Sport – Arrhythmias – Sudden Death

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Marc Vivien Foe of Cameroon, football player, died on June 26, 2003.
The Autopsy Results - Hypertrophic Cardiomyopathy

Eben Harrell. ***Sudden Cardiac Death: Should Young Athletes Be Screened?*** **Time CNN, Thursday, Sept 10, 2009**

Major (*mostly still unanswered*) **Questions in Sport Medicine/Cardiology**

- **Who are the athletes and what constitutes "sport" heart?**
  - Structural and Electrical Remodeling
  - Effect of withdrawal

- **Do athletes have more "arrhythmias" than others?**
- **Are these arrhythmias more dangerous?**
- **Are SCDs in athletes more common than in otherwise healthy people?**
- **What is the "nature" of arrhythmias and SCD in athletes?**
- **Does sport alleviate? Aggravate? Trigger arrhythmias?**

- **How to identify athletes at risk?**
- **What is the role of ECG in athletes screening?**
- **How to prevent and treat arrhythmias in athletes?**

Introduction

Sudden (cardiac) death of young athlete is always tragic and is highly unexpected event:

1. General public perception - trained athletes are the healthiest among all of us
2. Often witnessed by many (TV, mass media)

3. Unpredicted in the vast majority of cases
4. Difficult to prevent
5. Low overall survival rate in young athletes who suffer SCD (**14**% vs **5**%)

6. Due to low incidence of SCD - no prospective study, no good retrospective study
7. Most info – from mass media (case reports), isolated country-by-country experience

History

The first (*yet not likely*) recorded incident of sudden death of an athlete

Legend

- **Herodotus:**
  - Phidippides, a young Greek messenger, ran 26.2 miles from Marathon to Athens delivering the news of the Greek victory over the Persians, and then he collapsed and died
- ***Corrections:***
  - ***Distance from Marathon to Athens is 228 km not 42 km***
  - ***Author was Lucian not Herodotus***

"True" Story

- **Herodotus** (500 centuries earlier)**:**
  - In 490 BC, Phidippides was asked to run from Athens to Sparta for help (**Battle of Marathon)**
  - No info on sudden death

Cardiac death? Unexpected? Unexplained? Exertional?

Who are the Athletes?

Athletes: Definitions

- **Athlete**
  - Individual possessing the natural or acquired traits, such as strength, agility, and endurance, that are necessary for physical exercise or sports

Спритність

витривалість

- **Amateur Athlete**
  - Individual who plays for the joy of competing and winning
- **Competitive Athlete**
  - Individual who participate in an organized team or individual sport and requires systematic training and competitions (e.g. high school, college, club)
    - In USA: ~5 million competitive high school athletes and 500 000 competitive collegiate athletes
- **Professional Athlete**
  - Individuals who play sports for a living

EPIDEMIOLOGY

Incidence of SCD in Athletes*

ЗАХВОРЮВАННІСТЬ

Table 1 Incidence of sudden cardiac death in young athletes

	Study population	Study period	Reporting/data collection system	Incidence of SCD
Italy	Athletes age 12–35 years	1979–1982[a]	Regional registry for juvenile sudden death	1:25 000 [8••]
US military	Military recruits age 18–35 years with exercise-related SCD	1977–2001	Mandatory forensic registry (DoD-RMR)	1:9000 [9,10]
US athletes	High school and college athletes age 13–24 years	1983–1993	Reports from national athletic associations and newspaper clippings	1:300 000 [11]
	High school athletes age 13–19 years	1985–1997	Catastrophic insurance claims	1:200 000 [12]
	College athletes	1999–2005	Retrospective survey	1:67 000 [13]
	High school and college athletes age 12–23 years	1980–2005	Electronic resources and media reports	1:50 000 [14]
	Professional athletes	1999–2005	Retrospective survey	1:3500 [15]

DoD-RMR, Department of Defense Recruit Mortality Registry

** - From Corrado D. JAMA 2006; 296:1593–1601*

Incidence of SCD in Athletes (II)

- Annual incidence of SCD in young athletes:
  - **3X** higher than in the normal population
  - **4 - 56** times m
  - More commo
  - In USA - **1 : 50**
  - In Italy - **1 : 25** al screening program)
- US Sudden Dea
  - **115** cases of S of SCD every 3 days in the US organized spo
- US Military Rec
  - **126** non-traun
- In **USA**, SCD mo sketball (**2/3** of SCD)
- In the **ROW**, soccer is the sport most commonly associated with SCD

Поширеність

Epidemiology / Prevalence

- Does frequency of SCD among young competitive athletes increase in USA and Europe?
  - Yes
  - Why?
    - More young people involved with active sport
    - Public awareness

- The combined disease prevalence of all CVD that predispose young athletes to SCD is estimated at 0.3% (1:333)*

* - Maron BJ, Circulation 2007;115:1643–55

Mechanisms and Triggers of SCD

“Milieu Intérieur” Concept in Sport Cardiology

- Term introduced by Claude Bernard (1854-78) and currently used to emphasize the importance of intrinsic adaptive (physiological) responses to external and internal challenges to maintain a biological stability of the body (“homeostasis’)

- How the heart and its **electrical system** adjust to enormous (величезний) physical (and emotional) stresses?

