

EXERCISE TESTING IN PATIENTS WITH ARRHYTHMIC DISORDERS



Jeff Healey

*Director of Arrhythmia Services, Hamilton Health Sciences
Population Health Research Institute, McMaster University*

FACULTY/PRESENTER DISCLOSURE

- Faculty: Jeff Healey
- Relationships with commercial interests:
 - Grants/Research Support: None
 - Speakers Bureau/Honoraria: None
 - Consulting Fees: None

Why Perform Exercise Testing?

■ Diagnosis

- CPVT, Long QT (including sub-type)
- Workup of idiopathic VF (CASPER)

■ Prognosis

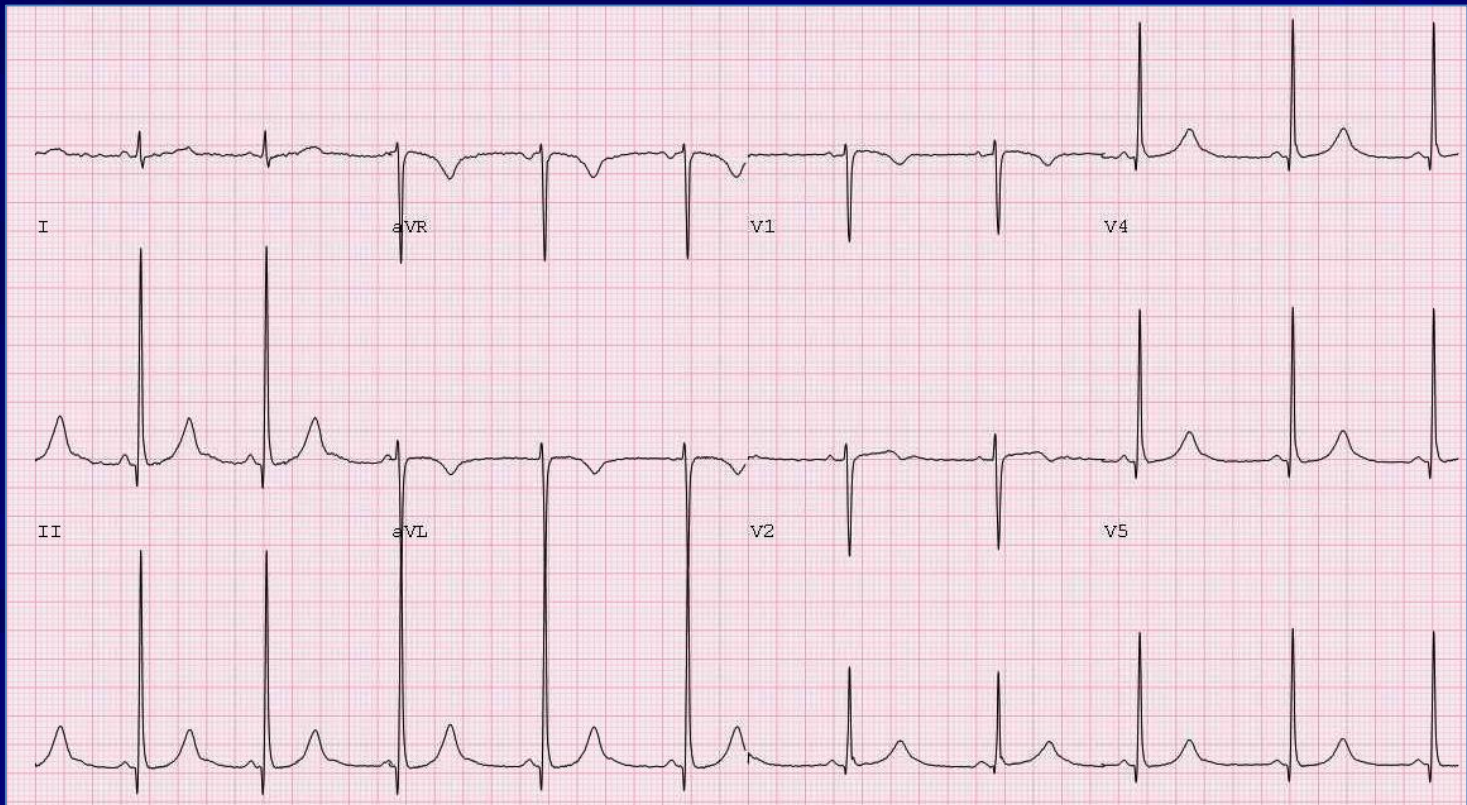
■ Tailor therapy

- Effective of beta-blockade: LongQT, ICD patients
- Dose finding, psychological benefit
- CRT optimization, response to therapy (met-cart)

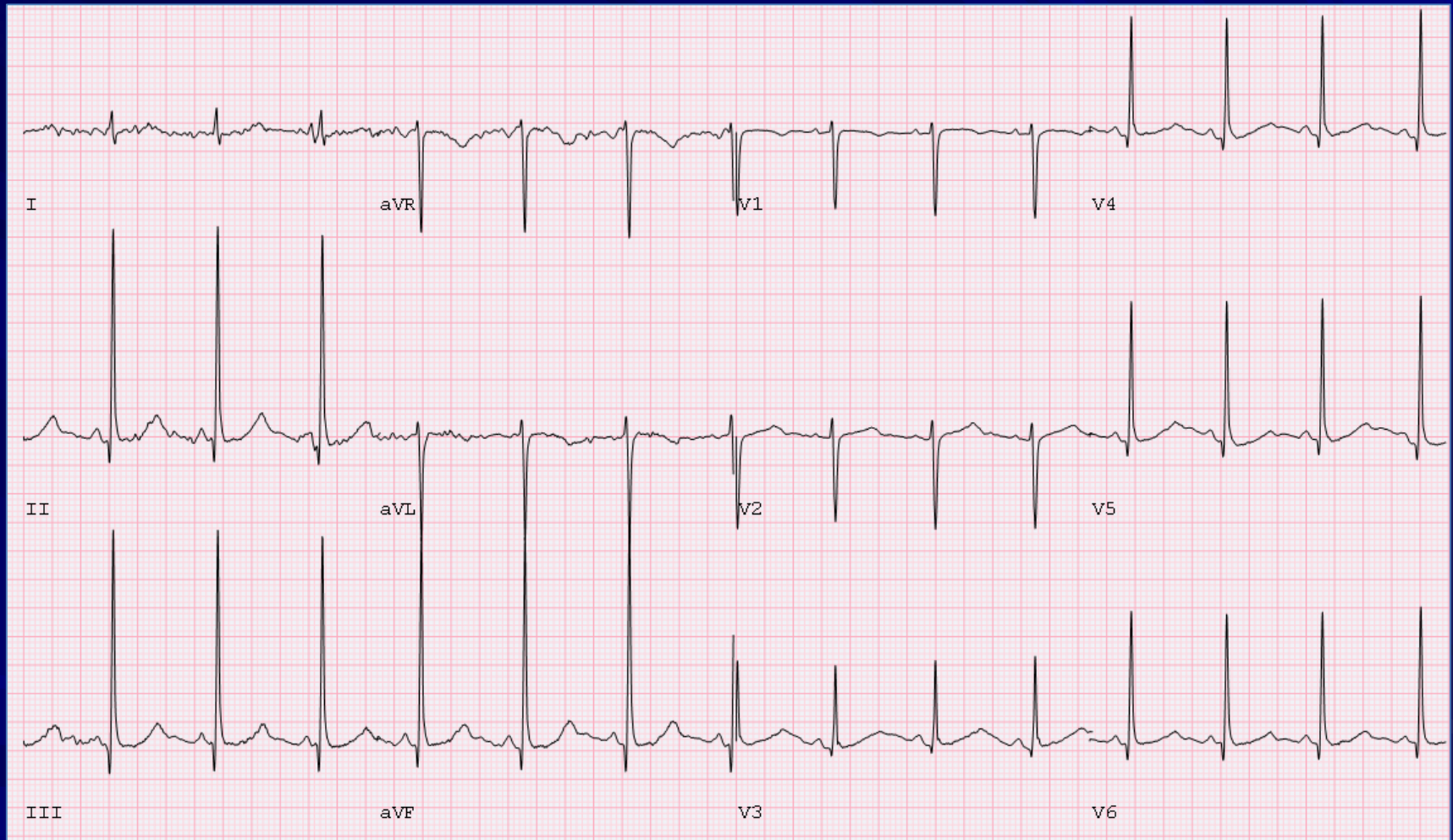


Case Presentation

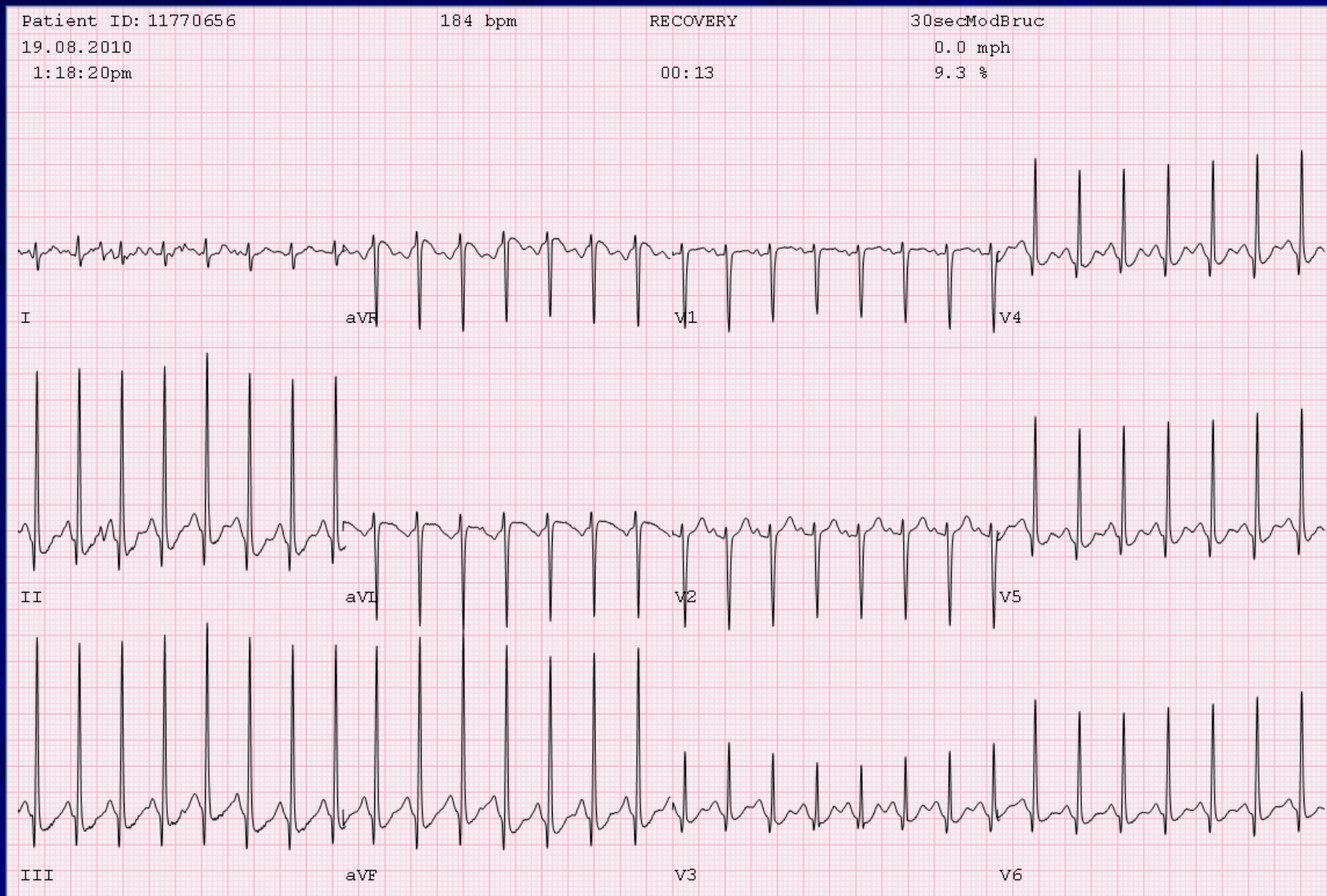
- 22 yo female with vasovagal presyncope, sent for assessment after computer interprets this ECG as borderline in student health services (QTc 455 msec)
- 2 siblings, parents A+W, cousin died boating, unsure if drowned (ETOH)



