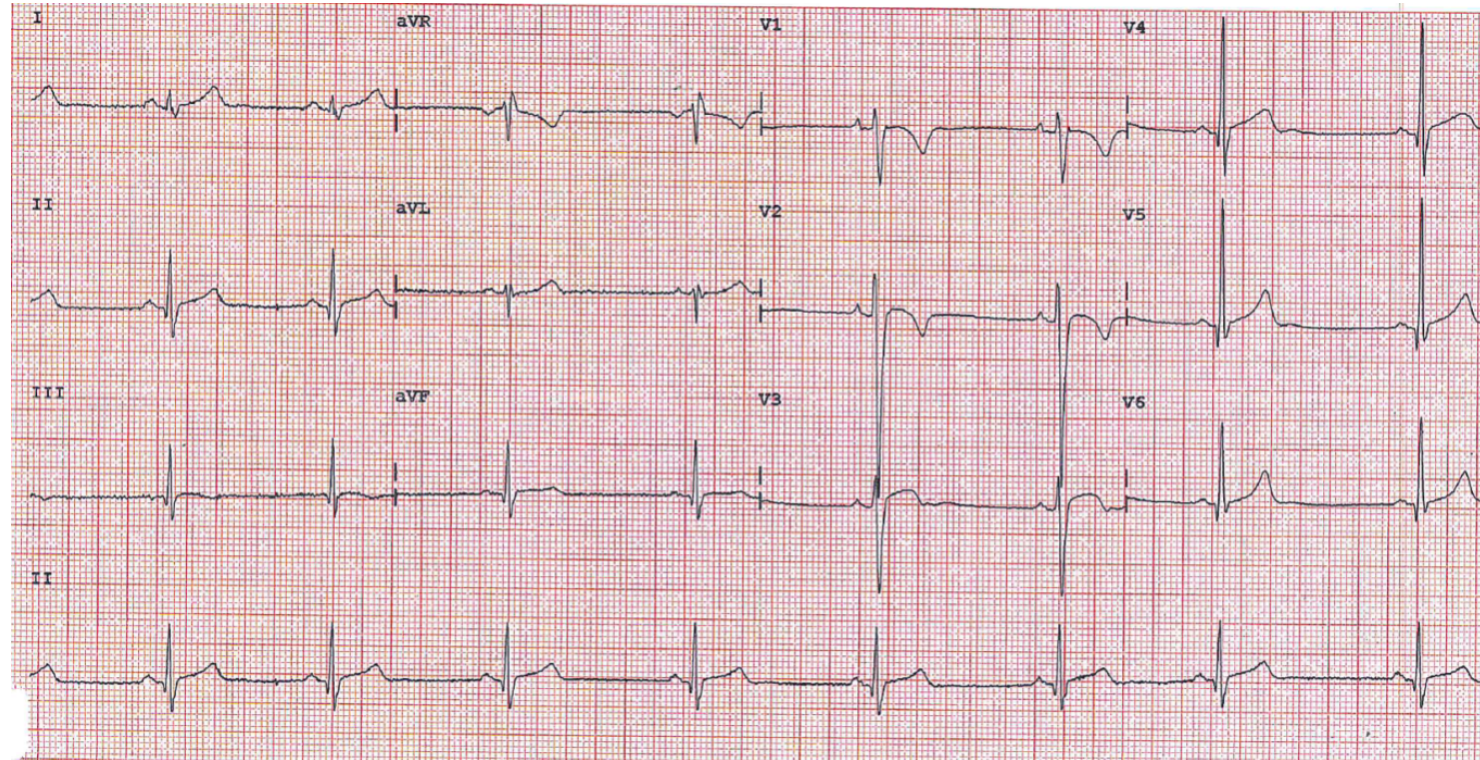
Follow-up in 1 year

September 2014: reduction in functional capacity during long races and occasional dizziness during races.

