Αθλητική καρδιά ή μυοκαρδιοπάθεια

Κων/νος Ριτσάτος

Μονάδα κληρονομικών και σπάνιων καρδιαγγειακών νοσημάτων
Ονάσειο καρδιοχειρουργικό κέντρο
Is this a cardiomyopathy?
The case:

17y o male

✓ Soccer player athlete
✓ Totally asymptomatic
✓ No family history
✓ Pre-participation screening
E/Ea : 4
The Question:

Is this myocardial morphology representative of primary LVNC or hypertrabeculation without clinical significance?
Athlete’s Heart

ELECTRICAL

- Bradycardia
- Repolarisation anomalies
- Voltage criteria for chamber enlargement
- Arrhythmias

FUNCTIONAL

- Enhanced diastolic filling
- Augmentation of stroke volume

STRUCTURAL

- Increased chamber wall thickness and cavity size
Athlete’s heart (structural remodelling)

- 40-50% increase in LV mass
- 6-10% increase in LV cavity size
- 10-14% increase in RV cavity size
- 15-20% increase in LV wall thickness
Athlete’s Heart vs HCM

LVH 16mm

Papadakis M et al Eur Heart 2011
<table>
<thead>
<tr>
<th>Feature</th>
<th>Athlete’s Heart</th>
<th>HCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bizarre patterns of LVH</td>
<td>_</td>
<td>+</td>
</tr>
<tr>
<td>LV cavity &gt; 54 mm</td>
<td>_</td>
<td>+</td>
</tr>
<tr>
<td>LA &gt; 50 mm</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>LV outflow obstruction</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Impaired diastolic function</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Isolated Sokolow-Lyon LVH</td>
<td>+</td>
<td>_</td>
</tr>
<tr>
<td>ST depression/Deep T wave inversion</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Female gender</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Absence of HCM in first degree relatives</td>
<td>+</td>
<td>_</td>
</tr>
<tr>
<td>Peak VO2 &gt; 50 ml/kg/min</td>
<td>_</td>
<td>+</td>
</tr>
</tbody>
</table>
Athlete’s heart vs DCM

Left Ventricular end diastolic cavity

Pellicia et al. Ann Int Med 1999
DCM vs ATHLETE’S HEART

Symptoms
- Family history
- Low E’
- Low Es
- Abnormal ECG
- Low peak VO2

Asymptomatic
- Exercise echo shows excellent LV function
- Isolated Sokolow Lyon voltage criterion for LVH
- High peak VO2

DCM
- Enlarged LV Cavity
- Low Ejection Fraction

Athlete’s Heart

Low peak VO2
ARVC vs Athlete’s heart

Zaidi et al Circulation 2013

NORMAL RV FUNCTION
NO SEGMENTAL HYPOKINESIS
NO ARRHYTMIAS
Definition of increased LV trabeculation

- Comes from a sedentary control population
- Mean number of trabeculations plus 2-SD (0.76+/−1.1)

\[ \geq 3 \text{ trabeculations} \]

Tamborini G et al J Am Soc Echocardiogr 2004
LV trabeculation in highly trained athletes: Is there need for more stringent criteria for the diagnosis of LVNC in athletes?

Gati, Sharma et al Heart 2013

- 1146 athletes competitive athletes
- ECG and Echocardiogram
- Age 20.9 (14-35yo)
- Gender: 80% male
- 80% Caucasian
- In comparison with:
  - 415 controls non-athletes,
  - 75 LVNC pts
Hypertrabeculation in athletes

- LVHT more common in athletes vs controls
  Athletes 18.5% vs 7% controls

- No gender differences in athletes
  Males 20.7% vs Females 18.1%

- LVHT more common in black athletes
  Black athletes 28.8% vs white athletes 16.3%

Gati S, Sharma S et al Heart 2013
LVNC - ECHO CRITERIA
8.1% of athletes met both criteria for LVNC

Non of the controls fullfilled the LVNC criteria
6 weeks

Heart Failure
Ventricular arrhythmias
Systematic embolic events

LVNC
Problems with current Criteria

- Based on very small cohorts
- Not prospectively derived
- Not validated
- Measurements performed in different phases of the cardiac cycle
Athlete's LV Cavity

LV cavity

Deep T wave ↓
EF

LVH
↑ LVED

Left ventricular non-compaction

Epiphenomenon to ↑ LV preload

EXERCISE

TIME

Gati S et al Heart 2013
The pregnancy model

First Trimester: Preload

Third Trimester: Normalisation of Preload

Post-Partum: LV

S Gati, M Papadakis et al. Circulation 2014
Pregnancy model results

✓ De novo LV trabeculations occurred in 25% of pregnant women

✓ 8 women fulfilled both the Jenni and Chin criteria

✓ During a follow-up period of two years 85% showed regression toward normal morphology
# Athletes fulfilling LVNC vs LVNC patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Athletes Fulfilling LVNC Criteria</th>
<th>LVNC Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td>0%</td>
<td>65%</td>
</tr>
<tr>
<td>Inverted T-waves</td>
<td>16%</td>
<td>31%</td>
</tr>
<tr>
<td>Inferior T wave inversion</td>
<td>5.4%</td>
<td>20%</td>
</tr>
<tr>
<td>Lateral T wave inversion</td>
<td>2.2%</td>
<td>28%</td>
</tr>
<tr>
<td>Mean LVED (mm)</td>
<td>$51.4 \pm 5.5$</td>
<td>$57.8 \pm 11.7$</td>
</tr>
<tr>
<td>LVEF</td>
<td>$63% \pm 8.3$</td>
<td>$46.3% \pm 19$</td>
</tr>
<tr>
<td>S’ Septal</td>
<td>$8.6 \pm 1.5$</td>
<td>$6.4 \pm 1.7$</td>
</tr>
<tr>
<td>S’ Lateral</td>
<td>$11.6 \pm 3.5$</td>
<td>$7.0 \pm 2.5$</td>
</tr>
</tbody>
</table>
Athletes with LVNC criteria - twi