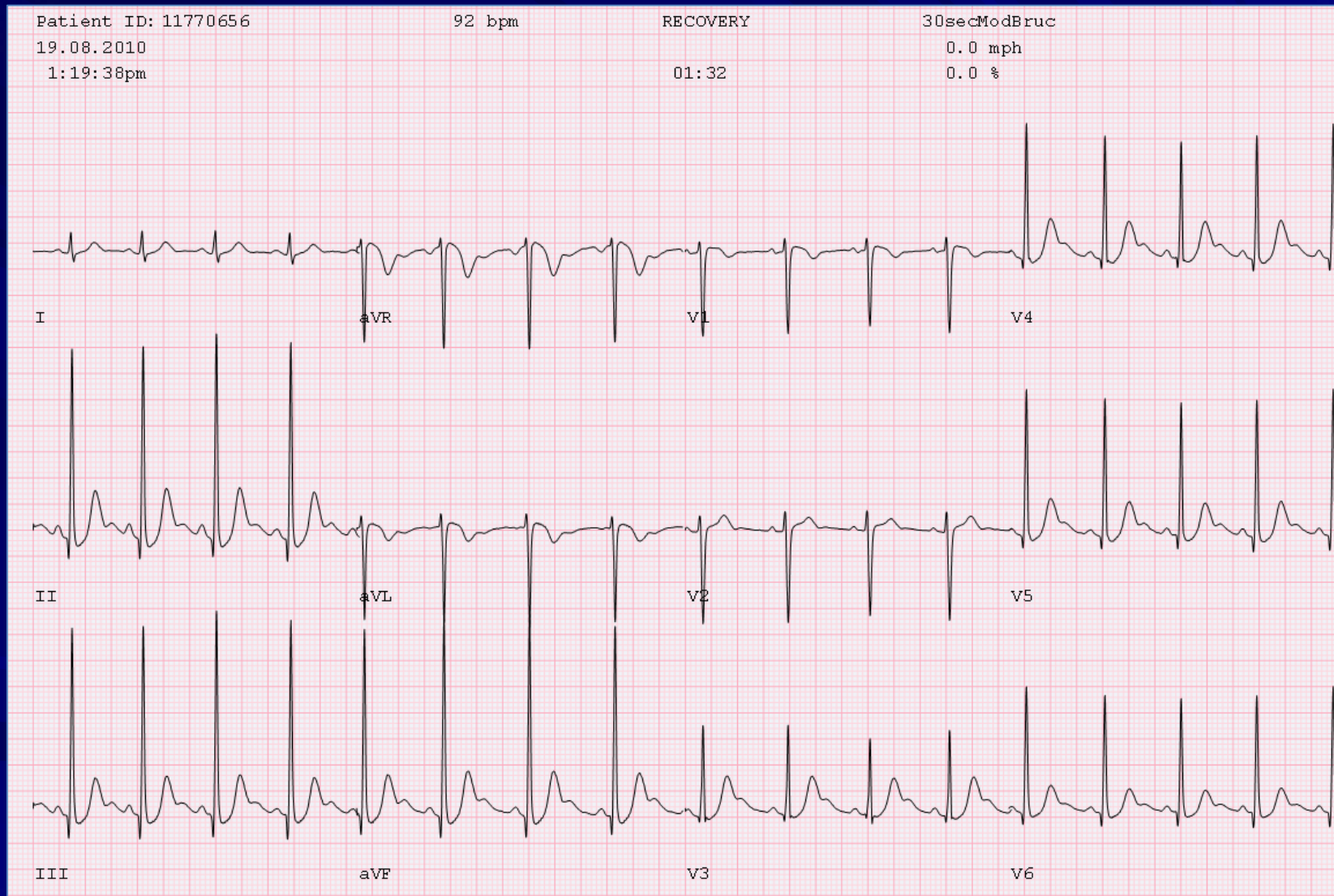
Stand up Test



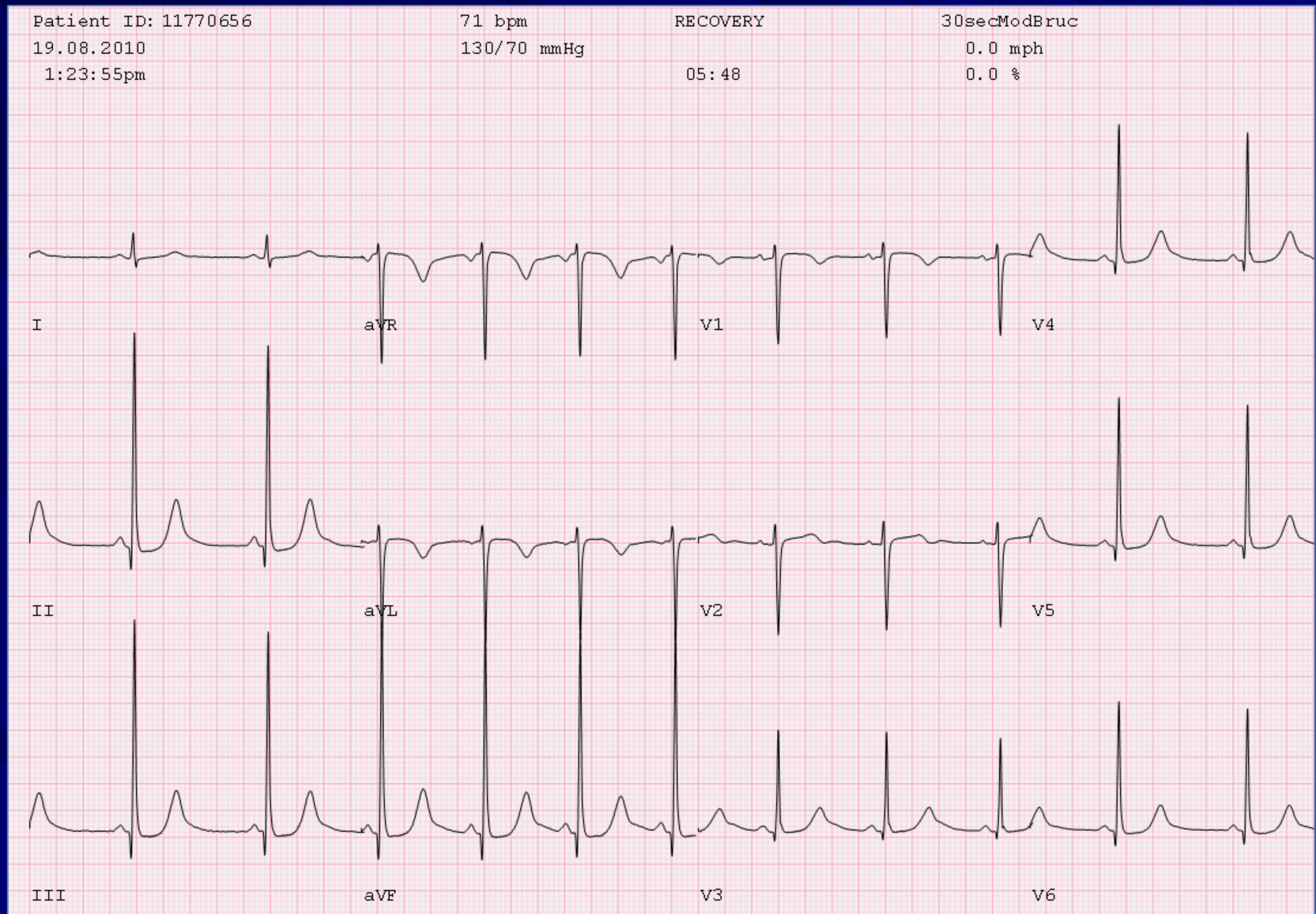
Exercise Test - Peak



Early Recovery

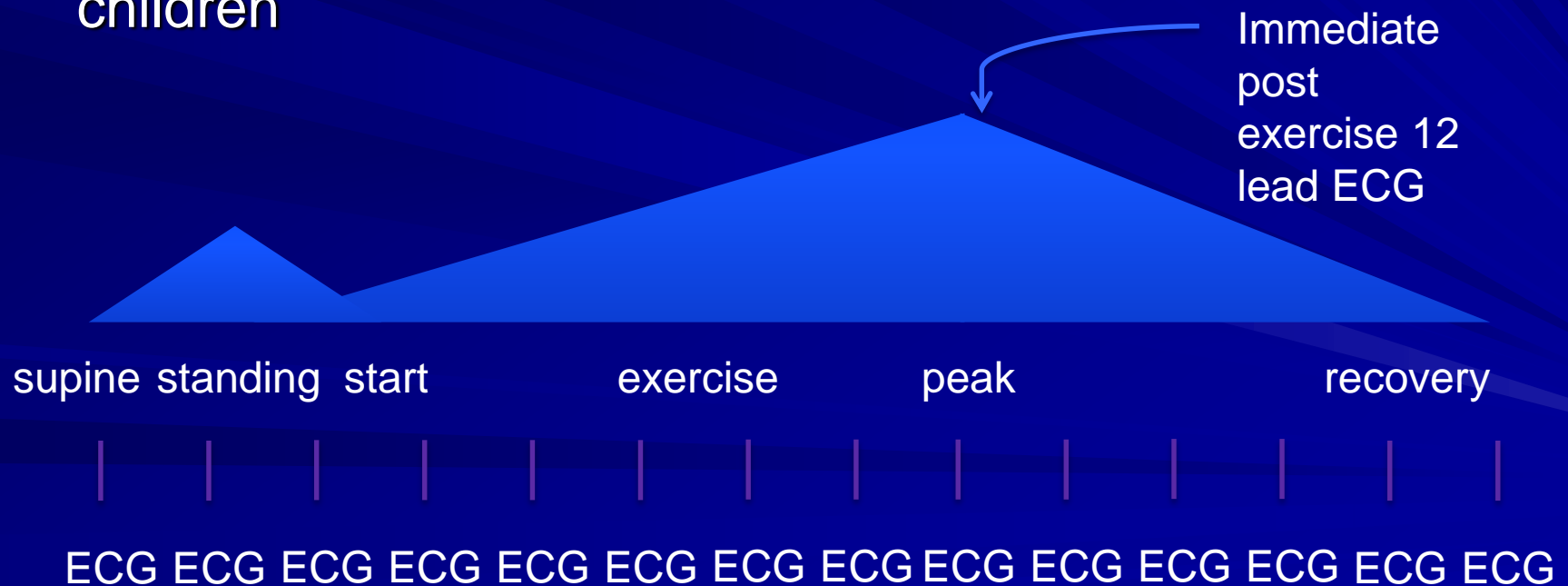


Late Recovery



QT Exercise Test

- Bruce, Modified Bruce Protocol
- Frequent ECGs: supine and standing, every minute during exercise and recovery
- Extend recovery to 6 minutes for adults, 10 minutes for children

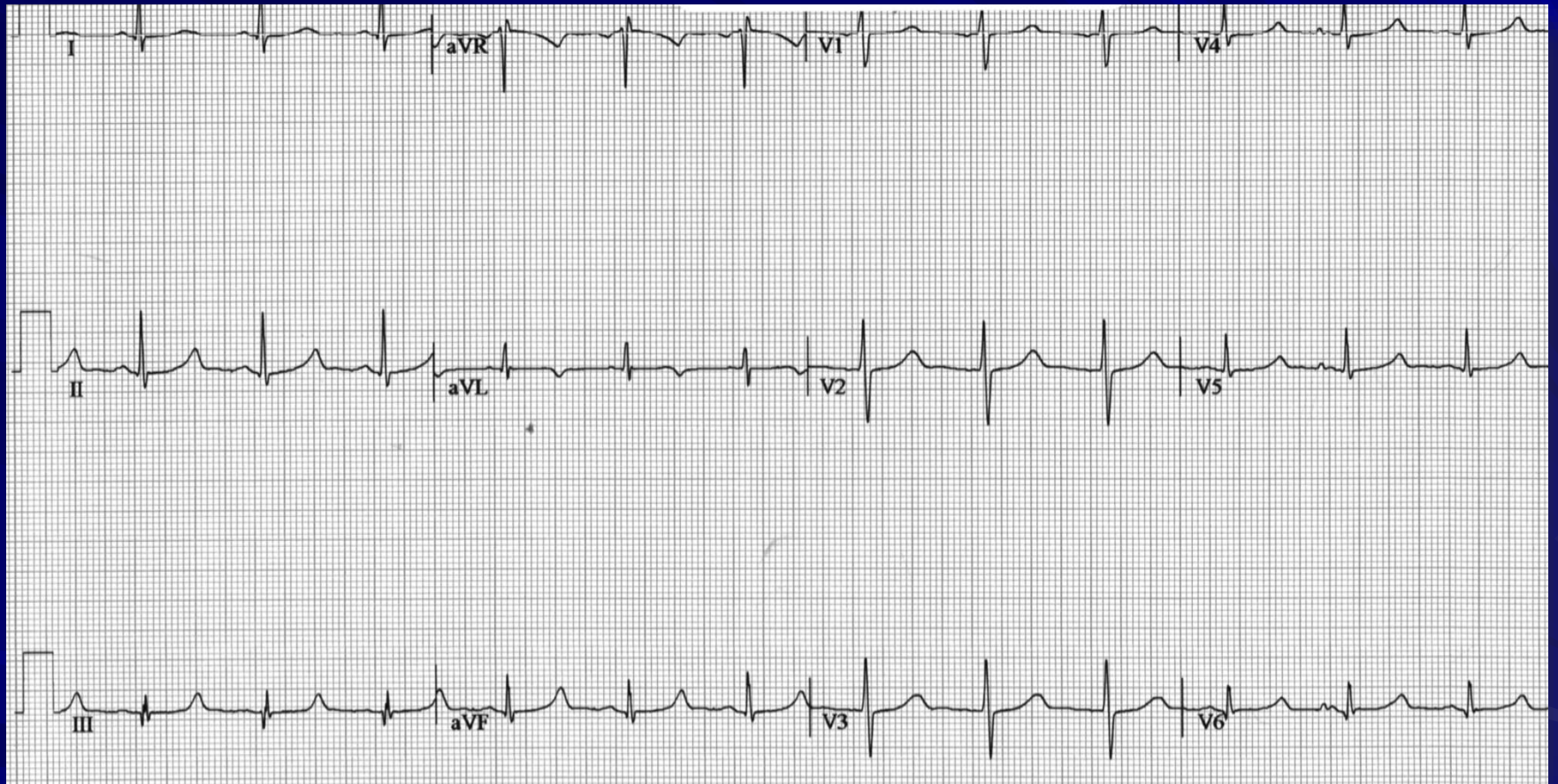


Case Presentation

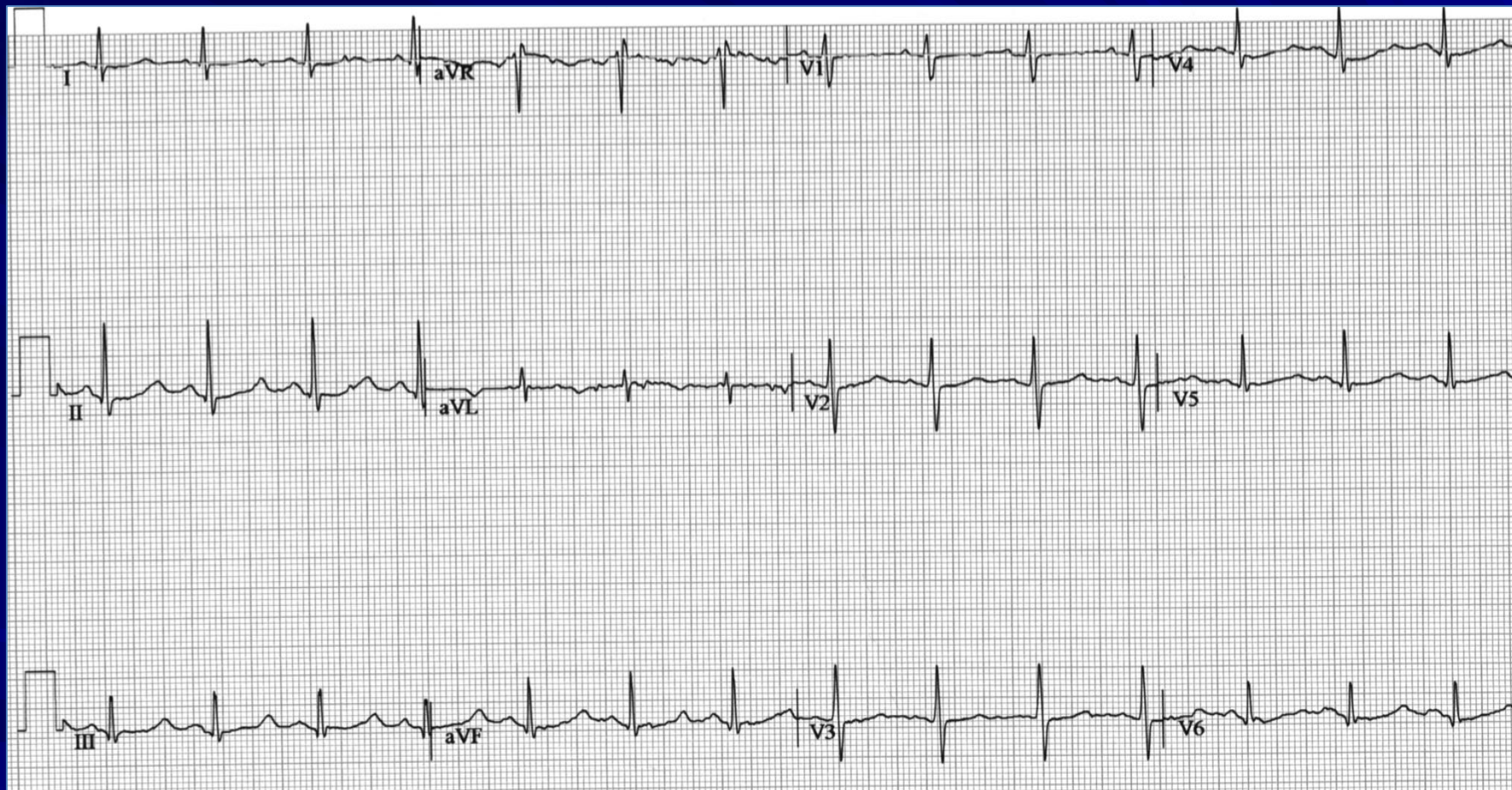
- 23 y. o. medical office assistant
- Competitive synchronized swimmer
- “spell” in the pool, possible brief syncope, adolescent vasovagal syncope
- BCP, no family history