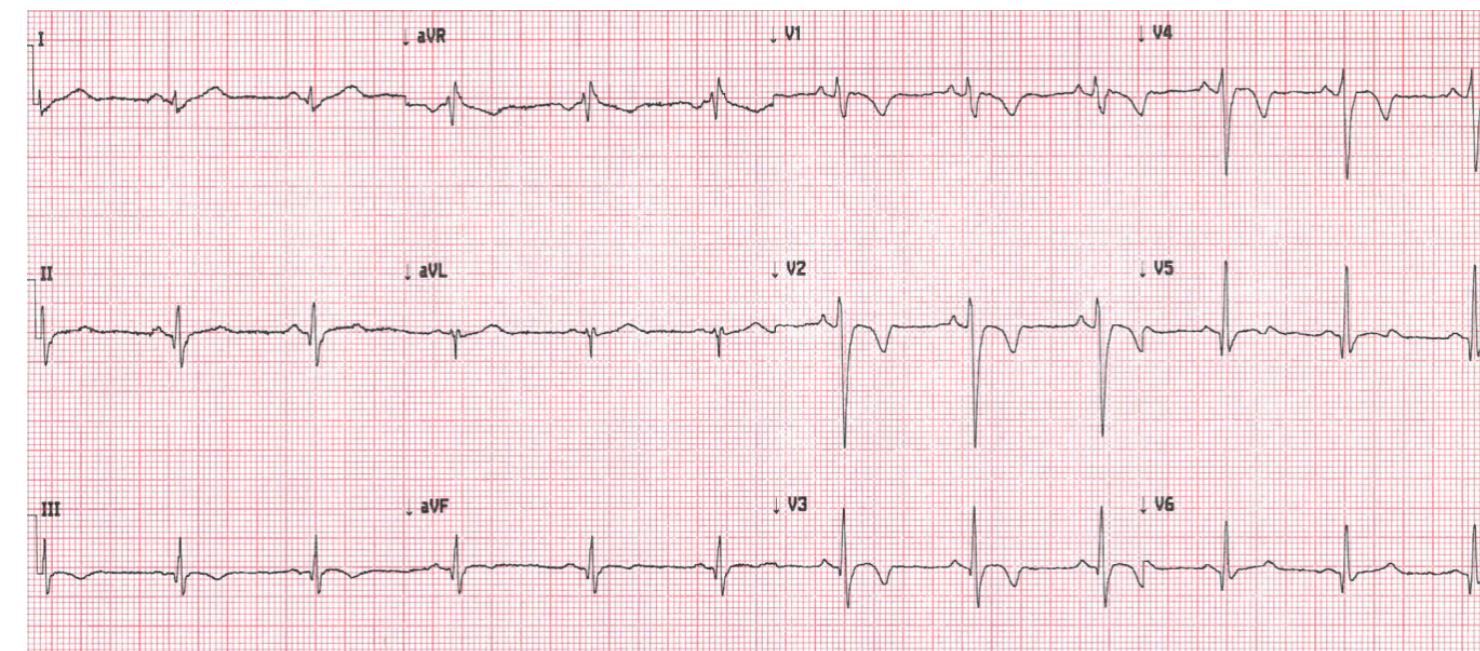
ECG (2015)



2013



2015



What would you do next?

A) Repeat the ECG in one year

B) Further investigations including cardiac MRI

C) Screen the family

D) Restriction from competitive sport

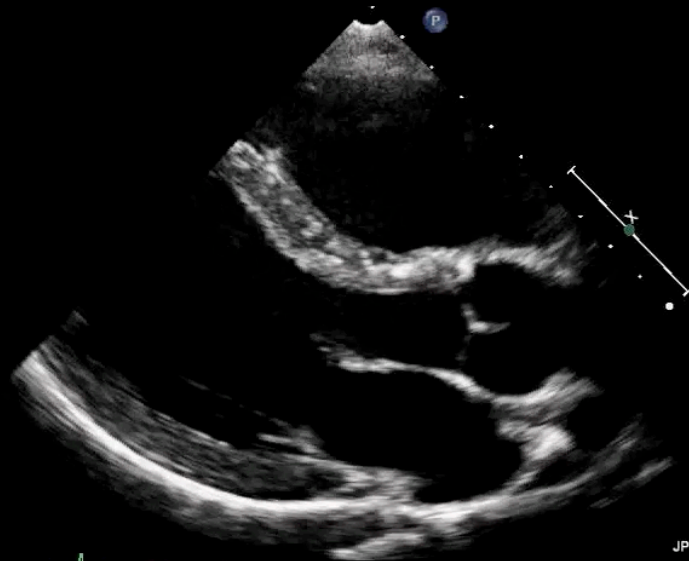
E) Detrain for 3 months and repeat ECG

Echocardiogram (2015)

FR 55Hz
13cm

2D
57%
C 50
P Low
HGen

③
P R
1.7 3.4

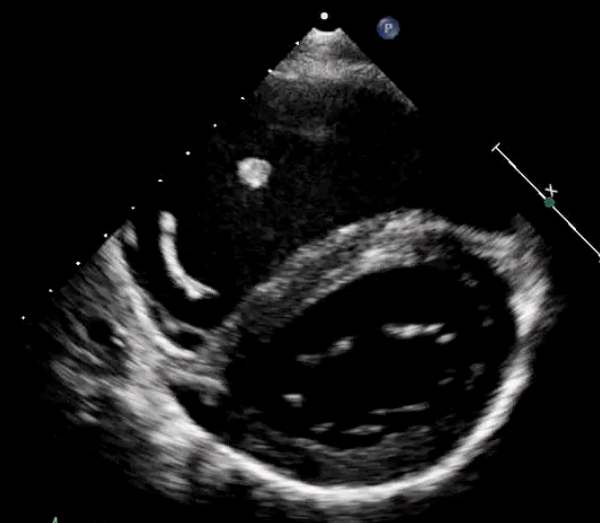


6.