Causes of Sudden Cardiac Death in Athletes

- Among those > 35 who die, about 75% have atherosclerotic CAD
- Among those < 35, most common causes of death are congenital (and/or acquired) cardiac abnormalities:
  - Hypertrophic cardiomyopathy
    - 1/3 of fatal cases in USA
  - Arrhythmogenic right ventricular cardiomyopathy/dysplasia
    - 1/4 in the Veneto Region of Italy
  - Electrical diseases of the heart
    - Only LQTS > 3000 unexpected deaths in children and young adults in USA/yr
  - Iatrogenic (drug-induced)
  - Myocarditis
  - Aortic rupture
  - Valvular disease
  - Congenital heart disease
  - Trauma (Commotio Cordis)

Inherited Primary
Electrical Diseases and Syndromes of the Heart

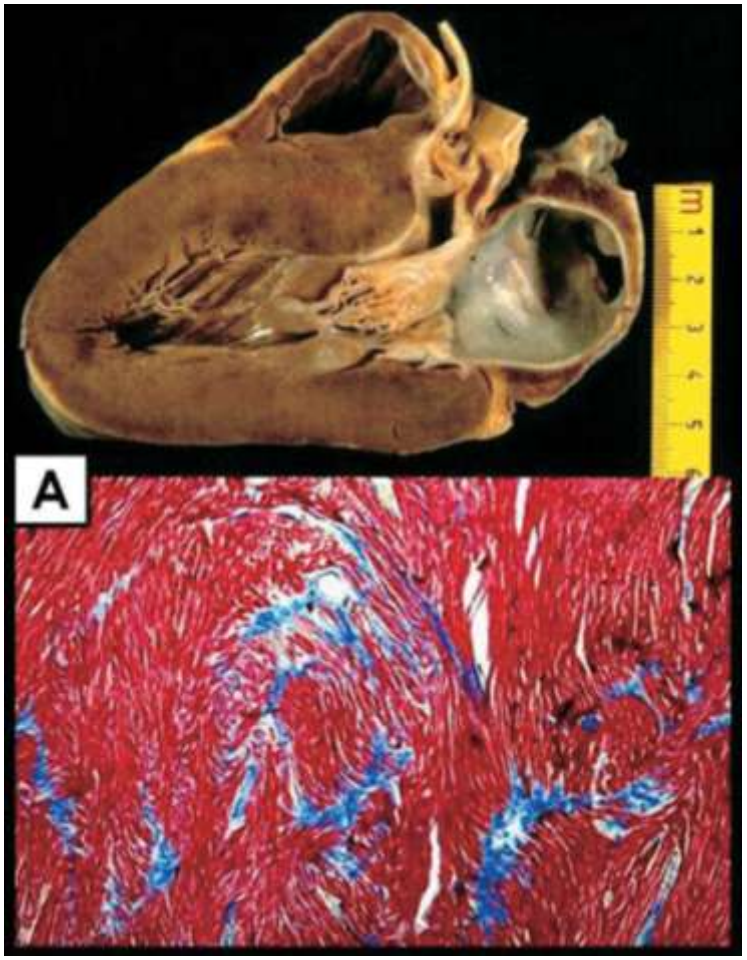
- Congenital Long QT Syndrome
- Andersen–Tawil and Timothy Syndromes
- Congenital Short QT Syndrome
- Brugada Syndrome
- Catecholaminergic Polymorphic Ventricular Tachycardia
- Progressive Cardiac Conduction Disease
- Familial Atrial Fibrillation and Standstill

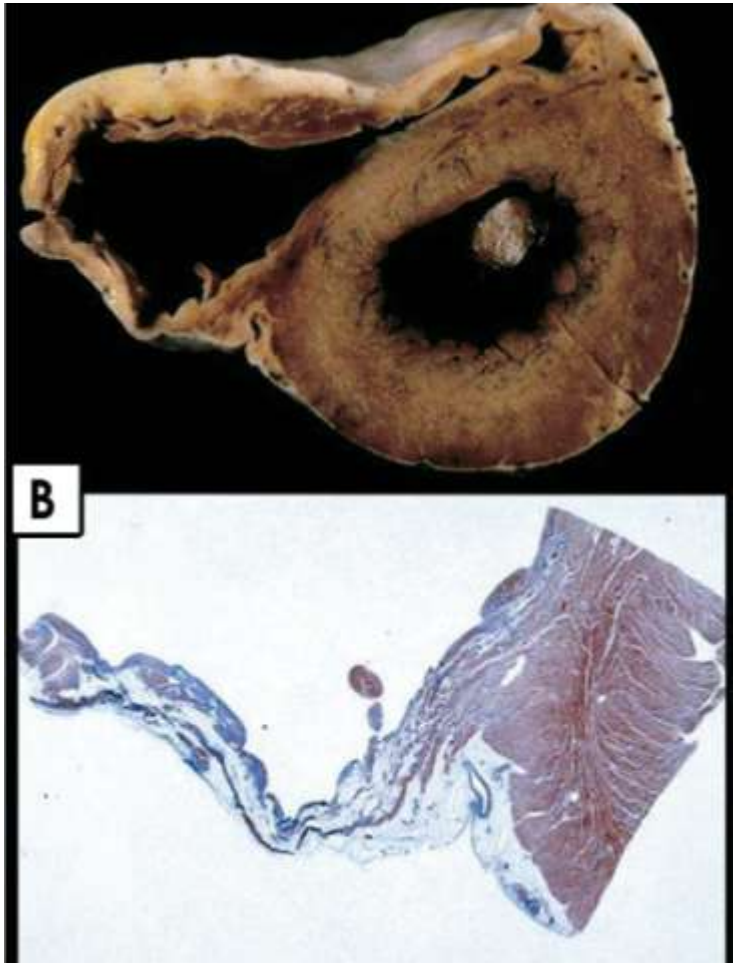
Inherited Secondary Electrical Diseases and Syndromes of the Heart