Rest



Standing



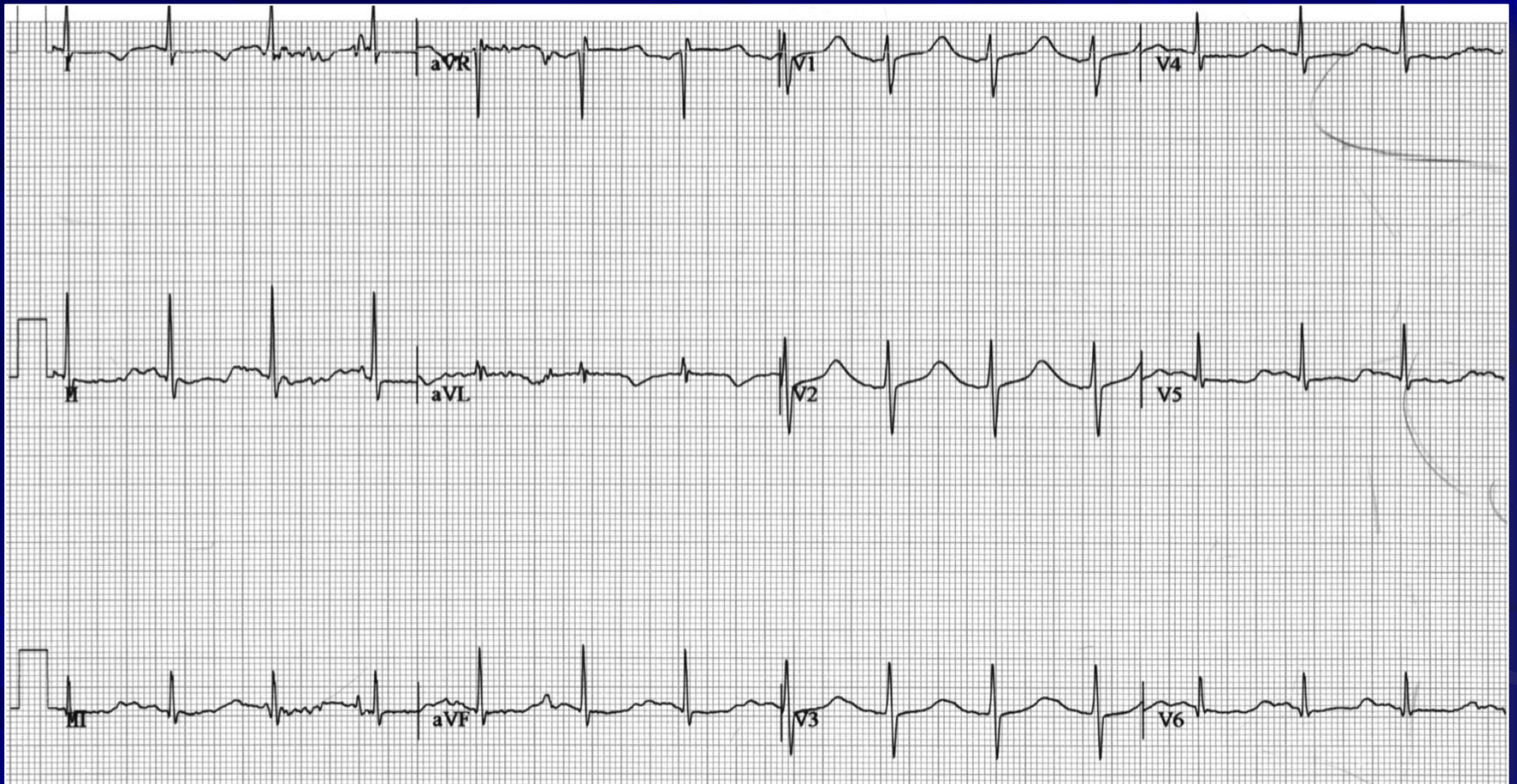
Peak Exercise



Oh My Goodness



4 min recovery



Posture Test

The Response of the QT Interval to the Brief Tachycardia Provoked by Standing

A Bedside Test for Diagnosing Long QT Syndrome

Sami Viskin, MD,* Pieter G. Postema, MD,§ Zahurul A. Bhuiyan, MD, PhD,§ Raphael Rosso, MD,||
Jonathan M. Kalman, MBBS, PhD,|| Jitendra K. Vohra, MD,|| Milton E. Guevara-Valdivia, MD,¶
Manlio F. Marquez, MD,# Evgeni Kogan, MD,* Bernard Belhassen, MD,* Michael Glikson, MD,†
Boris Strasberg, MD,‡ Charles Antzelevitch, PhD,** Arthur A. M. Wilde, MD§

Circulation

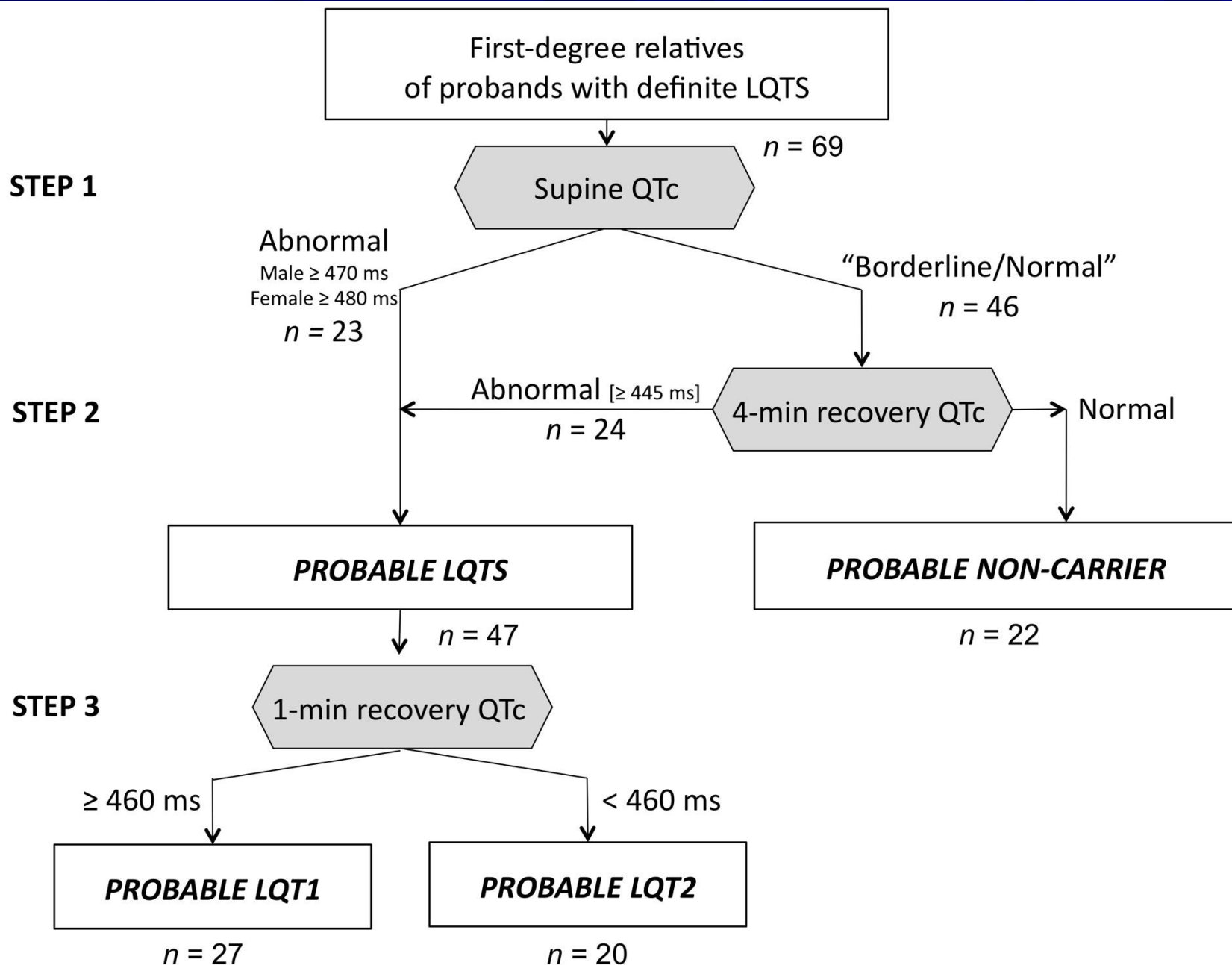
JOURNAL OF THE AMERICAN HEART ASSOCIATION



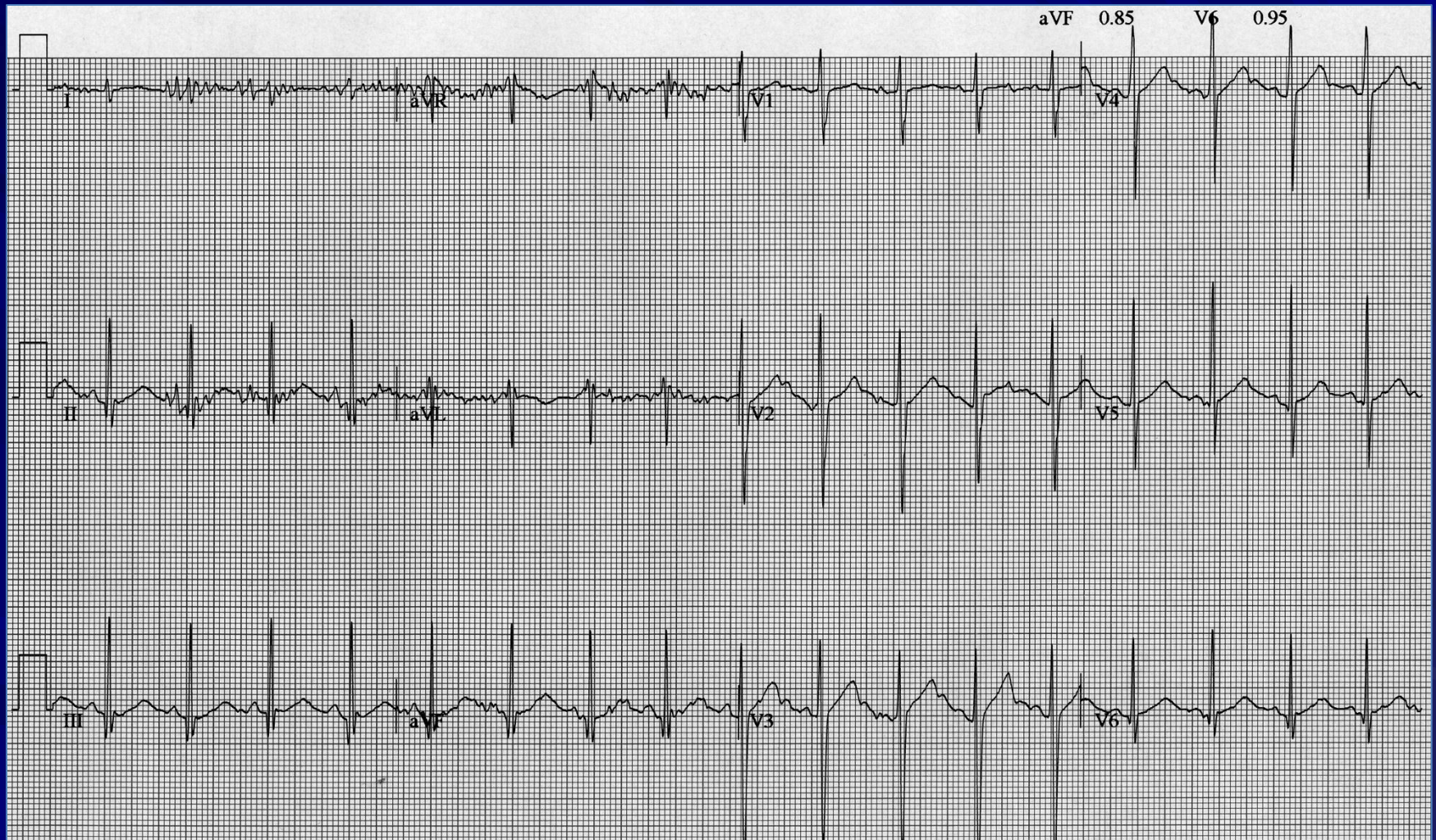
Derivation and Validation of a Simple Exercise-Based Algorithm for Prediction of Genetic Testing in Relatives of LQTS Probands

Raymond W. Sy, Christian van der Werf, Ishvinder S. Chattha, Priya Chockalingam, Arnon Adler, Jeffrey S. Healey, Mark Perrin, Michael H. Gollob, Allan C. Skanes, Raymond Yee, Lorne J. Gula, Peter Leong-Sit, Sami Viskin, George J. Klein, Arthur A. Wilde and Andrew D. Krahn