FR 55Hz
13cm

2D
56%
C 50
P Low
HGen

③
P R
1.7 3.4



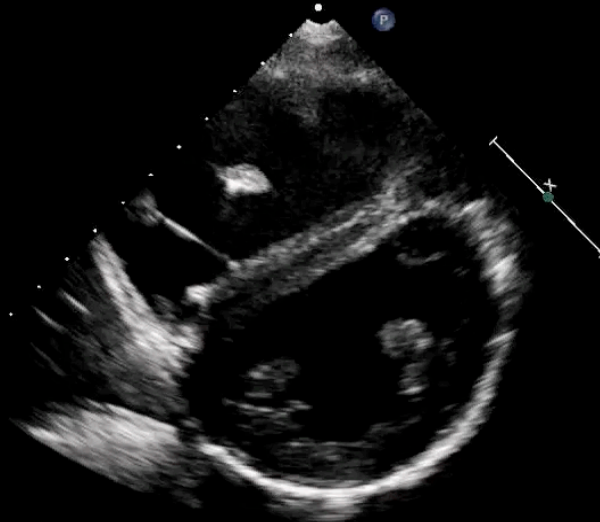
JPEG

66 bpm

FR 55Hz
13cm

2D
56%
C 50
P Low
HGen

③
P R
1.7 3.4



JPEG

66 bpm

FR 47Hz
17cm

2D
68%
C 50
P Low
HGen

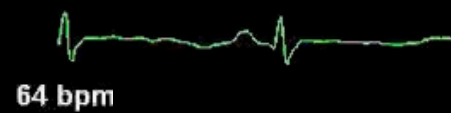


FR 73Hz
15cm

2D
68%
C 50
P Low
HGen



JPE

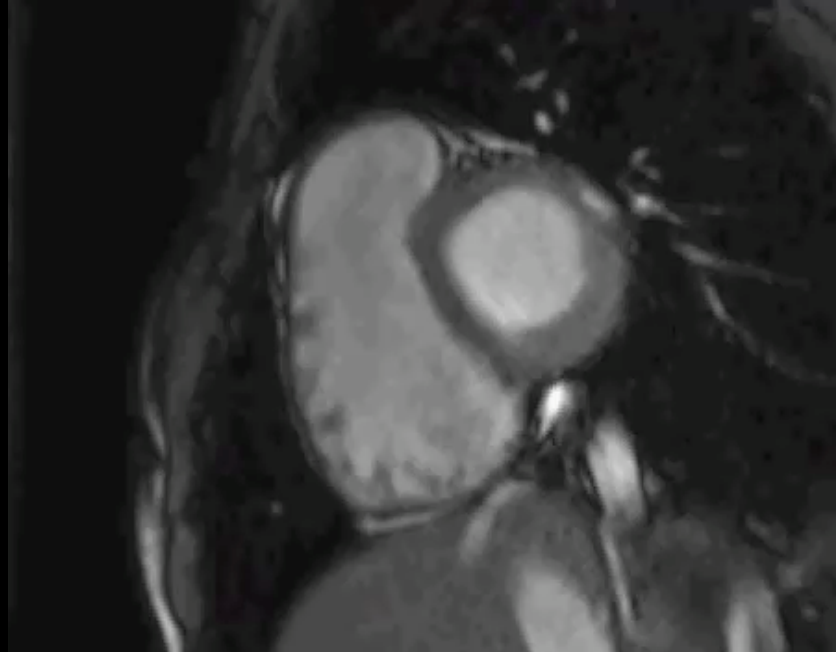
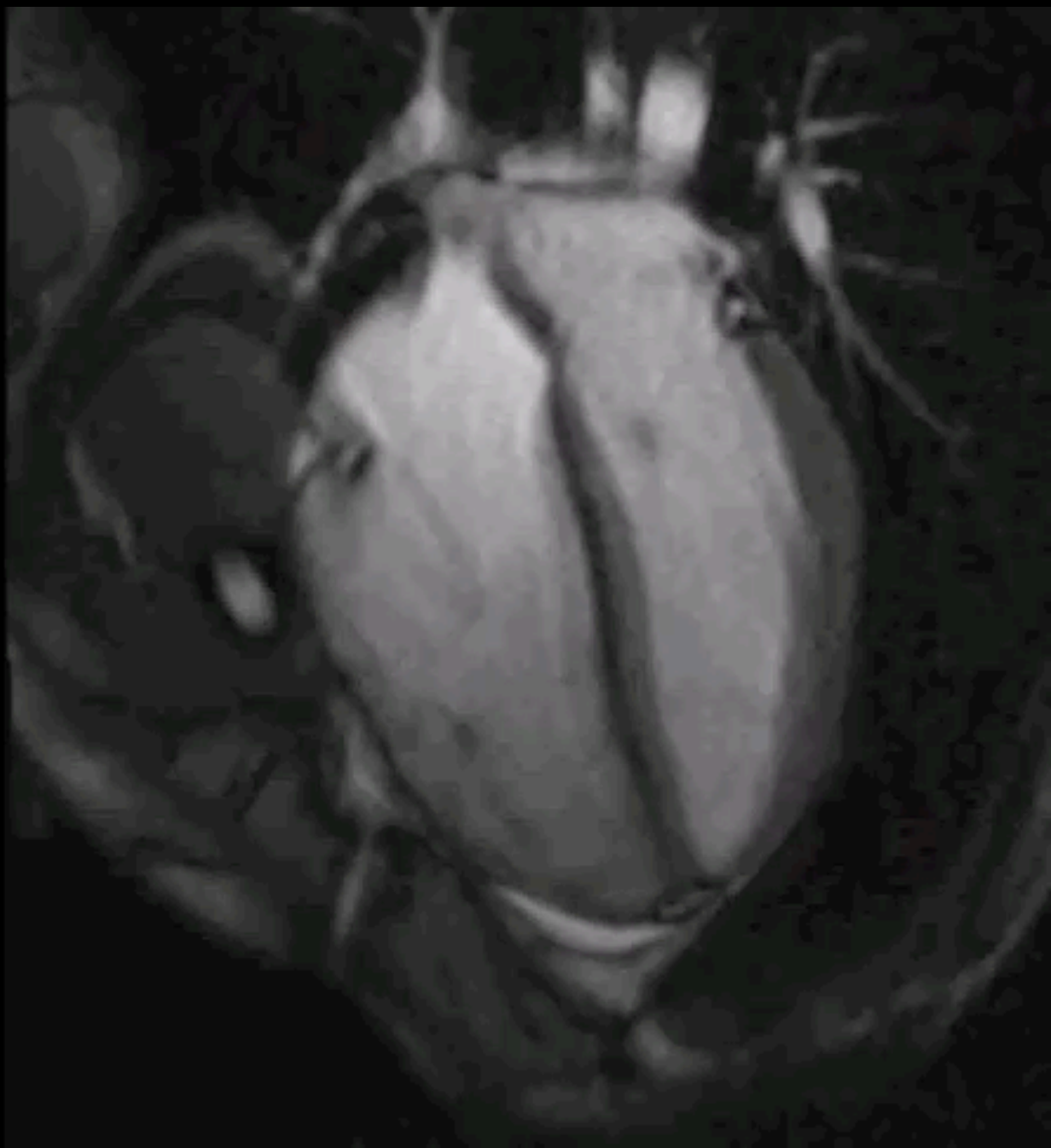


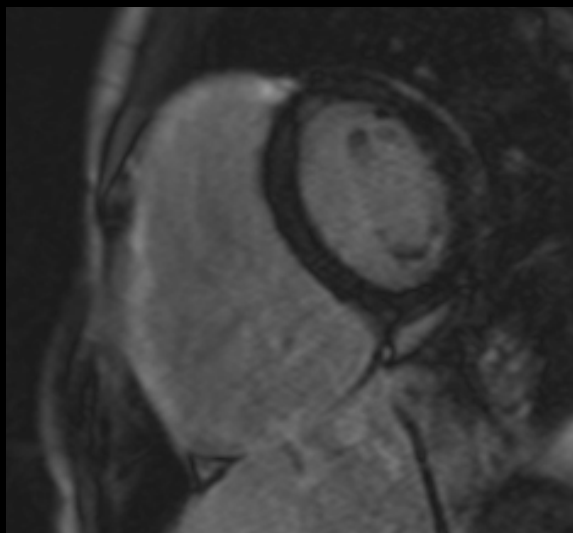
JPEG

67

LVEF: 55%
RV area: 37 cm²
RVFAC: 32%
RVOT1: 38 mm
RVOT2: 26 mm

Cardiac MRI (7/2015)





Slide 11



Cardiac MRI (2015)

- Left ventricle: low normal indexed volume with mildly reduced EF. Abnormal septal motion with pronounced flattening in diastole. Subtle region of hypokinesis in the mid lateral wall.
- Right ventricle: severely elevated indexed volumes (RVEDV/RVESV 183/139 ml) with severely reduced ejection fraction (EF 24%). Relatively preserved contraction of the basal free wall with akinesis/hypokinesis of all remaining segments.
- Tissue characterization: there is epicardial/mid wall late enhancement of the mid lateral wall.