- **Hypertrophic** and Dilated **Cardiomyopathies**
- Right Ventricular Dysplasia/Cardiomyopathy
  - 1 in 5000 people of all ages, race, and sex
  - It is an important cause of SCD among young athletes in their 20s and 30s, and accounts for 1/5 of SCD in people under age 35
- Wolff–Parkinson–White Syndrome
- Idiopathic Ventricular Fibrillation

(A) Hypertrophic Cardiomyopathy

(B) ARVD/C





Acquired Electrical Diseases and Syndromes of the Heart

- Acquired (Drug-Induced) Long QT Syndrome
- Acquired (Drug-Induced) Short QT Syndrome
- Acquired Forms of Brugada Syndrome

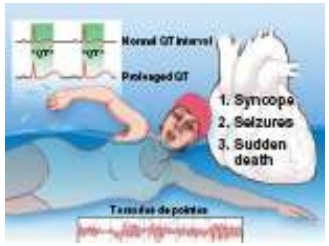
Athletes, Drugs, and Iatrogenic Death

Commonly Used Doping and Drugs in Sport Cardiology

- Stimulants
  - Sympathomimetics (e.g. epinephrine)
  - Egrogenic supplements (e.g. tetrahydrogestrinone)
  - Amphetamine
- Stimulants/Depressants
- Hormones, anabolic steroids and related substances
  - Growth hormones, Glucocorticosteroids, Testosterone and other Anabolic Steroids
- Erythropoietin
- Narcotics
- Cannabinoids
  - Hashish and marijuana
- Peptide hormones
  - Growth hormone, insulin, and erythropoietin
- Beta-2 agonists (used for opening airways, as in asthma)
- Anti-estrogen agents (in males)
- Masking agents (used to conceal doping)
- Polypharmacy (**arrhythmogenic potential**)

LQT1 Phenotype (KCNQ1)

- Most common genetic subtype
- Often associated with a high frequency of syncope but less SCD (*compare with LQT2*)
- Predominantly have exertional-triggered symptoms
  - **swimming** appears to be a gene-specific arrhythmogenic trigger associated almost exclusively with LQT1



  - other triggers - running, startle, anger, and fright
    (переляк, гнів і страх)

- Mutations caused by a defective I_{Ks} channel that is responsive to adrenergic stimulation:
  - Usual shortening of QT in response to increased heart rate is impaired and QTc progressively lengthens during exercise and early recovery
  - Most individuals with LQT1 show paradoxical prolongation of the QT interval with infusion of epinephrine. This can also unmark latent carriers of the LQT1 gene

LQTS


16223151
File Tools Zoom Old ECGs Window Algorithms Help
12 leads
10 seconds
2 mvolts
10 sec ECG
Start: 0.0 s
1000 Hz
I
II
III
aVR
aVL
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V1
V2
V3
V4
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1 sec
Lead I
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PR1
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QT1
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QT3
Origin: 0 0; Measuring an interval.....
Start
Inbox - Microsoft Outlook
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98%
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Screening in Sport Medicine: Role of ECG

Why Do We Need Screening in Sport Medicine?

- Almost all cases of SCD occur in athletes with "**silent**'' forms of:
  - Hereditary or congenital CV diseases, including primary or secondary electrical diseases, such as hypertrophic cardiomyopathy or
  - Acquired CV diseases, such as CAD
  - In 80% of cases, these diseases are asymptomatic and death occurs with little or no warning, almost always during or shortly after sport

- ECG screening for "cluster" PED can help identify family members at risk

- Screening programs can identify heart abnormalities, but physicians disagree on:
  - Which programs should be used, on whom and how often?
  - How much $$$ should be spent trying to screen and prevent SCD in athletes?

ECG Screening

- No international consensus on the role of ECG screening in Sport Medicine
  - cost-effectiveness, feasibility, and accuracy of including a 12-lead ECG when screening athletes (another words - $$$ and liability)

- Analyzing data from 42,000 athletes in the northeastern Veneto region between 1979 and 2004, Italian researchers found that :
  - ECG screening resulted in an almost **90%** drop in SCD
  - Incidence of SCD among the unscreened non-athletic population did not change significantly during that time*

- Some professional sports leagues, such as the NFL in USA and the Premier League in UK, already require their athletes to undergo ECG screenings

Drezner J et al. Br. J. Sports Med. 2009;43;625-626

Screening: Practical Recommendations

Identifying athletes at risk

<35 yr - Screening for heart abnormalities

- Screening for PED
- Screening for family history of SCD (*Rochester, MN experience*)
  - SVT-induced by exercise
- ECG Screening
  - **ECG "signatures" of PED**
  - Any new ECG abnormality
  - Persistent bradycardia at rest. How benign?
  - Early Repolarization . How benign?

