Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal heart.

Hanne Rasmussen
Consultant cardiologist, PhD
Dept. of Cardiology
Bispebjerg University Hospital
Copenhagen, Denmark
Conflicts of interest: None
Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal hearts
Exercise guidelines

Competitive sports vs. leisure-time sports (incl. treatment)

To be avoided:
- Burst exertion
- Extremely adverse environmental conditions
- Excessive participation
- Specific exercise in certain diseases


Mitchell et al, JACC 45 (8) 1364-7, 2005.
Exercise guidelines with ICD

No competitive sports unless...

Leisure-time sports:
- Avoid bodily contact
- Avoid high risk sports
- Extreme ipsilateral arm movement
- Tailor ICD settings → Avoid inappropriate shocks


Follow-up every 6 months

Mitchell et al, JACC 45 (8) 1364-7, 2005.
ECG changes might precede phenotypic signs of structural heart disease

24 yrs canoer
No signs of disease
Died suddenly within 1 yr
Autopsy: ARVC

26 yrs soccer player
No signs of disease
After 7 yrs develops phenotypic evidence of HCM

29 yrs soccer player
No signs of disease
After 12 yrs still phenotypic healthy
Pellicia et al, NEJM, 2008

Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal hearts
Classification of abnormalities of the athletes ECG

- **Group 1:**
  - Sinus bradycardia
  - First-degree AV block
  - Incomplete RBBB
  - Early repolarization
  - Isolated QRS voltage criteria for left ventricular hypertrophy

- **Group 2:**
  - T-wave inversion
  - ST-segment depression
  - Pathological Q-waves
  - Left atrial enlargement
  - Left axis deviation/left posterior hemiblock
  - Right axis deviation/left posterior hemiblock
  - Right ventricular hypertrophy
  - Ventricular pre-excitation
  - Complete LBBB or RBBB
  - Long- or short QT interval
  - Brugada-like early repolarization

Corrado et al, European Heart Journal 2010
Repolarization incl. J-point

Reopening of potassium channels PLUS closing of calcium channels are responsible for the repolarization phase.

Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal hearts
Repolarization abnormalities in structurally normal heart

• **Group 1:**
  - Early repolarization

• **Group 2:**
  - T-wave inversion
  - ST-segment depression
  - Long- or short QT interval
  - Brugada-like early repolarization

Corrado et al, European Heart Journal 2010
Early repolarization

Elevation of the J-point of at least 0.1 mV from baseline, associated with nothing or slurring of the terminal QRS complex which may vary in location, morphology, and degree

Corrado et al, Eur Heart J 2010
Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal hearts

ST-segment elevation

Wang et al, NEJM 2003
Sudden Cardiac Arrest Associated with Early Repolarization

Haïssaguerre et al, NEJM 2008

- Case-control study: 206 subjects with ideopathic ventricular fibrillation (IVF)
- All cases received ICD
- ER inferior/lateral leads odds ratio x10 in case subjects
- In case subjects with ER hazard ratio of recurrence within 5 yrs was 2
- Few cases of athletes or blacks among cases
Early Repolarization
Electrocardiographic Phenotypes Associated With Favorable Long-Term Outcome

Jani T. Tikkanen, BM; M. Juhani Juntuila, MD; Olli Anttonen, MD; Aapo L. Aro, MD; Samuli Luttinen, BM; Tuomas Kerola, MD; Solomon J. Sager, MD; Harri A. Rissanen, MSc; Robert J. Myerburg, MD; Antti Reunanen, MD; Heikki V. Huikuri, MD

Circulation 2011

Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal hearts
Brugada syndrome (BS)

Characterized by an ST-segment elevation in the right precordial leads (type 1) and a high incidence of sudden cardiac death in patients with structurally normal hearts

Antzelevitch et al, Circulation 2005
Brugada like ECG changes

Brugada: $\frac{ST_J}{ST_{80}} > 1$

Corrado et al, Eur Heart J 2010

Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal hearts
Diagnostic criteria of BS

- Type 1 ST segment elevation ≥ 2 mm in > 1 right precordial lead (V1-V3) spontaneously or after sodium-blocker exposure
- One of the following:
  - Documented VF
  - (Self-terminating) polymorphic ventricular tachycardia
  - Inducible ventricular arrhythmias with EPS
  - Family history of SCD <45 yrs
  - Presence of a coved-type ECG in family members
  - Syncope
  - Nocturnal agonal respiration

Other factors accounting for the ECG abnormality should be ruled out

Antzelevitch et al, Circulation 2005

Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal hearts
Clinical manifestation and prognosis of BS

Symptom occurrence:
- Mean age of onset: 40 yrs
- Phenotypic more prevalent in males (x10)
- Typically occur during sleep (like Type 3 LQTS) or fever

N=547 patients with BS
Mean follow-up 24 months
8 % developed cardiac event

Treatment of BS

Benito et al, Progress in Cardiovasc Dis 2008

Exercise guidelines in athletes with isolated repolarisation abnormalities and structurally normal hearts
Exercise recommendations for BS