The findings are strongly suggestive of ARVC

24h Holter (2015)

Frequent VEs, with 6 triplets and 246 couplets. No NSVT.

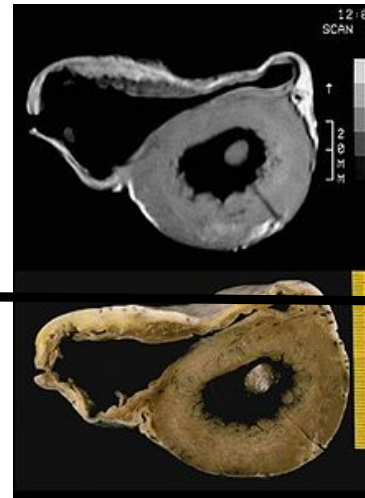
T wave inversion- a diagnostic conundrum

Prevalence and significance of T-wave inversions in predominantly Caucasian adolescent athletes

Michael Papadakis^{1,2}, Sandeep Basavarajaiah^{1,2}, John Rawlins^{1,2}, Carey Edwards^{1,2}, Jayesh Makan³, Sami Firoozi⁴, Lorna Carby², and Sanjay Sharma^{1,2*}

The prevalence, distribution, and clinical outcomes of electrocardiographic repolarization patterns in male athletes of African/Afro-Caribbean origin

Michael Papadakis^{1,2}, Francois Carre³, Gaelle Kervio⁴, John Rawlins^{1,2}, Vasileios F. Panoulas², Navin Chandra^{1,2}, Sandeep Basavarajaiah², Lorna Carby², Tiago Fonseca², and Sanjay Sharma^{1,2*}