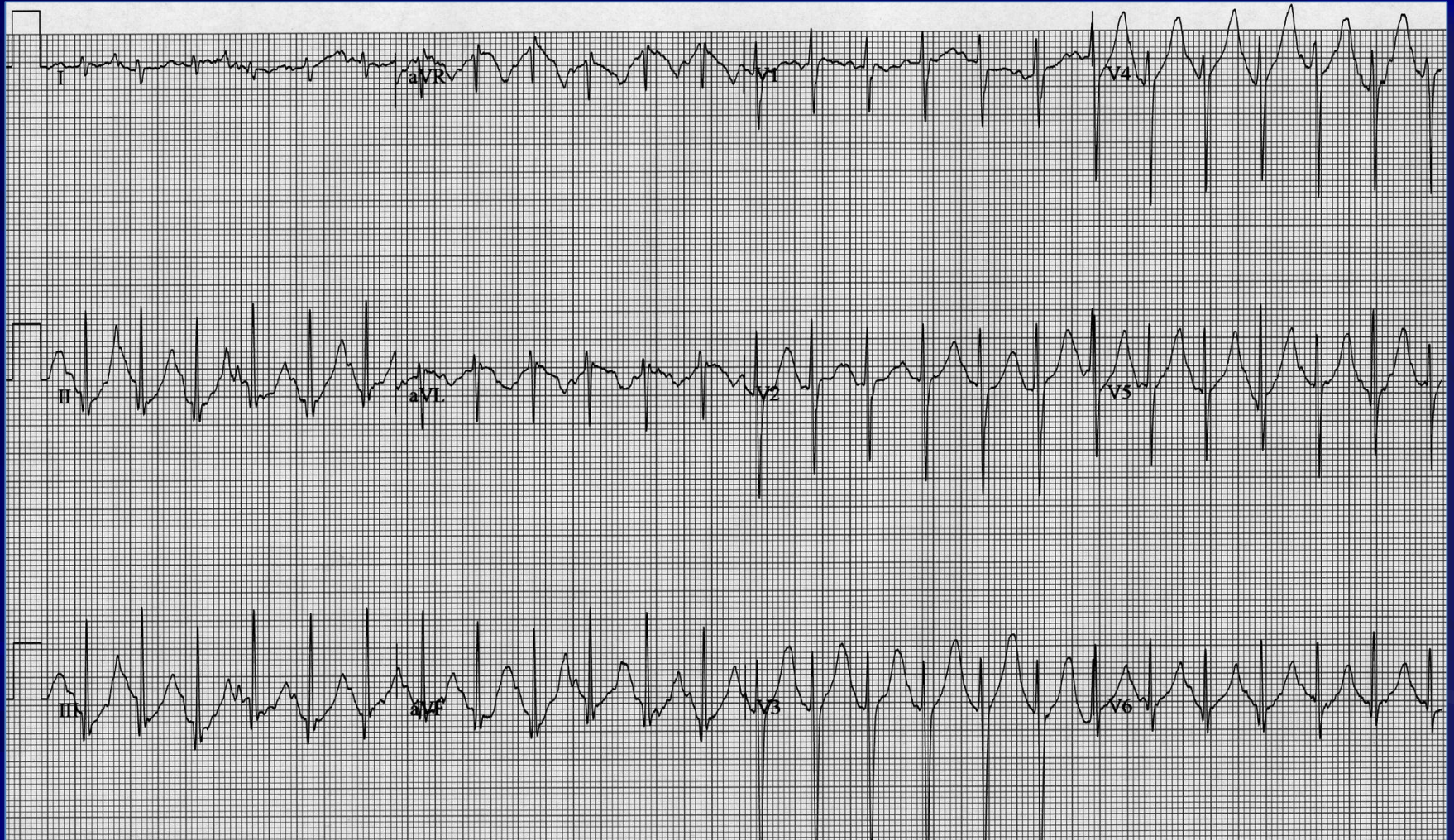
Circulation published online October 31, 2011



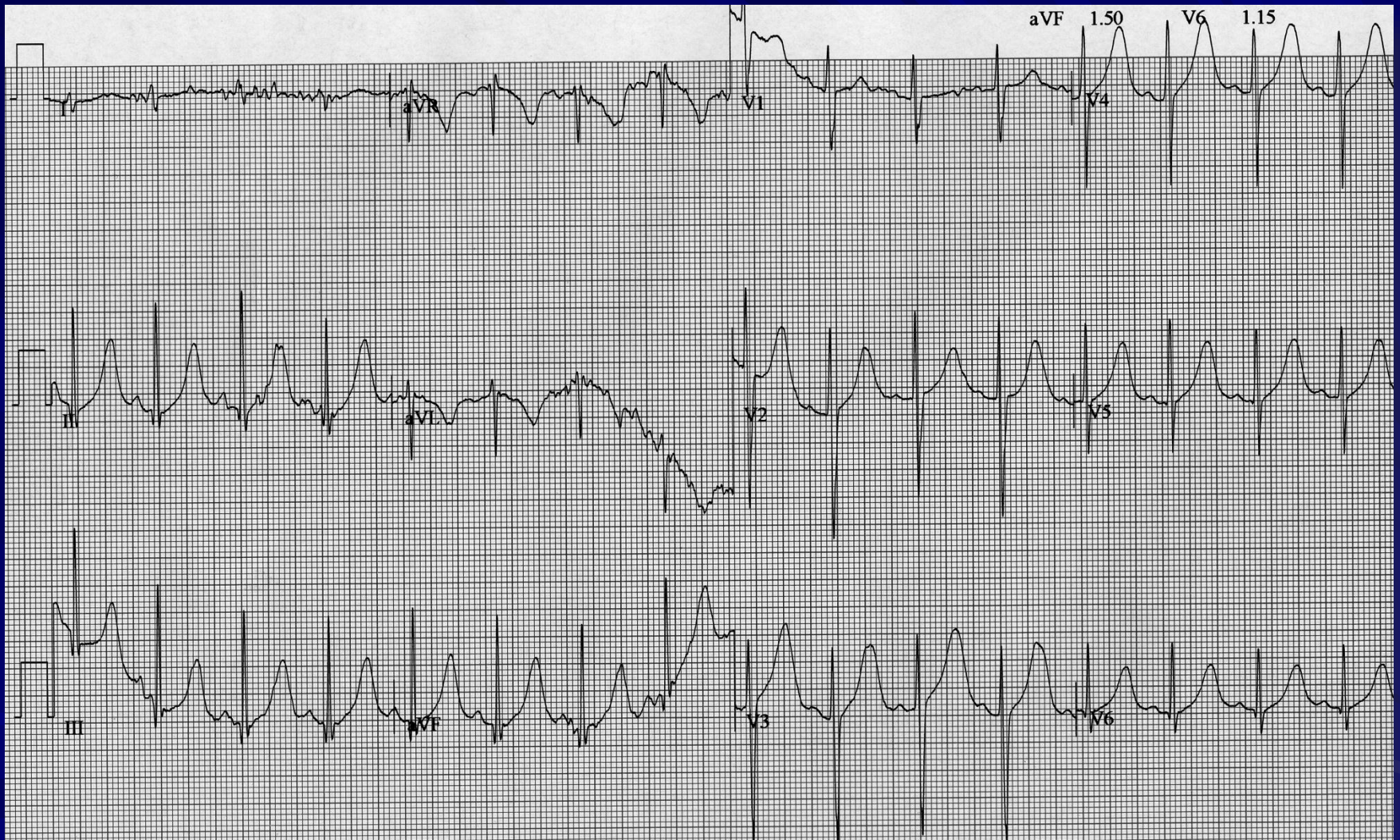
Back to our case - early exercise



peak



recovery



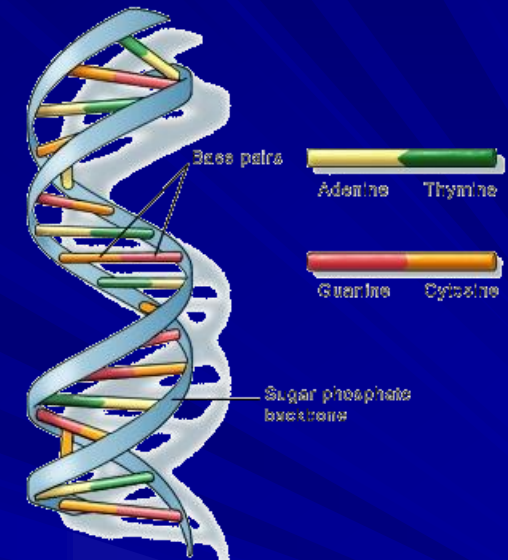
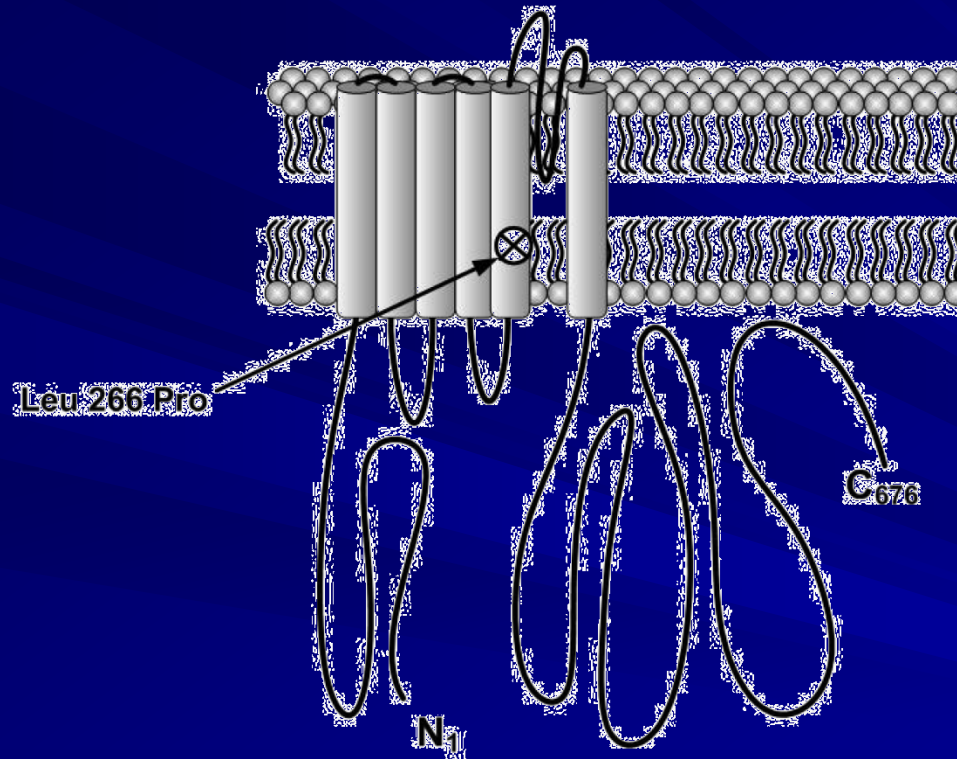
Early recovery QT prolongation predicts LQT1 genotype

Chattha et al Heart Rhythm 2010

Genetic Testing

KCNQ1/KVLQT1

LQT9922490626



Num	Gene	Region(G)	Nucl.Change	A.A.Change	Genotype	Region(P)	Region Type(P)	Class
1	KCNQ1	exon 6	797 T>C	Leu 266 Pro	T/C	S5 domain	Transmembrane	I
2	SCN5A	exon 12	1673 A>G	His 558 Arg	A/G	D1/DII	Transmembrane spanning linker	III

Derivation and Validation of a Simple Exercise-Based Algorithm for Prediction of Genetic Testing in Relatives of LQTS Probands

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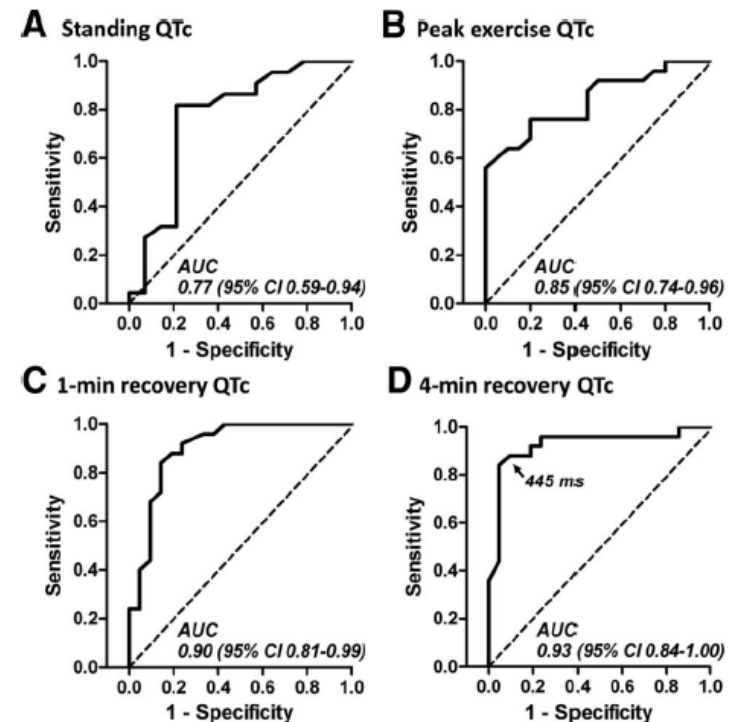
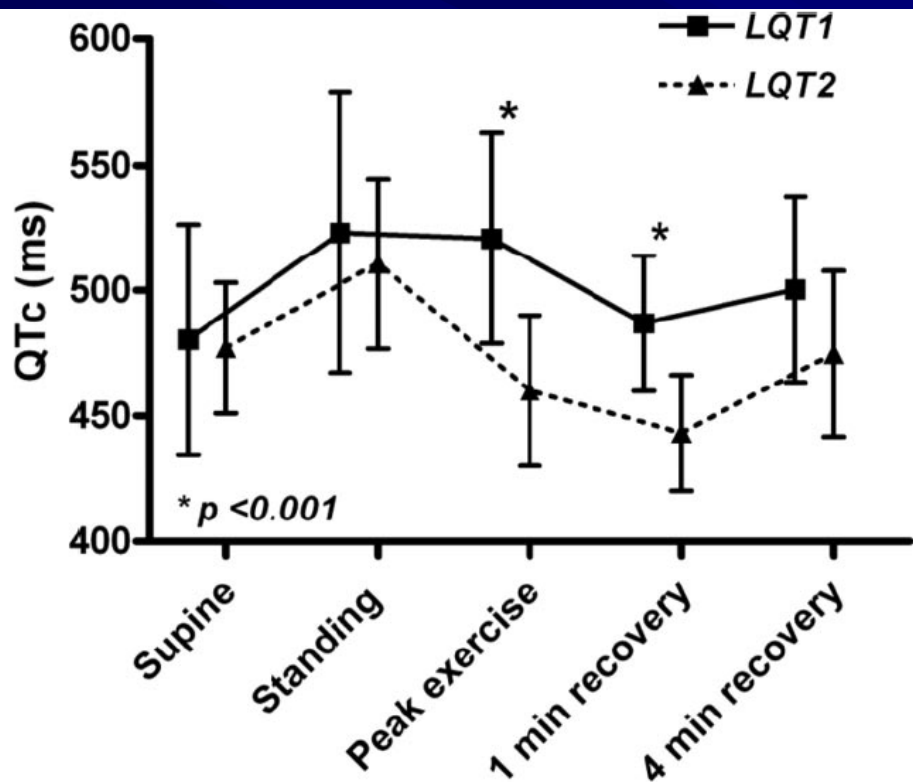


Figure 3. Receiver operating characteristics curves for detecting LQTS with standing corrected QT interval (QTc; A), peak exercise QTc (B), 1-minute recovery QTc (C), and 4-minute recovery QTc (D). Area under the curve (AUC) is presented for each parameter. 95% CI indicates 95% confidence interval.