>35 yr - Screening for CAD

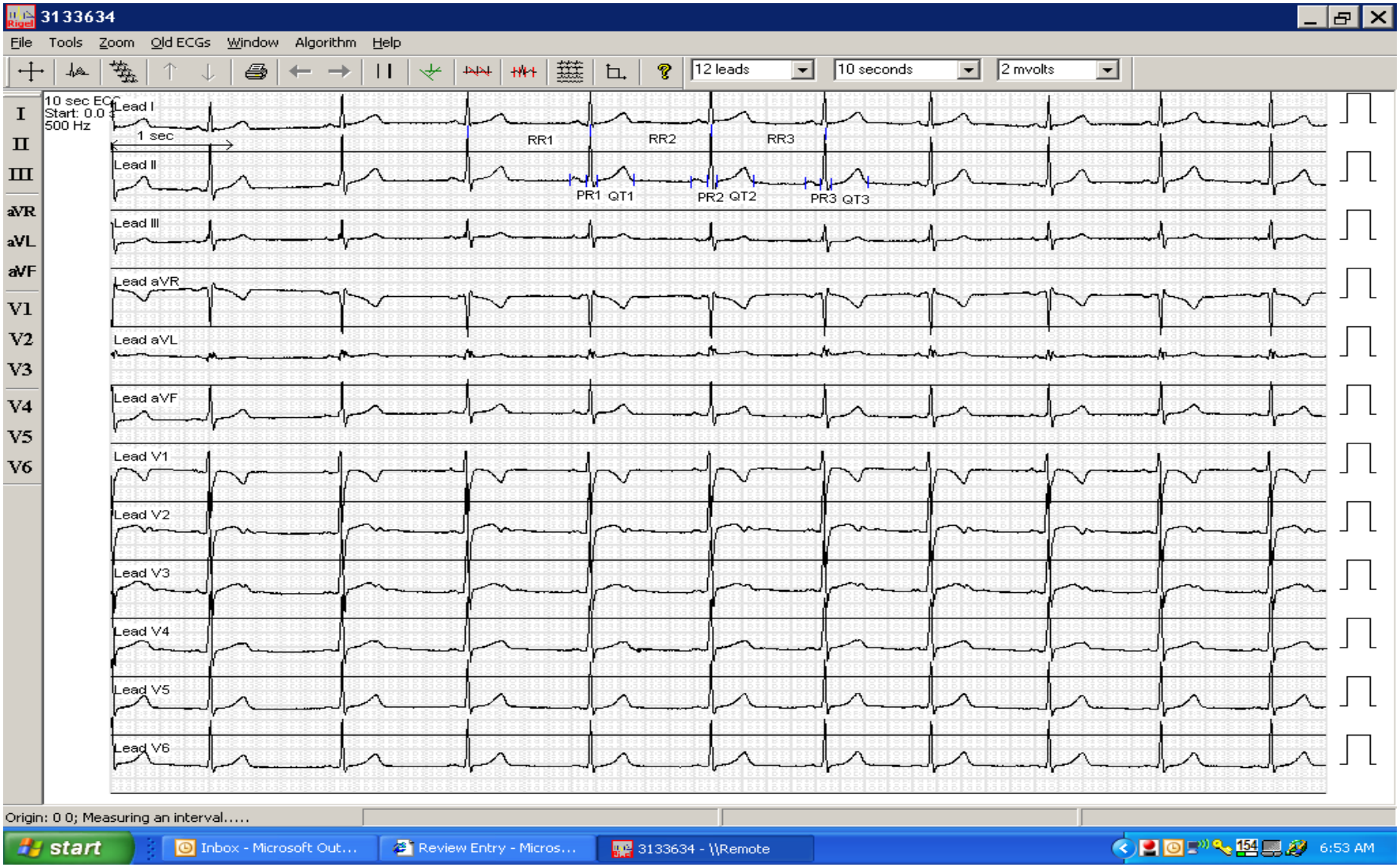
- Risk factors for CAD
- Hypertension
- DM
- Hypercholesterolemia
- **ECG changes and new abnormalities**