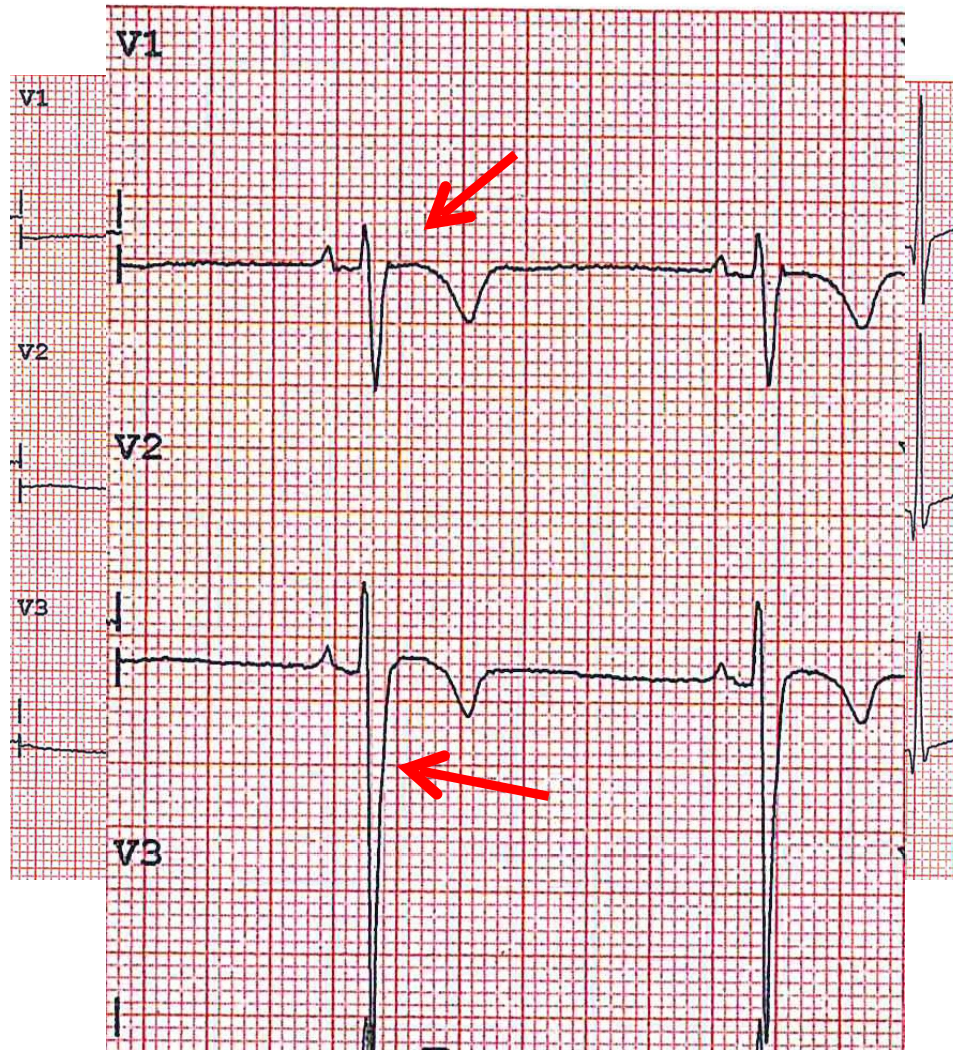
ARVC



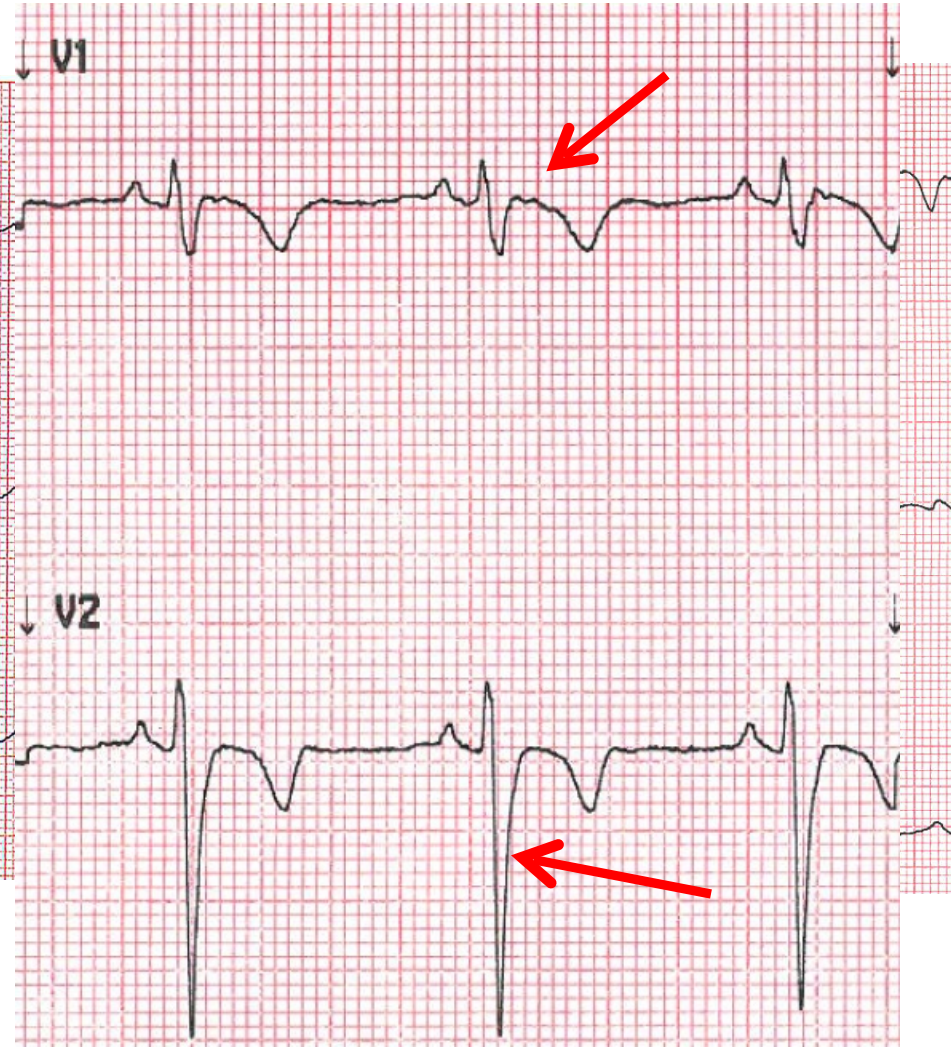
HCM

ECG in ARVC

2013

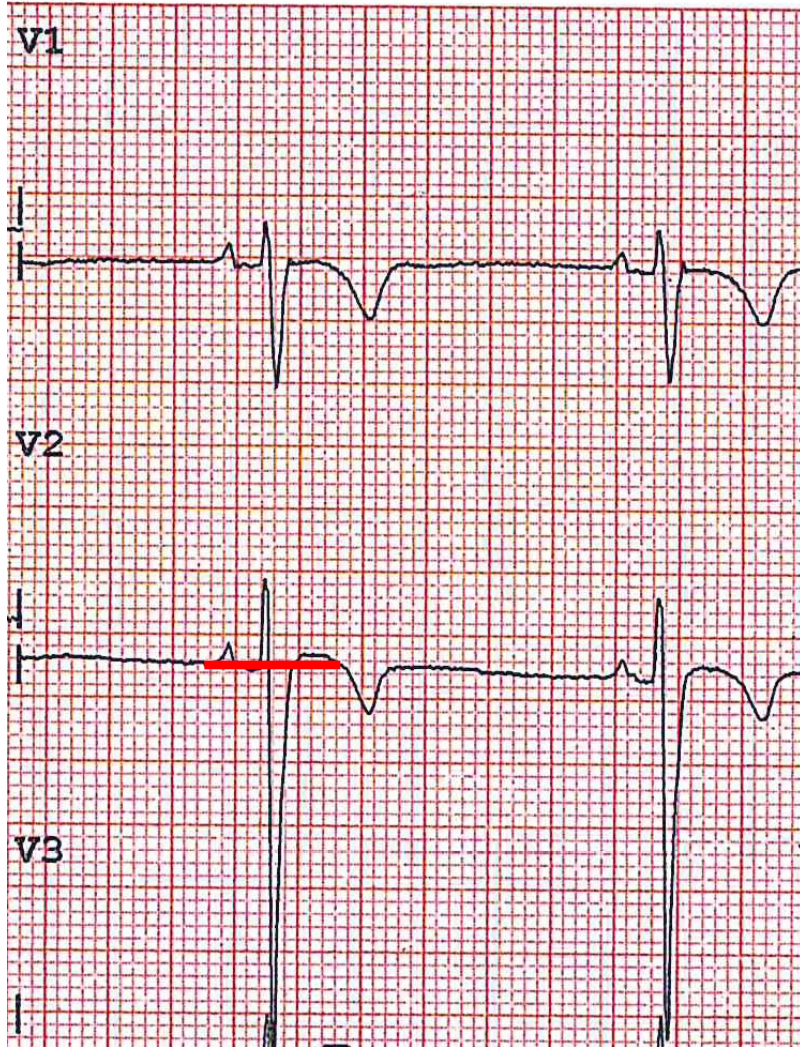


2015