STEP 1

First-degree relatives
of probands with definite LQTS

Supine QTc

$n = 69$

Abnormal
Male ≥ 470 ms
Female ≥ 480 ms
 $n = 23$

"Borderline/Normal"

$n = 46$

STEP 2

Abnormal $[\geq 445 \text{ ms}]$

$n = 24$

4-min recovery QTc

Normal

PROBABLE LQTS

PROBABLE NON-CARRIER

$n = 47$

$n = 22$

STEP 3

1-min recovery QTc

≥ 460 ms

< 460 ms

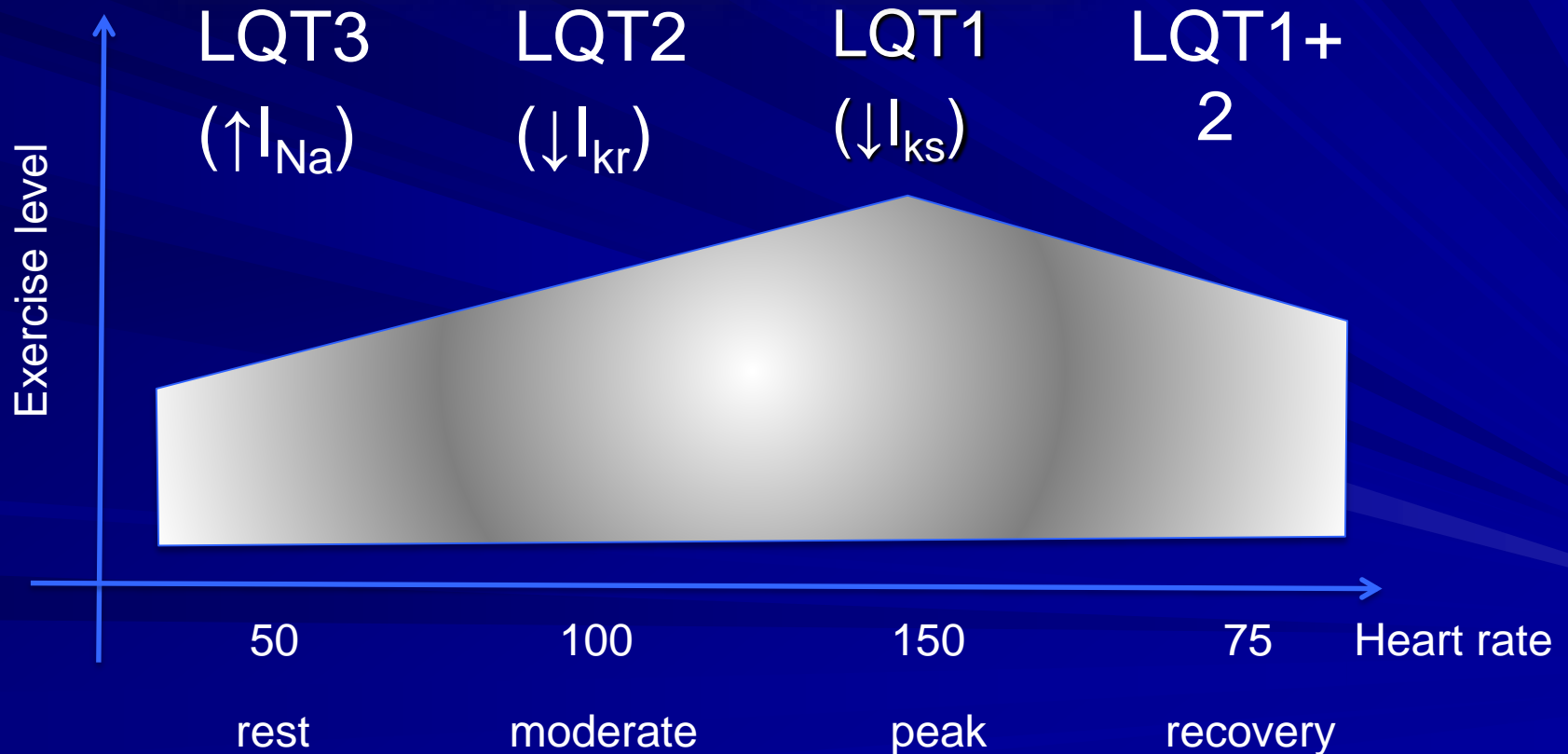
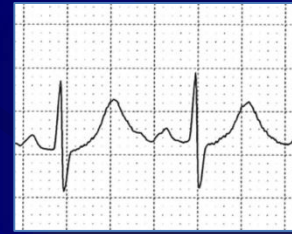
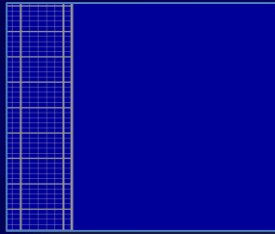
PROBABLE LQT1