Summary of ECG Abnormalities Common in Athletes (modified)*

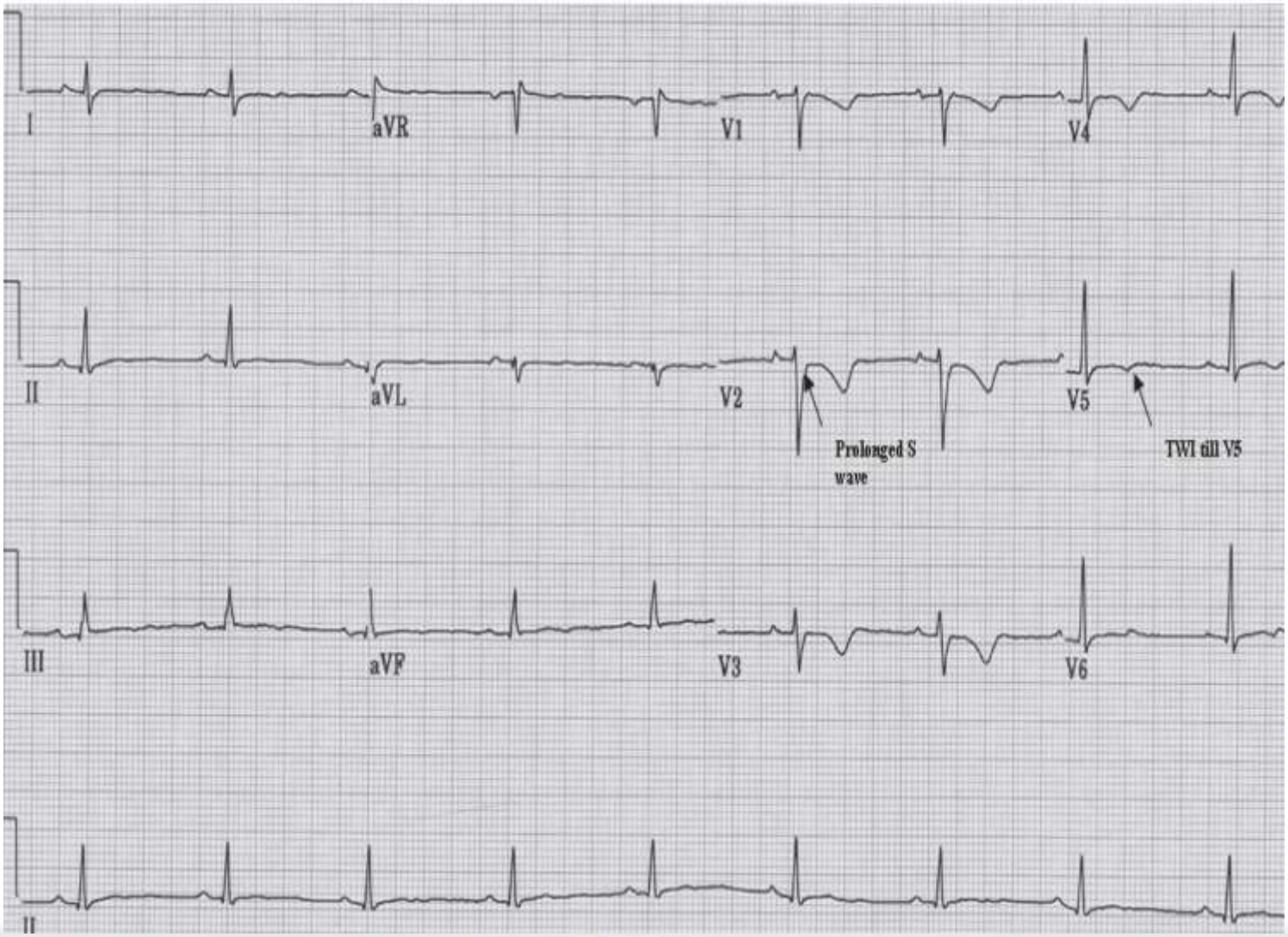
1) Sinus bradycardia
2) Sinus (respiratory) arrhythmia
3) P-wave with notches and of high voltage
4) 1st degree AV block: 6% to 36%
5) 2nd degree AV block, Wenckebach type (0.125% to 10%)
6) Incomplete RBBB
7) Voltage criteria for RVE/H
8) Voltage criteria for LVE/H
9) Early repolarization variant
10) J point and ST segment elevation or depression
11) Bordeline (long and short) QT interval
12) T-wave of increased voltage, peaked and inverted
13) Atrial fibrillation and flutter
14) Junctional rhythm
15) U-wave

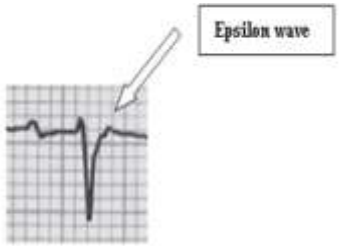
* - Furlanello, et al. J Cardiovasc Electrophysiol 1998;9 (Suppl 8); S63-S68