Competitive sports:
- Manifest syndrome + ICD or high risk → type Ia sports
- Silent gene carriers or Brugada like ECG changes → Moderate cardiovascular demand (no high risk sports, avoid hyperthermia) → close follow-up

Leisure-time sports (+/- ICD):
- Manifest syndrome → moderate demand
- No high risk sports for BS
- No extremely adverse environmental conditions/excessive participation
- Silent gene carriers or Brugada like ECG changes → No restrictions → close follow-up
Long QT syndrome (LQTS)

An inherited cardiac arrhythmic disorder due to mutations affecting the cardiac ion channels resulting in delayed ventricular repolarization and a prolonged QT interval on ECG. The associated arrhythmias may manifest as syncope, aborted cardiac arrest or SCD

Liu & Moss JACC 2011

Short QT syndrome (SQTS)

Channelopathy characterized by abnormally short repolarization: QT/QTc < 325 ms
Long QT syndrome

- QTc measured by Bazett’s formula

Athletes

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESC</strong> Corrado et al, 2010</td>
<td>&gt;440 ms</td>
<td>&gt;460 ms</td>
</tr>
<tr>
<td><strong>AHA</strong> Zipes et al, 2005</td>
<td>≥470 ms</td>
<td>≥480 ms</td>
</tr>
</tbody>
</table>

→ Further evaluation
### Diagnostic criteria for LQTS

#### Scoring:
- ≤ 1 point low probability
- 2-3 points intermediate
- ≥ 4 points high

<table>
<thead>
<tr>
<th>Finding</th>
<th>Score</th>
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<tbody>
<tr>
<td><strong>Electrocardiographic</strong>†</td>
<td></td>
</tr>
<tr>
<td>Corrected QT interval, ms</td>
<td></td>
</tr>
<tr>
<td>≥ 480</td>
<td>3</td>
</tr>
<tr>
<td>460–470</td>
<td>2</td>
</tr>
<tr>
<td>450 (in males)</td>
<td>1</td>
</tr>
<tr>
<td>Torsades de pointes‡</td>
<td>2</td>
</tr>
<tr>
<td>T-wave alternans</td>
<td>1</td>
</tr>
<tr>
<td>Notched T-wave in 3 leads</td>
<td>1</td>
</tr>
<tr>
<td>Low heart rate for age§</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Clinical history</strong></td>
<td></td>
</tr>
<tr>
<td>Syncope‡</td>
<td></td>
</tr>
<tr>
<td>With stress</td>
<td>2</td>
</tr>
<tr>
<td>Without stress</td>
<td>1</td>
</tr>
<tr>
<td>Congenital deafness</td>
<td>0.5</td>
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<tr>
<td><strong>Family history</strong></td>
<td></td>
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<tr>
<td>Family members with definite LQTS</td>
<td>1</td>
</tr>
<tr>
<td>Unexplained SCD in immediate family members &lt;30 yrs old</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Schwartz et al, Circulation 1993
Proposed scheme for risk stratification among patients with LQTS

- Genotype
- Gender
- QTc

Priori et al, Circulation 2003
Investigation of athletes with long QTc

Exclude acquired long QTc:

• **Drugs**
  • Antibiotics
  • Anti-histaminic drugs
  • Antifungals
  • Tricyclic antidepressant
    www.QTdrugs.org

• **Organic cardiac disease**
  • Sinus node disease or AV block

• **Non-cardiac causes**
  • Hypokalaemia
  • Anorexia nervosa
  • Hypothyroidism
Investigation of athletes with long QTc

QTc > 500 ms and/or symptoms → Referred to a specialist

"Grey zone" (460/470–500 ms) and asymptomatic

Schwartz et al, Circulation 1993

- Deconditioning
- Repeated ECGs
- Holter
- Exercise testing

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Exercise recommendations for LQTS

Competitive sports:
- Phenotypically overt → No competitive sports
- Silent gene carriers → No competitive sports

Leisure-time sports (on beta-blockers +/- ICD):
- No high risk sports for LQTS
  - Swimming (LQTS 1)
  - Diving (LQTS 1)
  - Abrupt loud noises (race starters pistol) (LQTS 2)
- No "burst" exertion
  - Basketball
  - Soccer
  - Tennis
- No extremely adverse environmental conditions/excessive participation
Investigation of athletes with short QTc

Exclude acquired short QTc:

- *Organic cardiac disease*
  - Tachycardia
- *Non-cardiac causes*
  - Hyperkalaemia
  - Hypercalcaemia
  - Hyperthermia
  - Acidosis
Exercise recommendations for SQTS

Competitive sports:
- Phenotypically overt → Low static/dynamic demand
- Silent gene carriers → Same

Leisure-time sports (+/- ICD):
- No "burst" exertion
- No extremely adverse environmental conditions/excessive participation
- No high risk sports (motorbike/car driving, diving, swimming)
Conclusion

- Interpretation of the ECG depends on the context
- We need more large scale data on repolarization abnormalities in athletes to give evidence-based guidelines on exercise