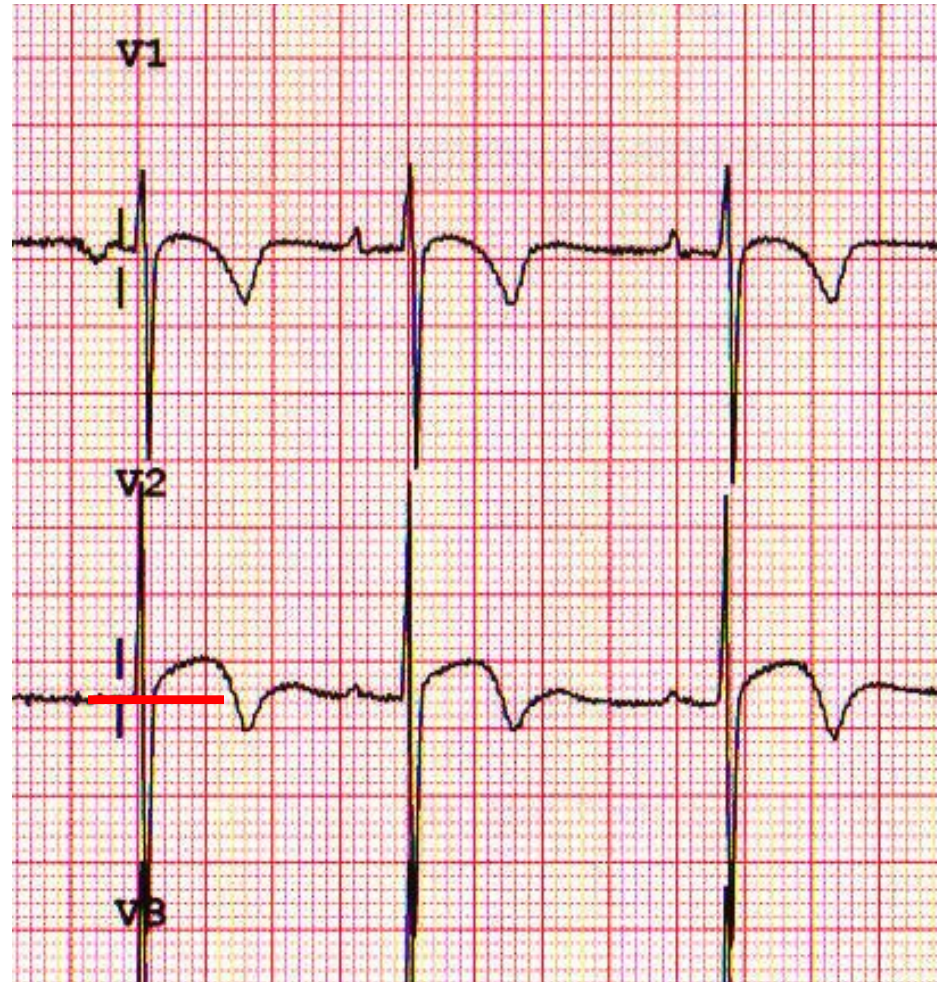


Differential diagnosis

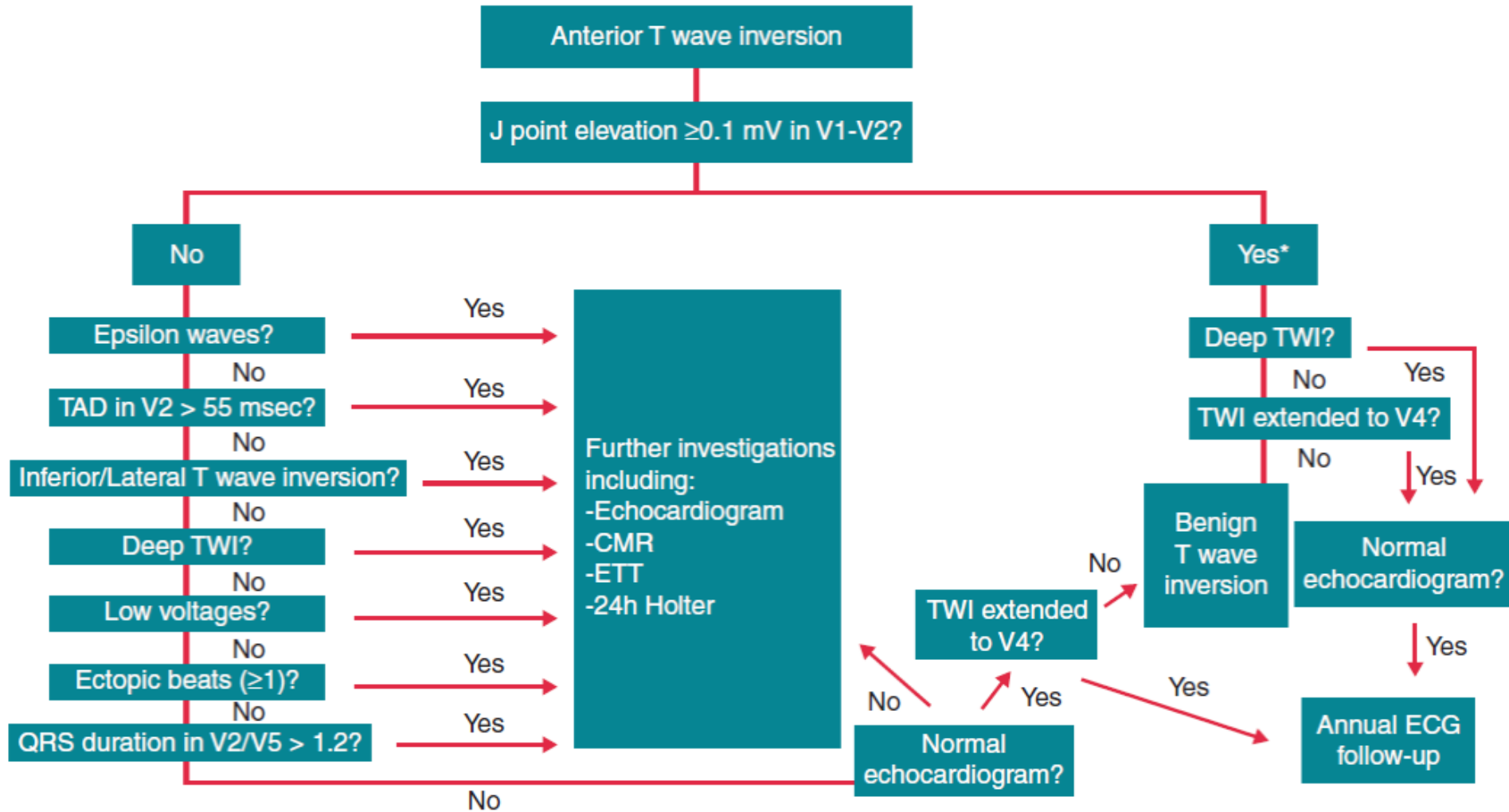
BF, “pre-clinical” ARVC



Marathon runner, male 18



How to differentiate ARVC from “benign” TWI?



MINICORSI

ROMA, 24 Giugno 2026

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Thank you

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