PROBABLE LQT2

$n = 27$

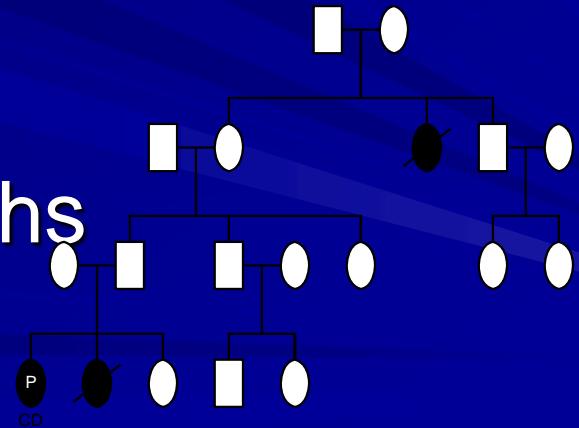
$n = 20$

Heart Rate Zones to look for QTc Prolongation in LQTS Types

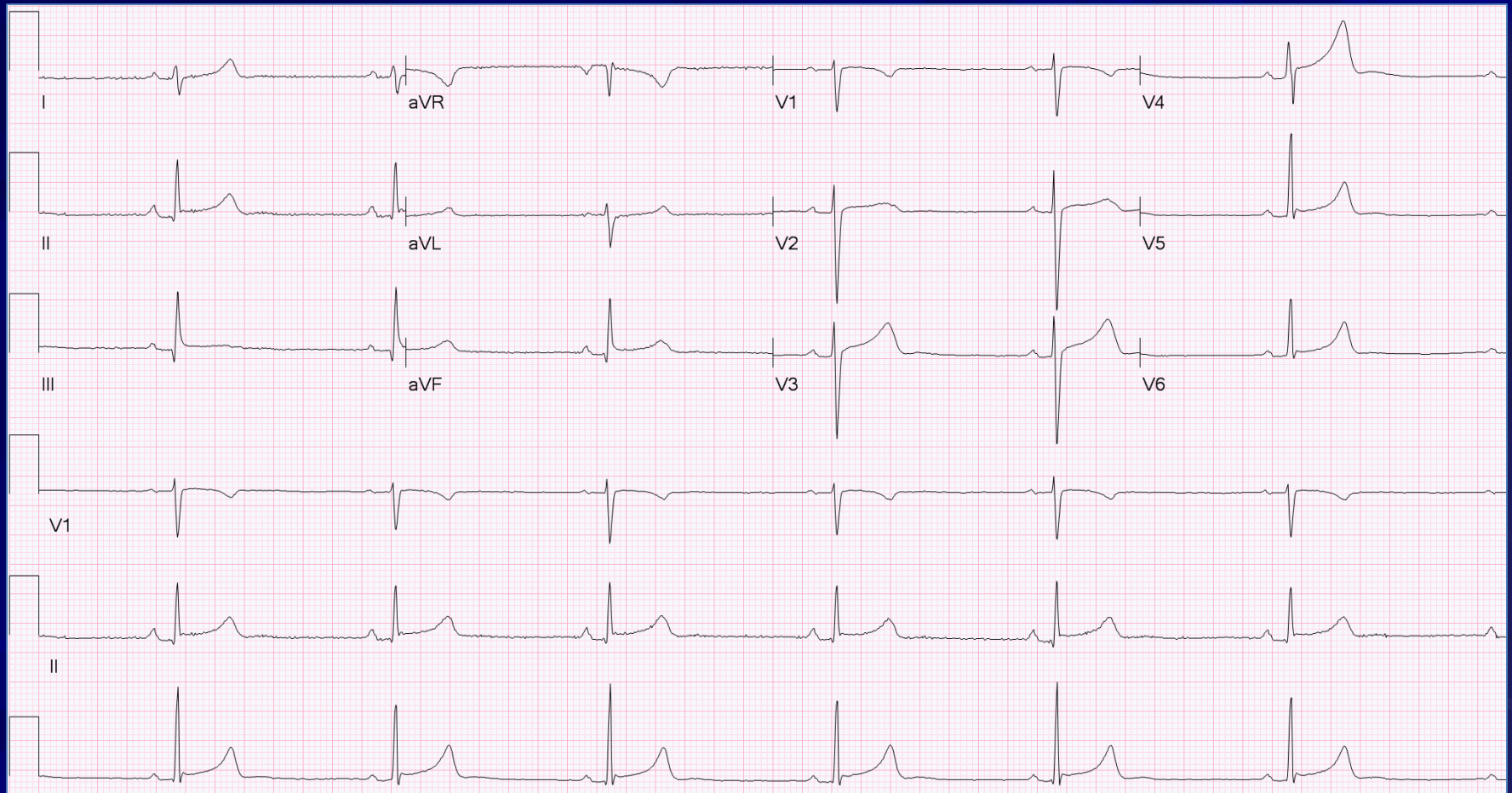


Case Presentation

- 29 year old female Triathlete
 - Palpitations while swimming, lightheaded
 - Gets out of pool and has syncope
 - Awakens after 10 seconds, heart pounding
 - Gets up, LOC again
 - No previous events
 - Sister with SIDS at 2 months
 - Dutch heritage
-
- ```
graph TD
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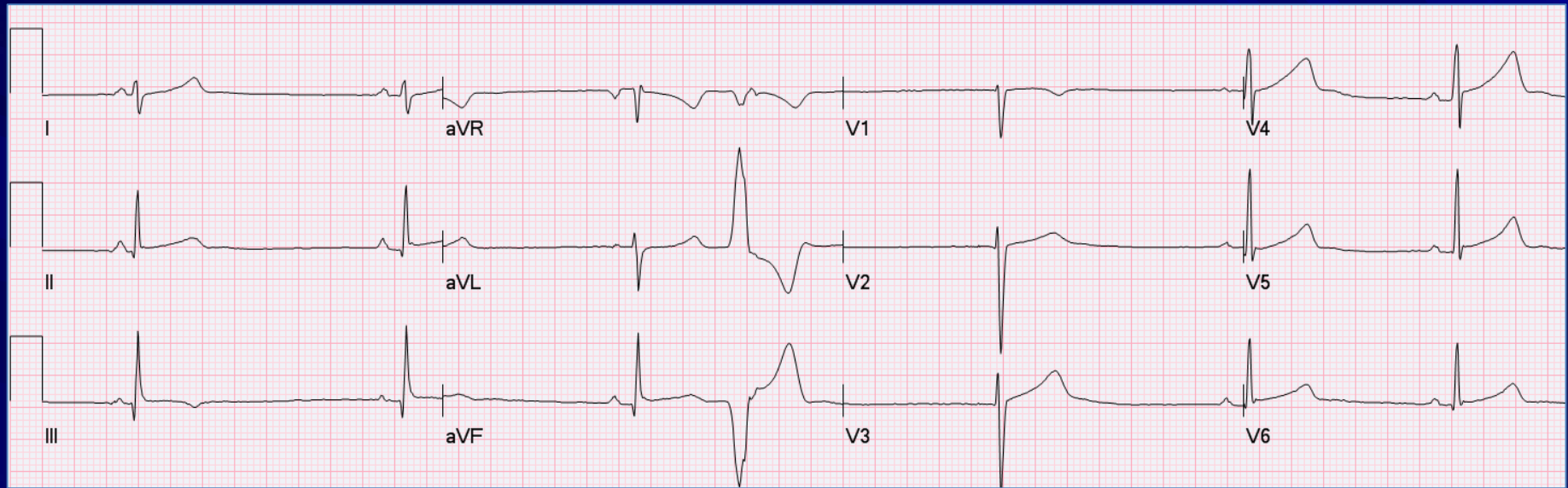


# Resting ECG

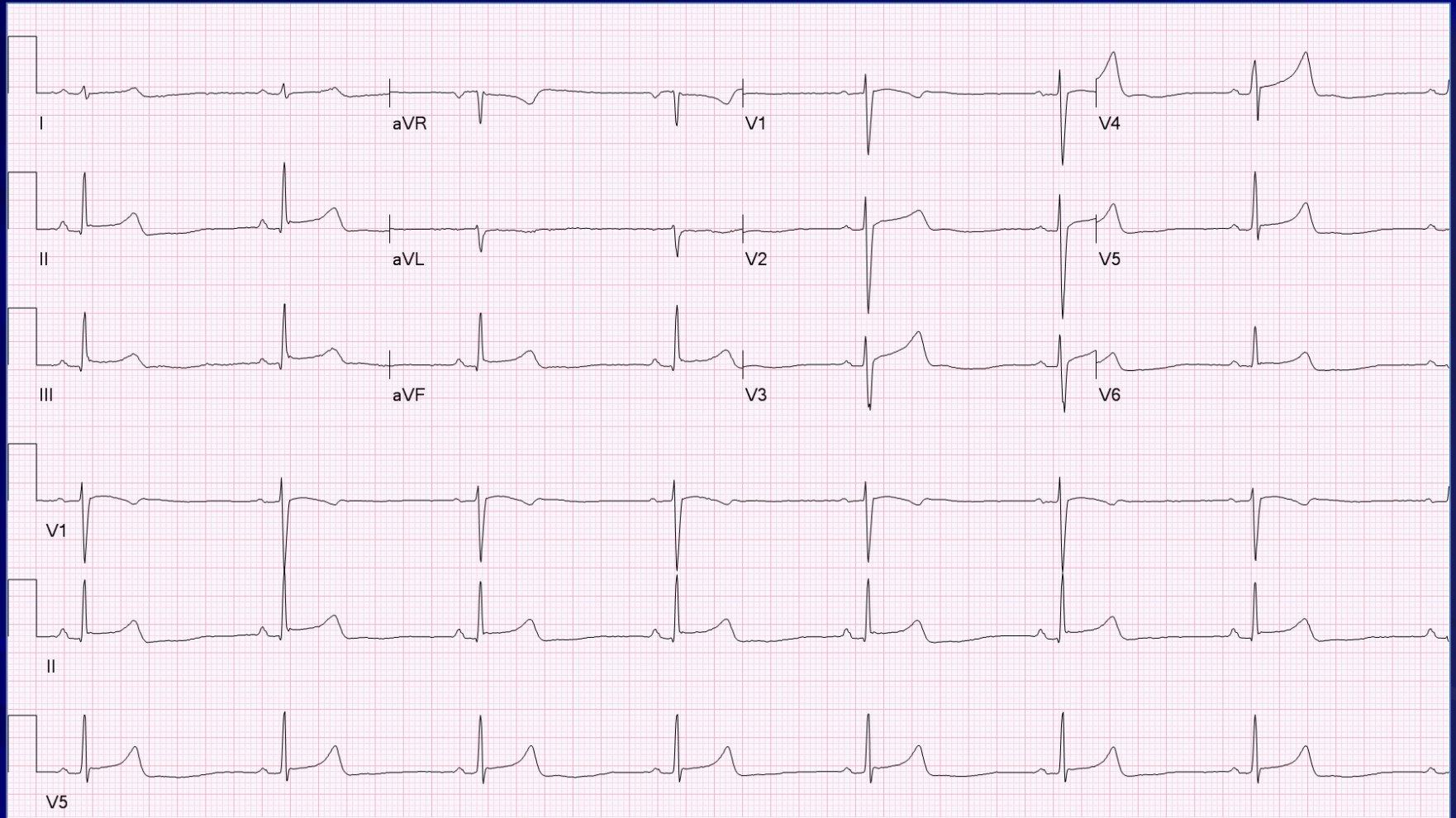




# Resting ECG 2 with wide QRS beat



# Resting ECG with Horizontal Early Repol



# Investigations

- Echo normal

- MRI

  - LV normal

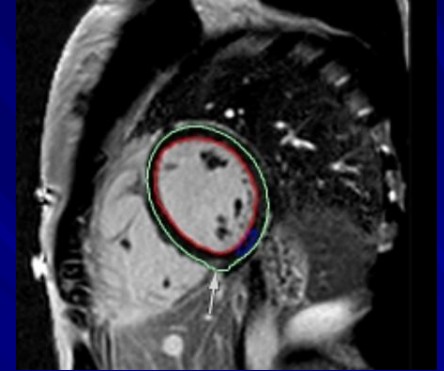
  - ? RV dilatation

  - at most 1 minor criteria for ARVC

  - Normal coronary arteries



Tissue Characterization: Delayed contrast imaging is abnormal. There is a mild amount of non-ischemic fibrosis seen at the right ventricular insertion point at the inferoseptal wall. This is typically seen in patients with chronic right ventricular volume / pressure overload and its clinical significance in this setting is uncertain.



#### SUMMARY

1. Normal left ventricular dimensions, wall thickness and systolic function. The LV ejection fraction is 58%.
2. The right ventricle is borderline enlarged when indexed to body surface area. There is regional wall thinning in the right ventricular outflow tract that is associated with hypokinesia. A small microaneurysm is also noted. Normal global systolic function with an ejection fraction of 60%. There is prominent trabeculation along the right ventricular free wall.
