Prevalence and clinical correlates of ECG patterns in adolescent athletes.

Filippo M. Quattrini, MD, PhD
Institute of Sport Medicine and Science
Italian National Olympic Committee
fquattrini@tiscali.it
Why talking about the ECG in adolescent athletes?
Sudden Deaths in Young Competitive Athletes

Barry J. Maron, MD; Joseph J. Doerer, BS; Tammy S. Haas, RN;
David M. Tierney, MD; Frederick O. Mueller, PhD

Adapted from Maron BJ et al Circulation. 2009;119:1085-1092
The great debate

Cardiovascular pre-participation screening of young competitive athletes for prevention of sudden death: proposal for a common European protocol

Consensus Statement of the Study Group of Sport Cardiology of the Working Group of Cardiac Rehabilitation and Exercise Physiology and the Working Group of Myocardial and Pericardial Diseases of the European Society of Cardiology

Sudden Cardiovascular Death in Sport

LAUSANNE RECOMMENDATIONS

Under the umbrella IOC Medical Commission 10 December 2004

PREPARTICIPATION CARDIOVASCULAR SCREENING

Recommendations and Considerations Related to Preparticipation Screening for Cardiovascular Abnormalities in Competitive Athletes: 2007 Update: A Scientific Statement From the American Heart Association Council on Nutrition, Physical Activity, and Metabolism: Endorsed by the American College of Cardiology Foundation

Barry J. Maron, Paul D. Thompson, Michael J. Ackerman, Gary Balady, Stuart Berger, David Cohen, Robert Dimoff, Pamela S. Douglas, David W. Glover, Adolph M. Hutter Jr, Michael D. Krauss, Martin S. Maron, Matthew J. Mitten, William O. Roberts and James C. Puffer

Circulation 2007;115:1643-1655; originally published online Mar 12, 2007;
DOI: 10.1161/CIRCULATIONAHA.107.181423
Circulation is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2007 American Heart Association. All rights reserved. Print ISSN: 0009-7322. Online ISSN: 1524-4539
The preparticipation cardiovascular screening of competitive athletes: is it time to change the customary clinical practice?

Antonio Pelliccia*
Institute of Sports Medicine and Science, Largo Piero Gabrielli 1, 00197 Rome, Italy

Should an electrocardiogram be included in routine preparticipation screening of young athletes?

An Electrocardiogram Should Not Be Included in Routine Preparticipation Screening of Young Athletes
Bernard R. Chokro, MD, FACC

Saving Athletes’ Lives
A Reason to Find Common Ground?
Pamela S. Douglas, MD, MACC
Durham, North Carolina

Preparticipation Screening of Competitive Athletes
Seeking Simple Solutions to a Complex Problem
Paul D. Thompson, MD

Should be the electrocardiogram required in young athletes?
Chaitman B
Lancet 2008;371:1489-90

Appropriate interpretation of the athlete’s electrocardiogram saves lives as well as money

Domenico Corrado* and William J. McKenna
1Department of Cardiac, Thoracic and Vascular Sciences, University of Padova Medical School, Padova, Italy; and 2The Heart Hospital, University College London, London, UK
Online published-ahead-of-print 10 July 2003
Cost-Effectiveness of Preparticipation Screening for Prevention of Sudden Cardiac Death in Young Athletes

Matthew T. Wheeler, MD, PhD; Paul A. Heidenreich, MD, MS; Victor F. Froelicher, MD; Mark A. Hlatky, MD; and Euan A. Ashley, MB ChB, DPhil

Cardiovascular Screening in College Athletes With and Without Electrocardiography

A Cross-sectional Study

Aaron L. Baggish, MD; Adolph M. Hutter Jr., MD; Francis Wang, MD; Kibar Yared, MD; Rory B. Weiner, MD; Eli Kupperman, BA; Michael H. Picard, MD; and Malissa J. Wood, MD
Cardiovascular Screening in College Athletes With and Without Electrocardiography

A Cross-sectional Study

Aaron L. Baggish, MD; Adolph M. Hutter Jr., MD; Francis Wang, MD; Kibar Yared, MD; Rory B. Weiner, MD; Eli Kupperman, BA; Michael H. Picard, MD; and Malissa J. Wood, MD
How can we reduce the number of false positives?
Recommendations for interpretation of 12-lead electrocardiogram in the athlete