“Normal” U-wave in Young Athlete

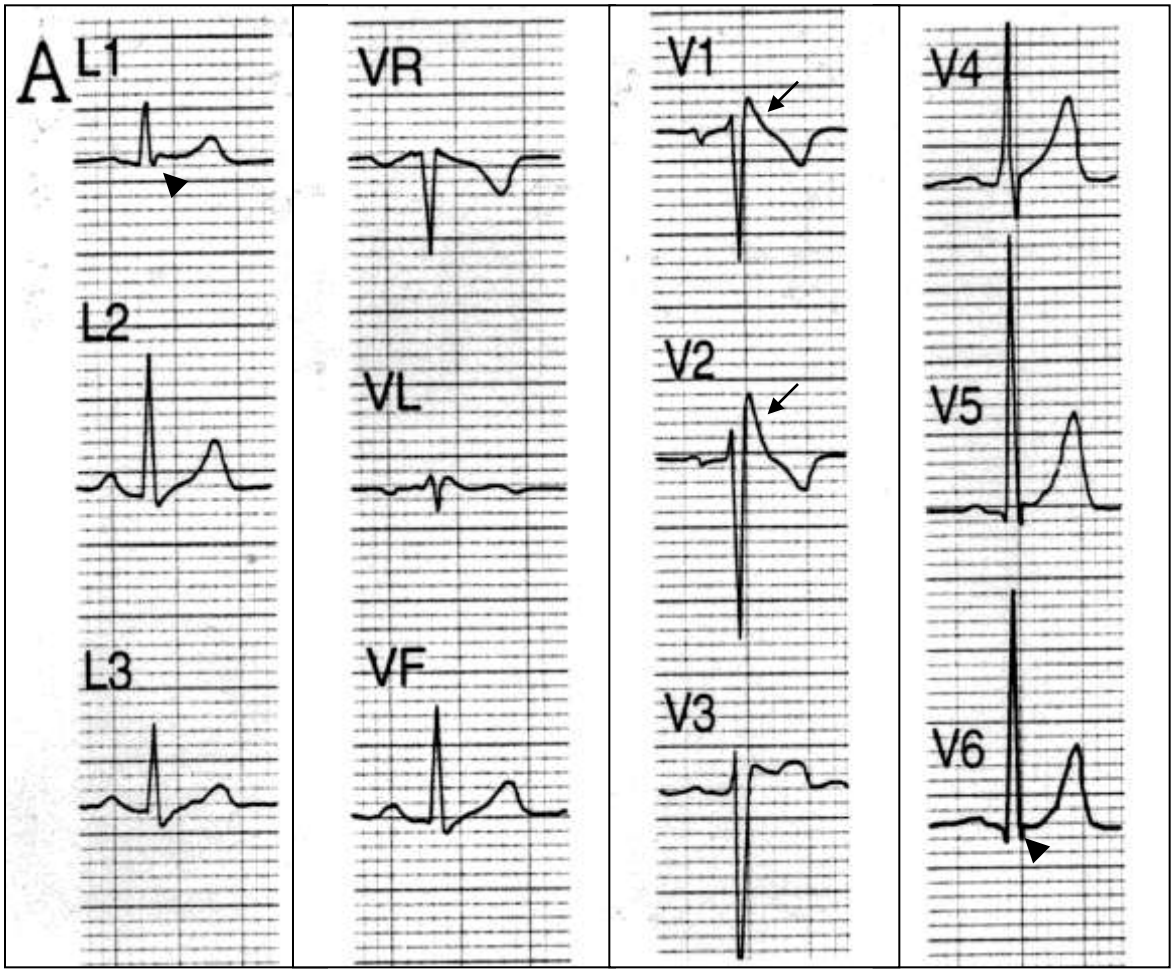


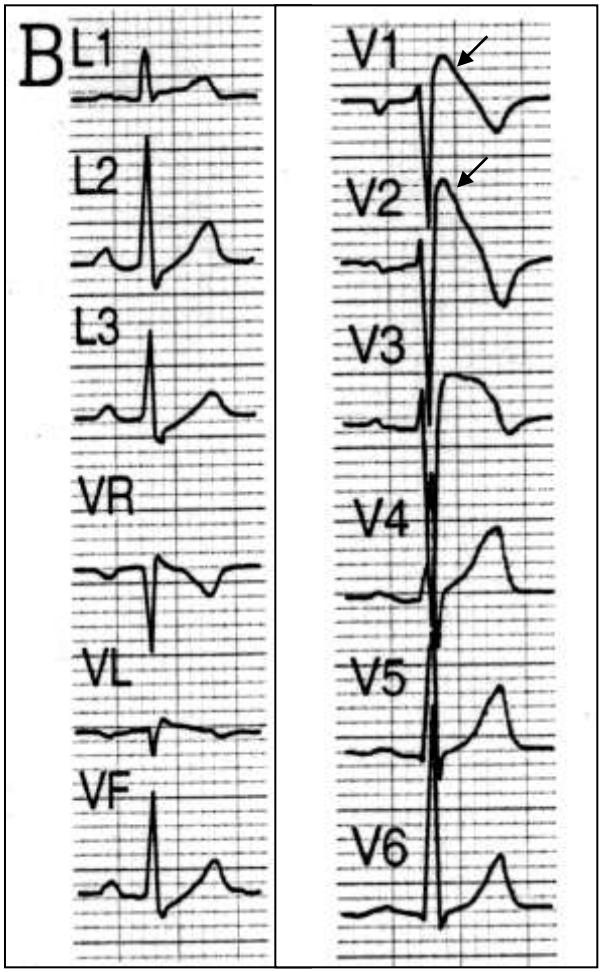
ECG from a Patient with ARVD/C



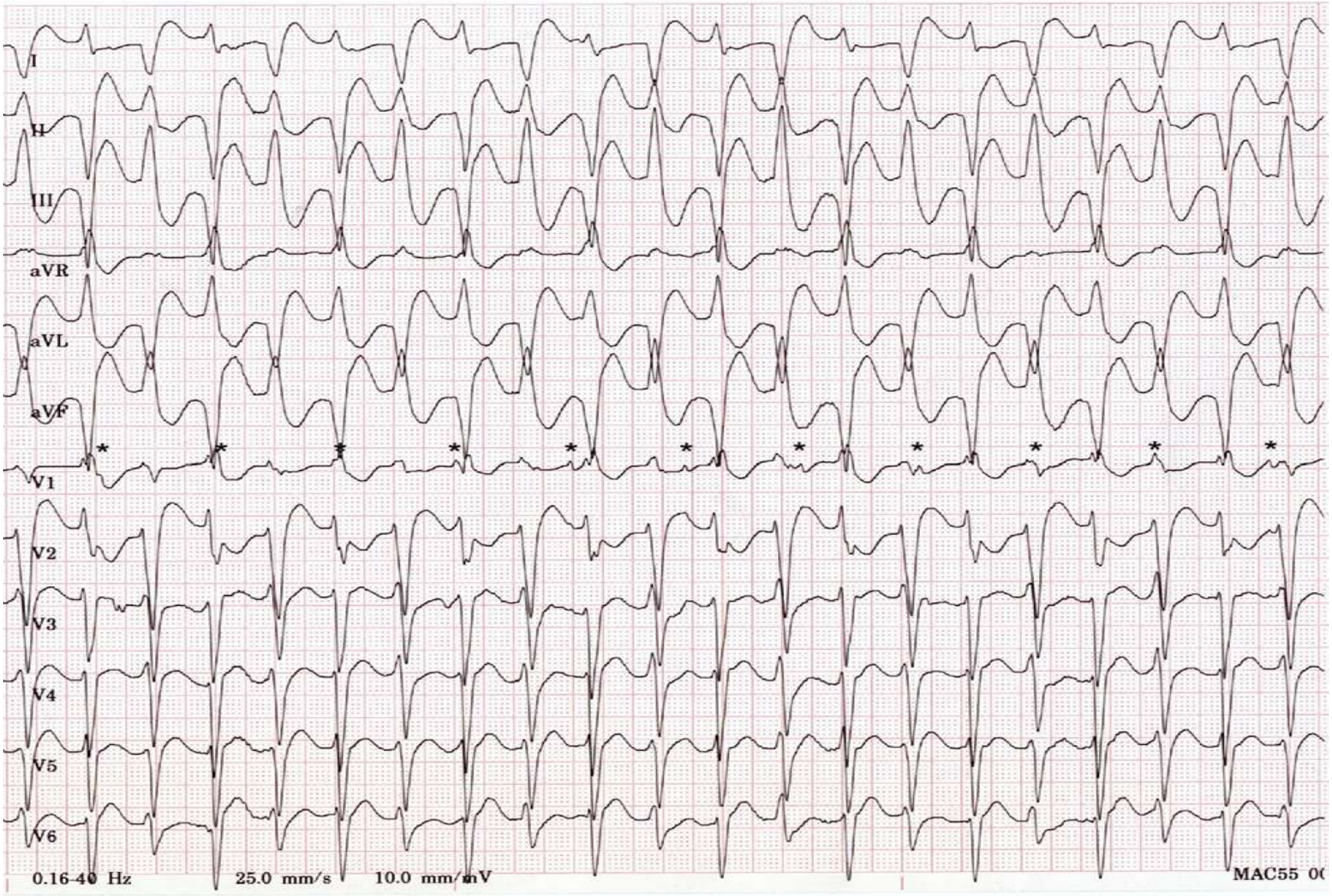