3. No evidence of intramyocardial fat or edema.
4. Non-specific mild fibrosis of the RV insertion site in the inferoseptal wall.
5. Normal atrial dimensions.
6. No significant valvular heart disease.

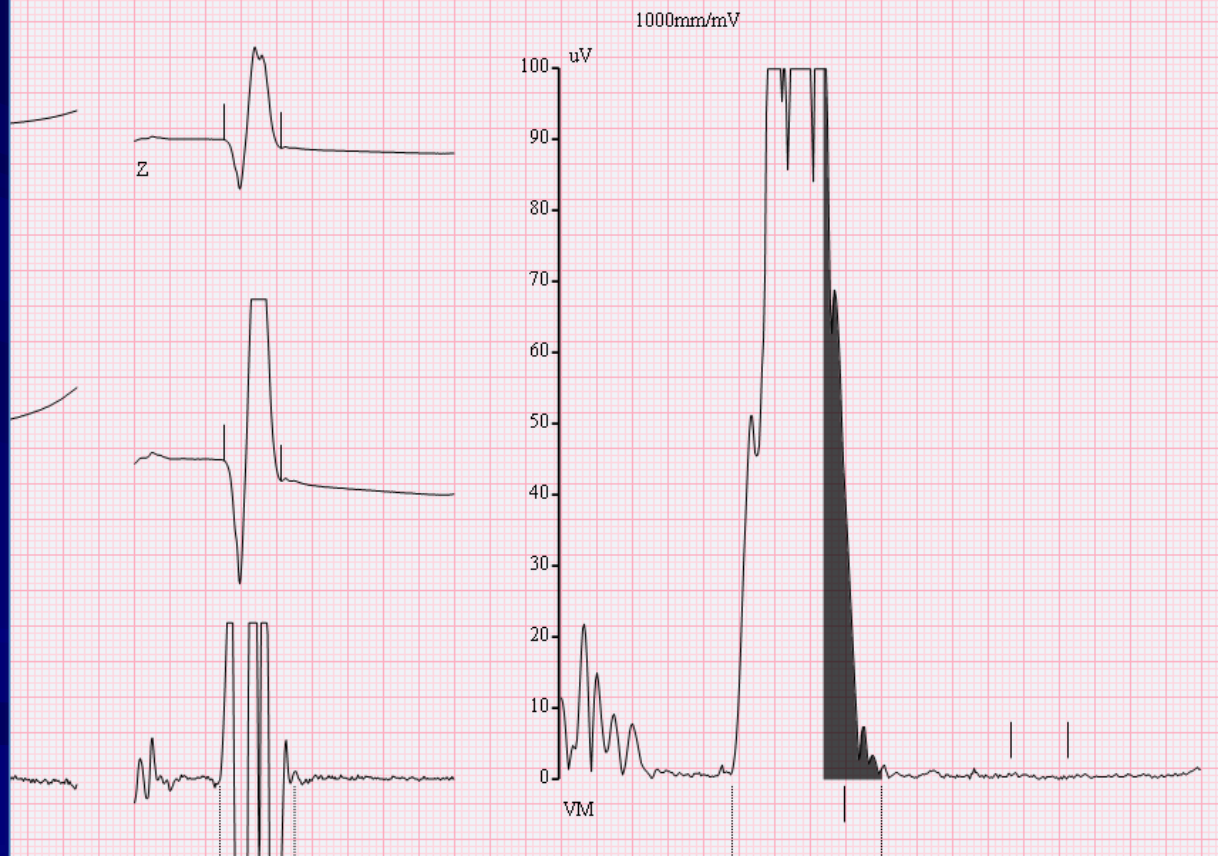
Overall, there are sufficient RV findings to classify a minor criterion for the diagnosis of a right ventricular cardiomyopathy (ARVC). There is no evidence of any other non-ischemic cardiomyopathic process that could explain the presenting arrhythmia. The coronary arteries are normal in origin and course.

Analysis Filter: 40-250Hz

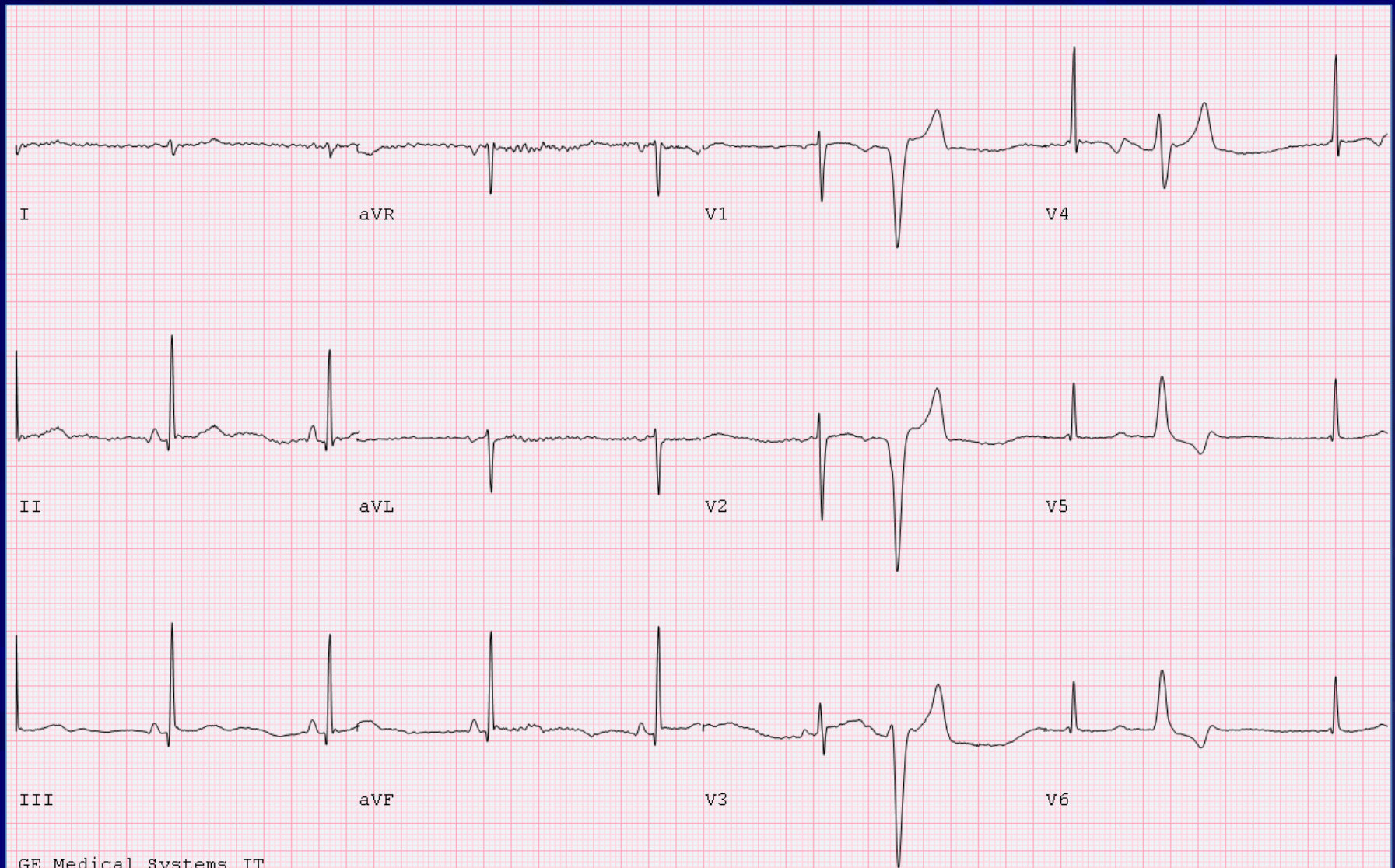
|                                       |   |            |                              |   |              |
|---------------------------------------|---|------------|------------------------------|---|--------------|
| Std. QRS Duration (unfiltered)        | : | 80 ms      | Number of Beats Averaged     | : | 401          |
| Total QRS Duration (filtered)         | : | 105 ms     | Number of Beats Detected     | : | 422          |
| Duration of HFLA signals < 40 $\mu$ V | : | 26 ms      | Noise Level (Std. Deviation) | : | 0.22 $\mu$ V |
| RMS Voltage in terminal 40 ms         | : | 42 $\mu$ V |                              |   |              |
| Mean Voltage in terminal 40 ms        | : | 29 $\mu$ V |                              |   |              |

Referred by: G. Klein

Demographics completed by: Andrea Kemps

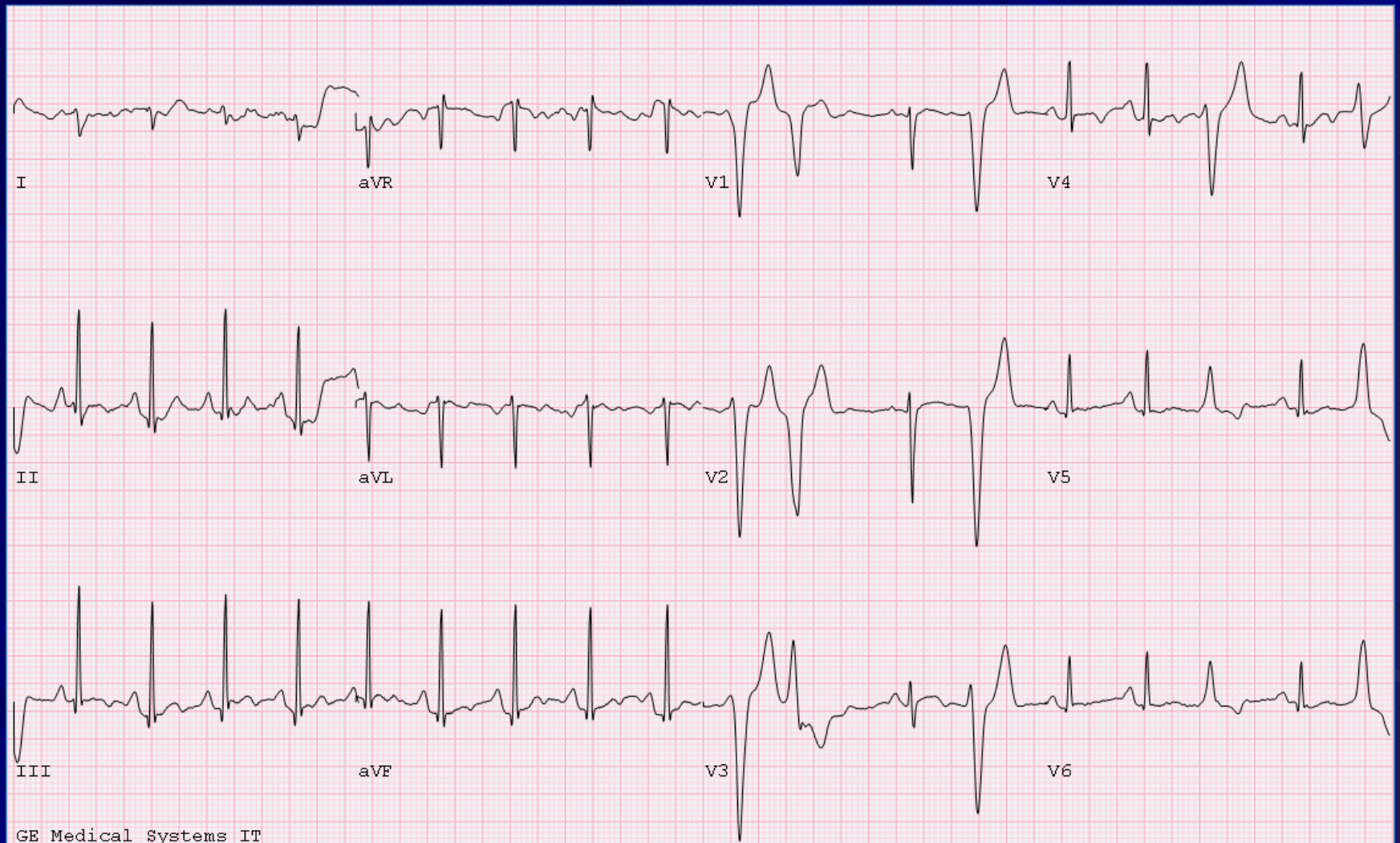


# Exercise Test - Rest

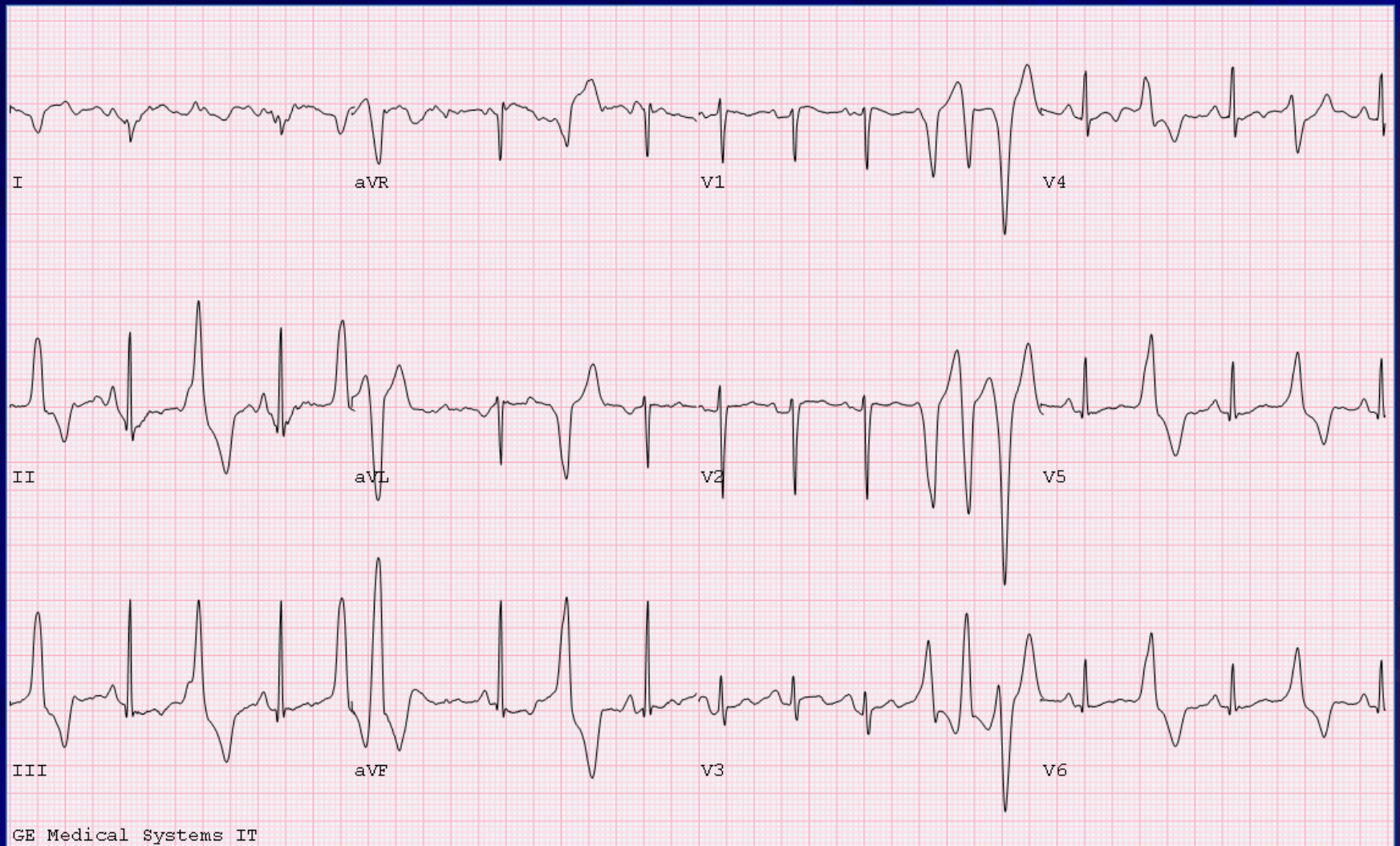