Domenico Corrado¹*, Antonio Pelliccia², Hein Heidbuchel³, Sanjay Sharma⁴, Mark Link⁵, Cristina Basso⁶, Alessandro Biffi², Gianfranco Buja¹, Pietro Delise⁷, Ihor Gussac⁸, Aris Anastasakis⁹, Mats Borjesson¹⁰, Hans Halvor Bjørnstad¹¹, François Carrè¹², Asterios Deligiannis¹³, Dorian Dugmore¹⁴, Robert Fagard³, Jan Hoogsteen¹⁵, Klaus P. Mellwig¹⁶, Nicole Panhuyzen-Goedkoop¹⁷, Erik Solberg¹⁸, Luc Vanhees³, Jonathan Drezner¹⁹, N.A. Mark Estes, III⁵, Sabino Iliceto¹, Barry J. Maron²⁰, Roberto Peidro²¹, Peter J. Schwartz²², Ricardo Stein²³, Gaetano Thiene⁶, Paolo Zeppilli²⁴, and William J. McKenna²⁵ On behalf of the Sections of Sports Cardiology of the European Association of Cardiovascular Prevention and Rehabilitation; and the Working Group of Myocardial and Pericardial Disease of the European Society of Cardiology

- Uncommon and training-unrelated ECG changes
  - T-wave inversion
  - ST segment depression
  - Pathological Q waves
  - Left atrial enlargement
  - Left axis deviation/left anterior hemiblock
  - Right axis deviation/left posterior hemiblock
  - Right ventricular hypertrophy
  - Ventricular preexcitation
  - Complete LBBB or RBBB
  - Long or short QT interval
  - Brugada like early repolarization

- Common and training-related ECG changes
  - Sinus bradycardia
  - First degree AV block
  - Incomplete RBBB
  - Early repolarization
  - Isolated QRS voltage criteria for LVH
<table>
<thead>
<tr>
<th>Condition</th>
<th>Adult Elite Athletes (n = 1,005)</th>
<th>Amateur Athletes (n = 32,652)</th>
<th>Junior Elite Athletes (n = 1,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete RBBB, PR interval &gt; 0.20, early repolarization</td>
<td>34 %</td>
<td>7 %</td>
<td>29%, 5%, 43% respectively</td>
</tr>
<tr>
<td>Increased R/S wave voltages (LVH)</td>
<td>40 %</td>
<td>0.8 %</td>
<td>45 %</td>
</tr>
<tr>
<td>RBBB</td>
<td>0.2%</td>
<td>1%</td>
<td>0.6%</td>
</tr>
<tr>
<td>T wave inversion</td>
<td>2.7 %</td>
<td>2.3 %</td>
<td>4 %</td>
</tr>
</tbody>
</table>
ECG abnormalities are present in up to 95% of HCM patients and > 80% of ARVC patients.
Prevalence and significance of T-wave inversions in predominantly Caucasian adolescent athletes

Michael Papadakis¹,², Sandeep Basavarajaiah¹,², John Rawlins¹,², Carey Edwards¹,², Jayesh Makan³, Sami Firoozi⁴, Lorna Carby², and Sanjay Sharma¹,²*
Adolescent Athletes

1643 (96%) Without T-wave inversion
14 (0.8%) Deep T-wave inversion
25 (1.5%) T-wave inv. Inf. ± lat.

1710
67 (4%) T-wave inversion
42 (2.5%) T-wave inv. Ant. (V1-V4)

Sedentary Adolescents

388 (97%) Without T-wave inversion
12 (3%) T-wave inversion

400
0 T-wave inv. Inf. ± lat

Athletes with T-wave inversion in anterior precordial leads

- 42 athletes in total
  - 29 T-wave inversion confined in V1-V2
  - 13 T-wave inversion extending beyond V2
    - 11 Aged < 16 years old
    - 2 Aged ≥ 16 years old

Adolescent Athletes

67 (4%) T-wave inversion

Sedentary Adolescents

12 (3%) T-wave inversion

Exercise Test
Holter monitoring
CMR with late enhancement

NO HCM or ARVC

Repolarization abnormalities in adolescent athletes

- Repolarization abnormalities in anterior precordial leads probably represent ECG juvenile pattern in athletes < 16 years.