Brugada Syndrome



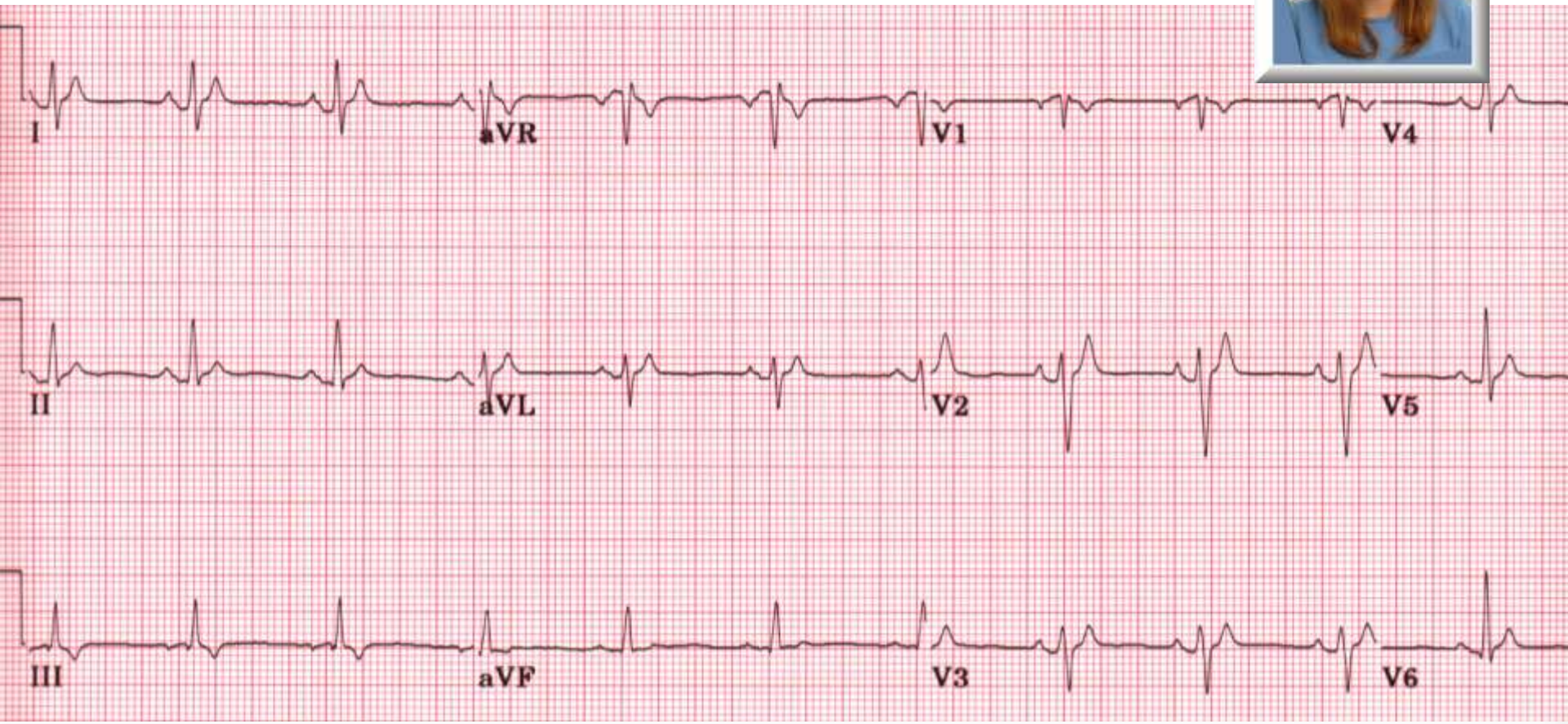


Bidirectional Ventricular Tachycardia



Exercise-induced Bidirectional Ventricular Tachycardia (II)