# Exercise Test

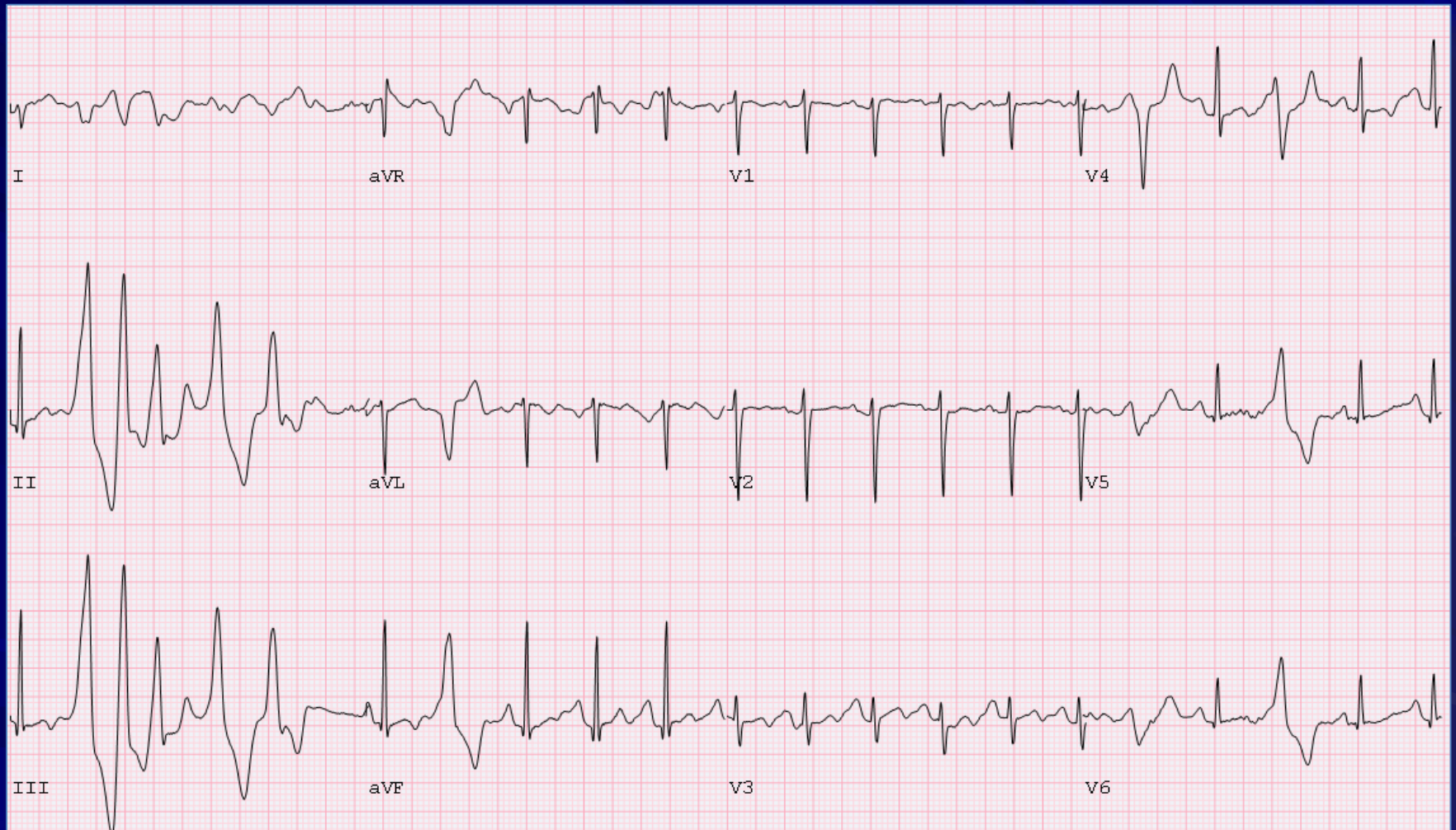


# Exercise Test

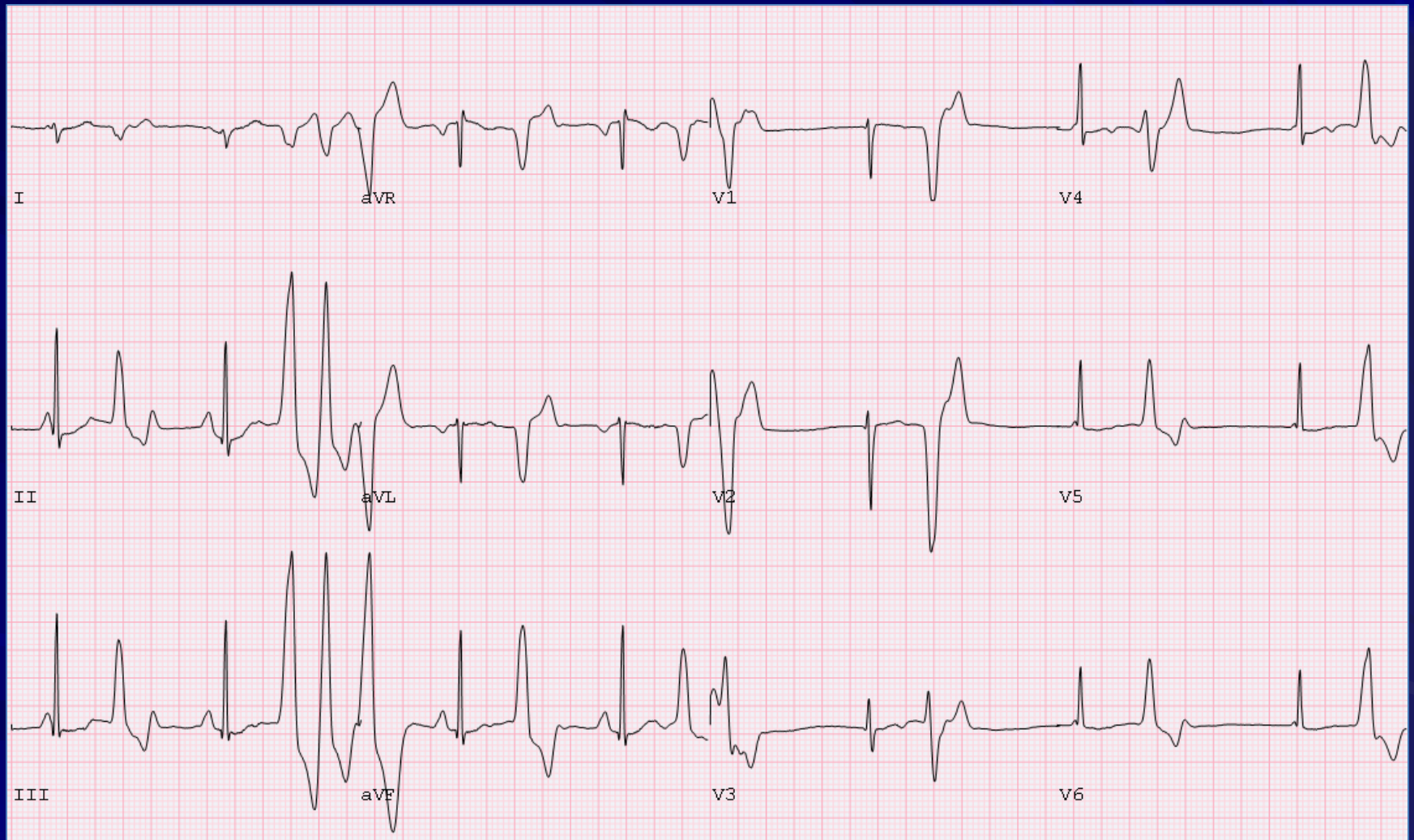




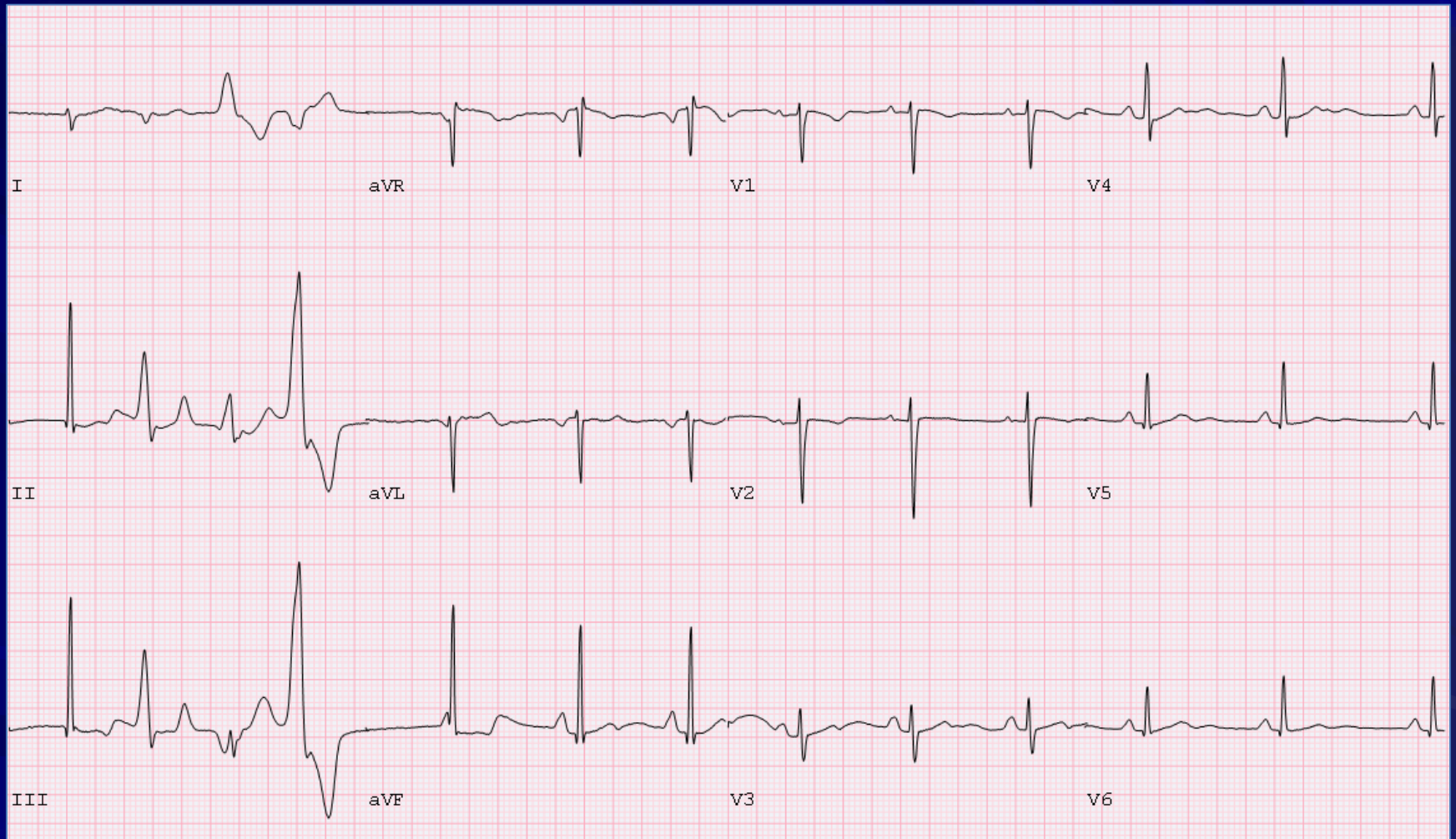
# Exercise Test



# Recovery



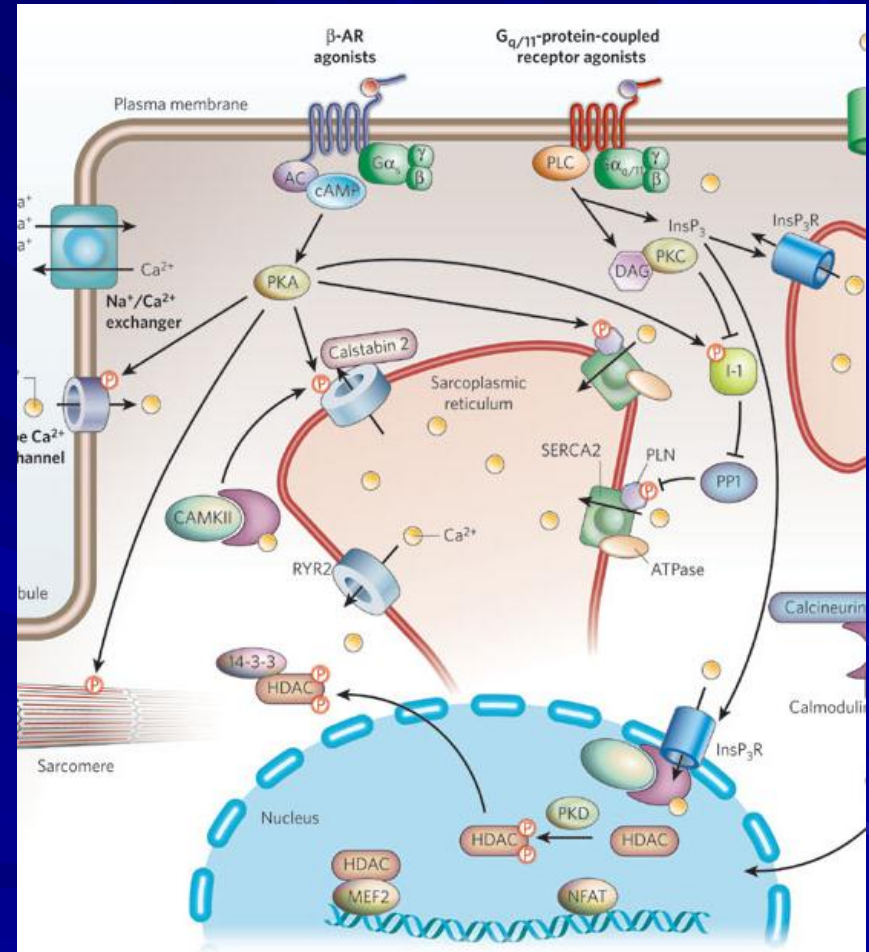
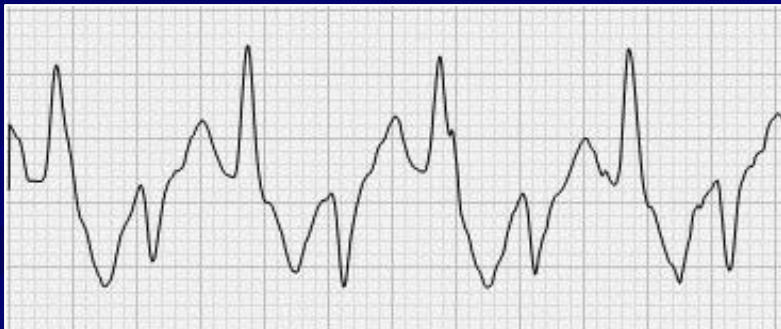
# Recovery





# Catecholaminergic Polymorphic Ventricular Tachycardia - CPVT

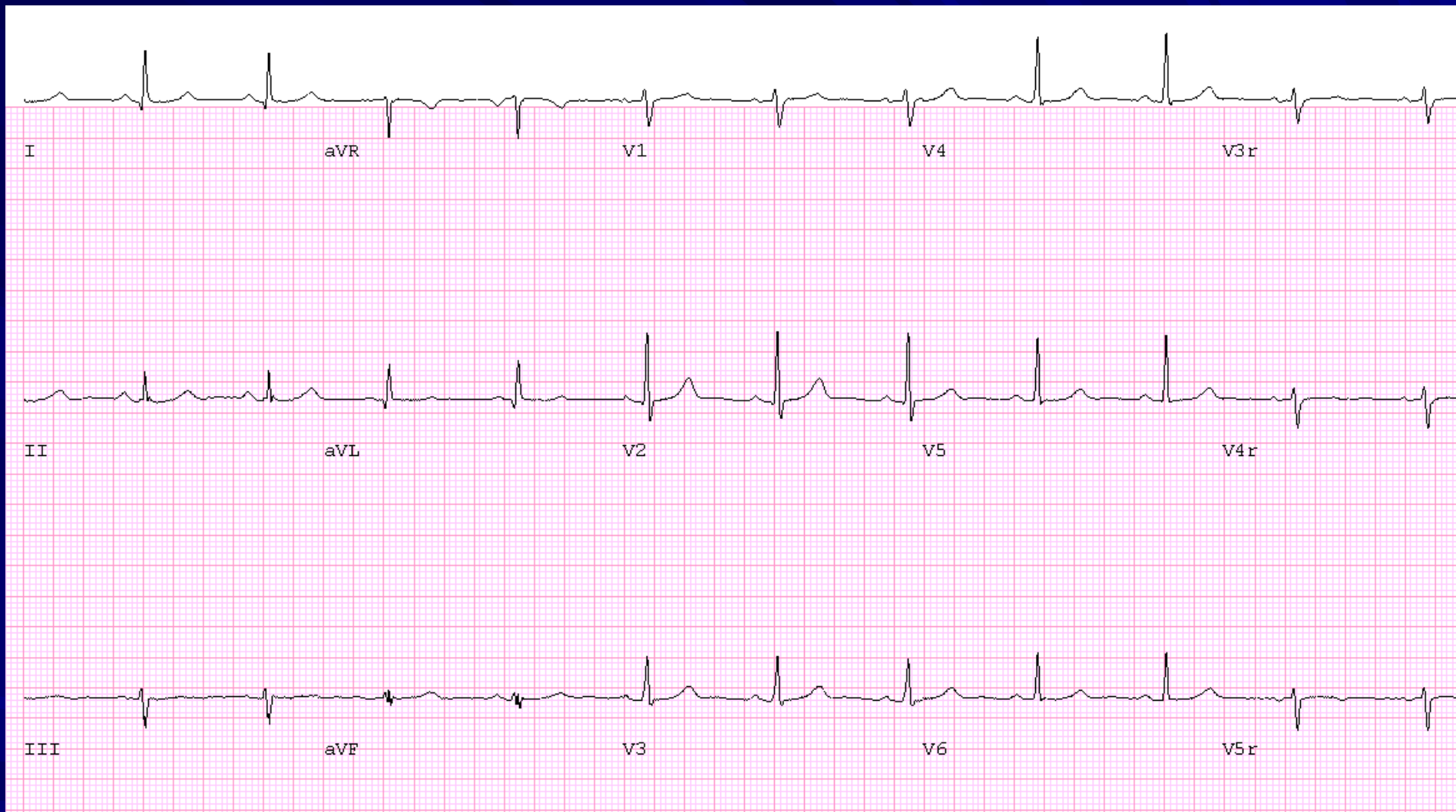
- Intracellular  $\text{Ca}^{++}$  overload
- Exercise/swimming induced syncope / SCD



# Case from Minnesota

- a 73 year old male who is absolutely asymptomatic has no previous hx of CAD( his coronary angiogram was clean in 2004) and recent stress was negative, has Htn but otherwise well was going in for pre-op and had treadmill ECG. I have his ECGs as attachment.
- He has no family hx of SCD and he has no syncope or presyncope. The PMVT happened during stress and completely recovered with rest.
- He had MRI performed locally which was re-read here and found to have RV mildly dilated without any akinesis or hypokinesis and EF is around 35% ( RV), LV function is normal. By MRI criteria it was borderline for ARVC.
- He was sent for ICD implant based on his exercise ECG. What is your opinion about this patient ? What further testing would you recommend?

## Resting before exercise





04/19/2012

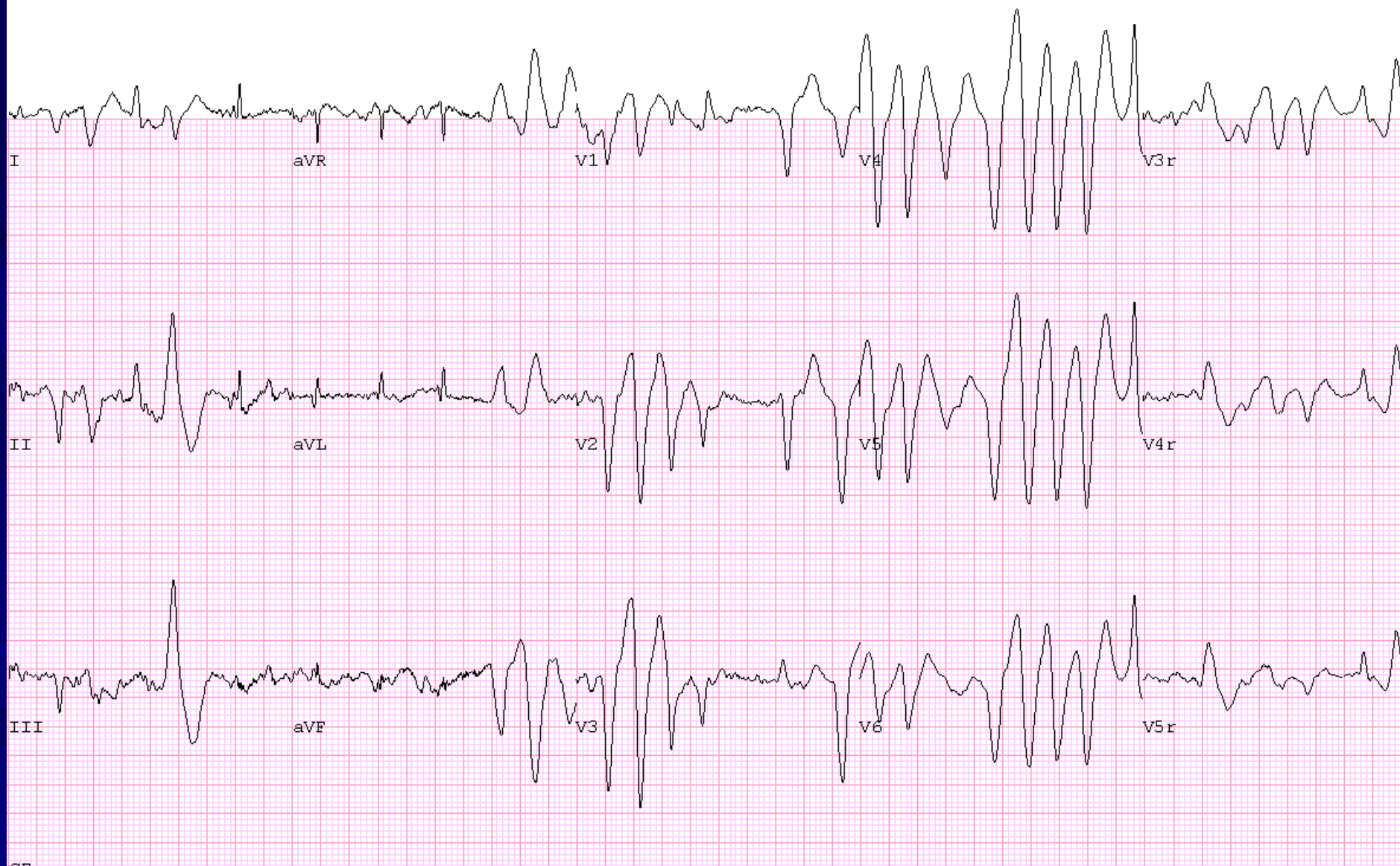
STAGE 3

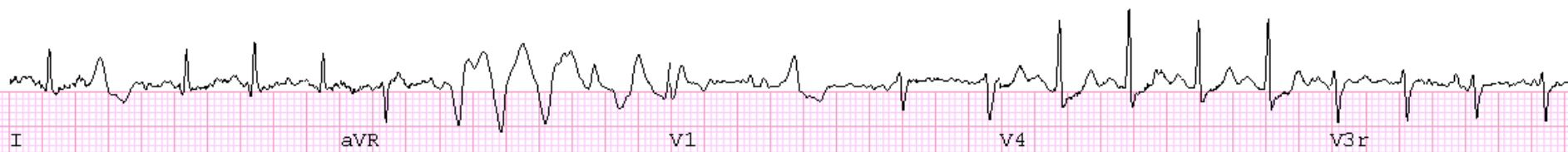
3.4 mph

9:42:55am

07:00

14.0 %





# Conclusions

- Exercise testing for arrhythmic disorders requires special considerations
- However; if done correctly can yield invaluable information