- Deep T wave inversion, repolarization abnormalities in inferior and/or lateral leads and repolarization abnormalities beyond V2 in athletes ≥ 16 years require further investigations to exclude cardiomyopathies.
What about the ECG in adolescent amateur athletes?
Very few data on adolescents who approach to sport activities!
STUDY POPULATION

Subjects: 994 adolescent amateur athletes evaluated for competitive sport
Age: 14 ± 2 years (median 14; range 12-18)
Gender: 784 males (79%), 210 females (21%)
Training: 5 ± 1.5 hours/week
Sports: 36 different sport disciplines, mostly soccer (37%), fencing (10%), tennis (6%), basketball (5%), track & field (5%), rowing (3%), rugby (3%)
Total ECGs: 994

- Normal ECG Pattern: 575 (58%)
- Training Related ECG changes: 220 (22%)
- Training unrelated ECG changes: 199 (20%)

Evaluated according to the ESC recommendations.
### Electrocardiographic findings in 994 adolescent athletes

#### Training related ECG changes
- Sinus bradycardia: 21%
- Incomplete RBBB: 31%
- Sokolow Lyon (LVH): 17%
- Early repolarization: 16%
- 1st degree AV block: 1%

#### Training unrelated ECG changes
- LAD or RAD: 2.0%
- LAFH/LPFH: 0.1%
- Complete RBBB: 0.5%
- LA enlargement: 0.5%
- Deep Q wave (≥4 mm): 0.3%
- Brugada Like ECG: 0.3%
- Prolonged QTc: 1.6%
- Flat/mildly inverted T: 13%
- Deep T-wave inv. (≥2 mm): 1.8%
Athletes with flat T-waves or mild T-wave inversion

134 (13%)

118 (11.8%) T-wave ab. anterior

84 (8.4%) ≤14 years

34 (3.4%) >14 years

16 (1.6%) T-wave ab. Inf.±lateral
Athletes with deep T-wave inversion

18 (1.8%)

15 (1.5%) T-wave inv. anterior

- 12 (1.2%) ≤14 years
  - No CMPs

- 3 (0.3%) >14 years
  - No CMPs

3 (0.3%) T-wave inv. Inf.±lateral

1 HCM
Comparison of electrocardiographic findings in adolescent athletes

<table>
<thead>
<tr>
<th><strong>Highly trained athletes (n=1710)</strong></th>
<th><strong>Amateur athletes (n=994)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sinus bradycardia</strong></td>
<td>80%</td>
</tr>
<tr>
<td><strong>Incomplete RBBB</strong></td>
<td>30%</td>
</tr>
<tr>
<td><strong>1st degree AV block</strong></td>
<td>4.5%</td>
</tr>
<tr>
<td><strong>Sokolow Lyon (LVH)</strong></td>
<td>45%</td>
</tr>
<tr>
<td><strong>ST segment elevation</strong></td>
<td>45%</td>
</tr>
<tr>
<td><strong>Complete RBBB</strong></td>
<td>0.6%</td>
</tr>
<tr>
<td><strong>T-wave inversion</strong></td>
<td>4%</td>
</tr>
<tr>
<td><strong>Deep T-wave inversion</strong></td>
<td>0.8%</td>
</tr>
<tr>
<td><strong>Flat/mild inv. T-waves</strong></td>
<td>13%</td>
</tr>
<tr>
<td><strong>Deep T-wave inversion</strong></td>
<td>1.8%</td>
</tr>
</tbody>
</table>
CONCLUSIONS

• 12-lead ECG must be included in the pre-participation screening of adolescent athletes to prevent SCD.

• Specific age criteria should be included in the recommendations for the interpretation of repolarization abnormalities in anterior precordial leads in adolescent athletes.

• Further studies are needed to evaluate the clinical outcome of repolarization abnormalities in adolescent athletes.
Thank you for your attention!