Both Chin et al and Jenni et al criteria
n=93
(8.1%)

Black
n=16
(11.0%)

Caucasian
n=77
(8.4%)

P=0.342

T-wave ↓
n=5
(3.4%)

T-wave ↓
n=10
(1.1%)

P=0.042

EF<50%
n=5
(3.4%)

EF<50%
n=5
(0.5%)

P=0.012
Features of athletes that present with LVNC and abnormal LV function

Table 5: Demographic data on the 10 athletes with LVNC criteria and reduced systolic function

<table>
<thead>
<tr>
<th>Athlete</th>
<th>Age (years)</th>
<th>BSA (m²)</th>
<th>Ethnicity</th>
<th>Sex</th>
<th>Sport</th>
<th>Hrs of training</th>
<th>LVNC CRITERIA</th>
<th>EF REDUCED</th>
<th>TW INVERSION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V1-V3</td>
<td>V1-V3</td>
<td>V1-V3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>II, III, aVF</td>
<td>V1-V4/III, aVF</td>
<td>V1-V3</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>1.76</td>
<td>Black</td>
<td>M</td>
<td>Boxing</td>
<td>20</td>
<td>56</td>
<td>11</td>
<td>56</td>
</tr>
<tr>
<td>2</td>
<td>19</td>
<td>1.88</td>
<td>Black</td>
<td>M</td>
<td>Cricket</td>
<td>8</td>
<td>62</td>
<td>11</td>
<td>62</td>
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<tr>
<td>3</td>
<td>26</td>
<td>2.00</td>
<td>Black</td>
<td>F</td>
<td>Netball</td>
<td>15</td>
<td>48</td>
<td>11</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>2.26</td>
<td>Black</td>
<td>M</td>
<td>Soccer</td>
<td>20</td>
<td>50</td>
<td>11</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>34</td>
<td>2.04</td>
<td>Black</td>
<td>M</td>
<td>Soccer</td>
<td>18</td>
<td>59</td>
<td>12</td>
<td>59</td>
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<tr>
<td>6</td>
<td>21</td>
<td>2.52</td>
<td>White</td>
<td>M</td>
<td>Soccer</td>
<td>22</td>
<td>57</td>
<td>10</td>
<td>57</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
<td>2.29</td>
<td>White</td>
<td>M</td>
<td>Soccer</td>
<td>20</td>
<td>53</td>
<td>11</td>
<td>53</td>
</tr>
<tr>
<td>8</td>
<td>25</td>
<td>2.18</td>
<td>White</td>
<td>M</td>
<td>Swimming</td>
<td>25</td>
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<td>9</td>
<td>51</td>
</tr>
<tr>
<td>9</td>
<td>26</td>
<td>1.83</td>
<td>White</td>
<td>F</td>
<td>Netball</td>
<td>15</td>
<td>50</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>19</td>
<td>2.28</td>
<td>White</td>
<td>M</td>
<td>Soccer</td>
<td>22</td>
<td>56</td>
<td>9</td>
<td>56</td>
</tr>
</tbody>
</table>

LVNC, left ventricular non-compaction. BSA, Body Surface Area; E/A, ratio of early diastolic mitral valve peak inflow to peak early diastolic mitral annular velocity; EF, Ejection Fraction; LVED, Left Ventricular End Diastolic Diameter; E/E', ratio of early diastolic mitral inflow velocity to peak early diastolic mitral annular velocity; LVWT, Left Ventricular Wall Thickness.
Athlete with LVNC–Like morphology risk stratification and management

LVNC criteria in asymptomatic athletes

Left Ventricular Function

EF > 50%
- Negative family history
- Normal LV diastolic function
- No ECG abnormalities
- No arrhythmias/syncope
  - No additional testing.
  - No LVNC.
  - No restriction for sport participation.
  - Follow-up advised

EF < 50%
- Positive family history
- ECG abnormalities
- Ventricular tachyarrhythmias
- CMR with LGE
  - Genetic testing
  - Normal CMR and negative genetic testing:
    - LVNC unlikely.
    - Sport participation allowed, with periodic follow-up
  - Positive CMR and/or genetic testing:
    - LVNC likely.
    - Restrict sport participation
ECG interpretation in athletes

**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

**Borderline ECG Findings**
- Left axis deviation
- Left atrial enlargement
- Right axis deviation
- Right atrial enlargement
- Complete RBBB

**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

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

2 or more

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

S. Sharma et al Eur Heart J 2017
Conclusions

- Overlapping between subclinical forms of cardiomyopathies and athletes heart exist

- The increased isolated LV trabeculation are apparently benign, suggesting a cardiac morphologic variant more than a true pathologic condition

- The combination of marked ECG repolarization with LV dysfunction merits further evaluation
Ευχαριστώ για την προσοχή σας !!!

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Ωνάσειο καρδιοχειρουργικό κέντρο

MONADA Κ.κα.πα