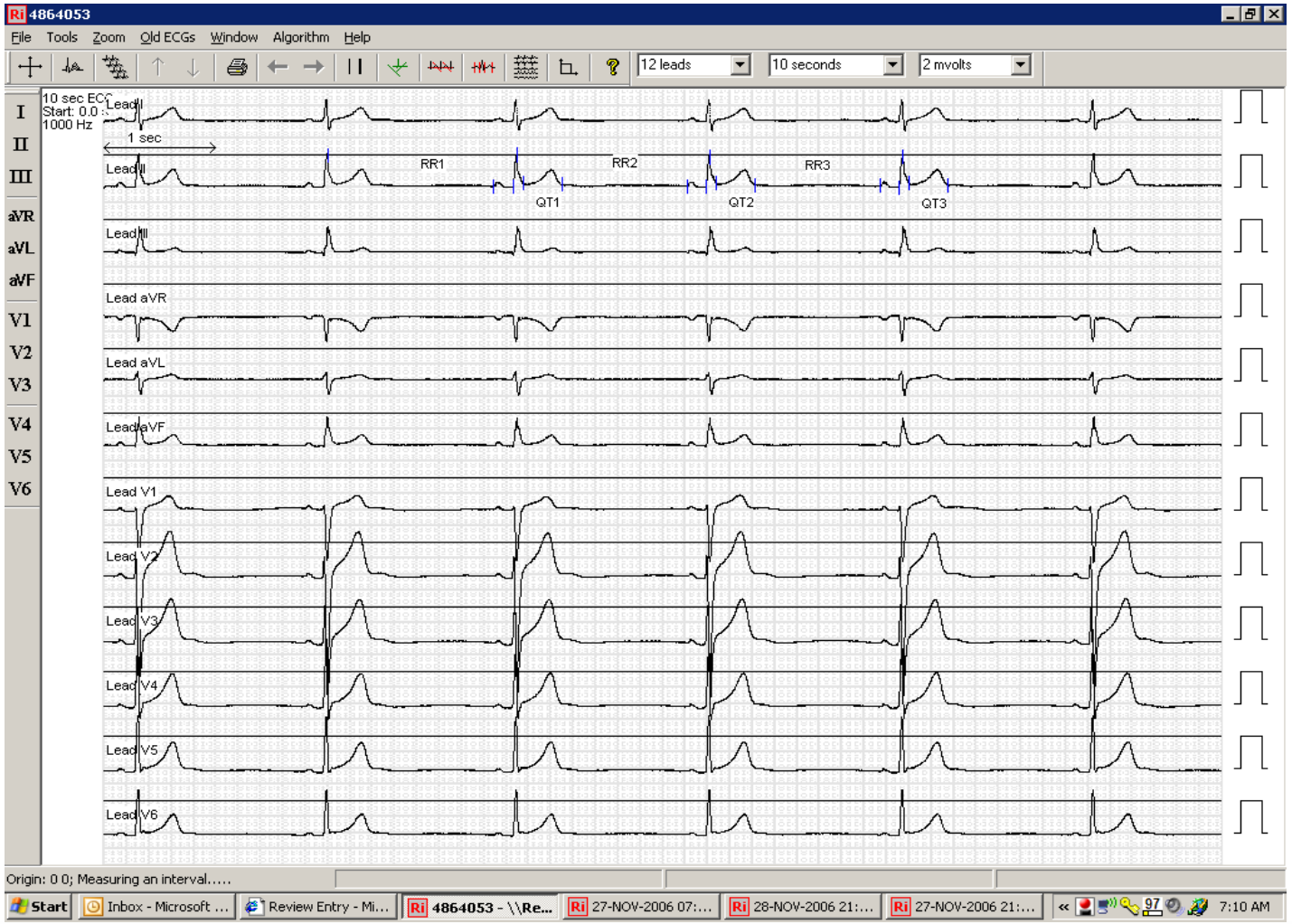
ECG during Sinus Rhythm of the First Patient – 17 Year Old Female – with *Short QT Syndrome*



QT = 230 msec, QTc = 300 msec

Short QTS and ERS

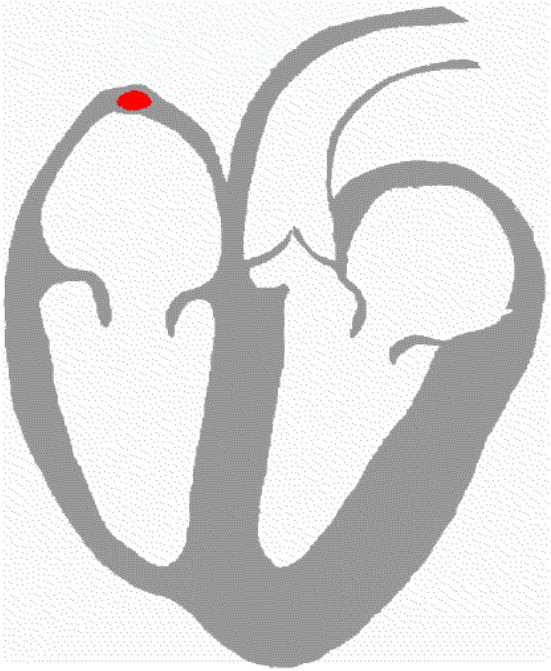
(HR = 35 bpm, QT – 442 ms, QTcB – 338 ms, QTcF – 370 ms)



Lifestyle Modification

Дякую За Увагу

Питання?



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