Prevalence of significant ECG abnormalities in 1,072 elite Australian athletes

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Declaration of interests

None to declare
Background

Pre-participation screening inclusive of an ECG in young athletes to prevent sudden cardiac death (SCD)

Pre-participation screening (PPS) in Italy – reduction of incidence of SCD by 89% ¹

Cardiomyopathies (HCM & ARVC) leading causes of SCD; often no symptoms prior to SCD detectable on ECG in >80%

BUT

ECG changes in trained athletes can mimic pathology

¹ Corrado et al. 2006 JAMA
2010 ESC recommendations for athlete ECG interpretation

**Group 1**
Common, “training related”
- Sinus bradycardia
- First degree AV block
- Incomplete RBBB
- Early repolarisation
- Isolated QRS voltage criteria for LVH

**Group 2**
Uncommon, “training unrelated”
- T-wave inversion (>2mm in 2 or more leads)
- ST-segment depression
- Pathological Q waves
- Left or right atrial enlargement
- Left axis deviation/left anterior 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 repolarisation

Corrado *et al.* Recommendations for interpretation of the 12-lead electrocardiogram in the athlete *EHJ* 2010; 31: 243-59
Background

Pre-participation screening in Australia

No screening recommendations

Unique racial mix; indigenous athletes well represented

No data on prevalence of ECG abnormalities
Aims

To evaluate the prevalence of ECG abnormalities in a group of elite Australian athletes

To determine how often ECG abnormalities correlate with evidence of significant cardiac pathology on further investigation
Methods

Competitive athletes recruited

Age 16-35
No known cardiac disease

Demographic and morphometric data
Sport, position on field, hours per week
Personal and family history

12-lead ECG
Interpreted by primary investigators as per ESC recommendations

Group 1 ECG changes or normal

Group 2 ECG changes

Age <16 or >35
Known cardiac disease
Previously screened in study

Further investigation recommended as appropriate
Methods
Non-endurance vs. endurance

Football *
Netball
Cricket
Basketball
Volleyball
Hockey
Baseball
Gymnastics
BMX/track sprint cycling

*Australian football (AFL), soccer, rugby union, rugby league

Chi-square tests, p<0.05 significant

Mitchell et al. JACC 2005
Results
Athlete demographics (n=1,072)

- **Non-endurance**
- **Endurance**
- **Female (18%)**
- **Indigenous (12%)**

The chart shows the distribution of athletes in various sports categories.
Results
Non-endurance vs. endurance characteristics

Total
n = 1072
18% F, 88% M
20 ± 4 years (49%≤18 years)
15 ± 7 hours training/week
BSA 2.04± 0.19m²

Non-endurance
n = 871 (81% total)
14% F, 86% M
20 ± 4 years
13 ± 5 hours/week
BSA 2.06 ± 0.19m²

Endurance
n = 201 (19% total)
35% F, 65% M*
22 ± 5 years*
24 ± 6 hours/week*
BSA 1.92 ± 0.18 m²*

*p <0.05
## Results

### Group 1 ECG changes

<table>
<thead>
<tr>
<th>Group 1 ECG change</th>
<th>Total (1072)</th>
<th>Non-endurance</th>
<th>Endurance</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>% of total 871</td>
<td>of total 201</td>
<td></td>
</tr>
<tr>
<td>None (normal ECG)</td>
<td>172</td>
<td>16%</td>
<td>18%</td>
<td>8%</td>
</tr>
<tr>
<td>HR ≤ 50</td>
<td>201</td>
<td>16%</td>
<td>17%</td>
<td>31%</td>
</tr>
<tr>
<td>1° HB (PR &gt;200ms)</td>
<td>78</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
</tr>
<tr>
<td>iRBBB (RsR’ V1)</td>
<td>331</td>
<td>31%</td>
<td>30%</td>
<td>36%</td>
</tr>
<tr>
<td>LVH (S-Lyon ≥ 35mm)</td>
<td>308</td>
<td>29%</td>
<td>27%</td>
<td>37%</td>
</tr>
<tr>
<td>LVH (R-Estes ≥ 5)</td>
<td>141</td>
<td>13%</td>
<td>11%</td>
<td>23%</td>
</tr>
<tr>
<td>Early repolarisation</td>
<td>393</td>
<td>36%</td>
<td>34%</td>
<td>50%</td>
</tr>
</tbody>
</table>

**Common (84%)**

More common in endurance (92%)
# Results

**Group 2 ECG changes**

9.3% of total ECG changes

<table>
<thead>
<tr>
<th>Group 2 ECG change</th>
<th>Total</th>
<th>Non-endurance</th>
<th>Endurance</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal ECG</td>
<td>101</td>
<td>9.3%</td>
<td>7.2%</td>
<td>19%</td>
</tr>
<tr>
<td>Abnormal T-wave inversion &gt;0.2mV in 2 or more leads (excluding V1-2 in isolation)</td>
<td>27</td>
<td>2.5%</td>
<td>2.5%</td>
<td>2.5%</td>
</tr>
<tr>
<td>ST – segment depression</td>
<td>2</td>
<td>0.2%</td>
<td>2.2%</td>
<td>-</td>
</tr>
<tr>
<td>Right axis deviation ≥110°</td>
<td>20</td>
<td>1.9%</td>
<td>1.6%</td>
<td>3%</td>
</tr>
<tr>
<td>Left axis deviation &lt; -30°</td>
<td>6</td>
<td>0.6%</td>
<td>0.7%</td>
<td>0.5%</td>
</tr>
<tr>
<td>RVH on voltage (RV1+SV5 ≥ 10.5mm)</td>
<td>48</td>
<td>4%</td>
<td>3%</td>
<td>11%</td>
</tr>
<tr>
<td>RA enlargement (P&gt;2.5mm)</td>
<td>6</td>
<td>0.6%</td>
<td>0.1%</td>
<td>1.5%</td>
</tr>
<tr>
<td>LA enlargement (- P V1 &gt; 40ms/1mm + &gt;120ms)</td>
<td>8</td>
<td>0.7%</td>
<td>0.8%</td>
<td>0.5%</td>
</tr>
<tr>
<td>RBBB/ IVCD (QRS &gt; 120ms)</td>
<td>7</td>
<td>0.65%</td>
<td>0.68%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Pre-excitation (WPW)</td>
<td>1</td>
<td>0.09%</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Ventricular ectopy (&gt;3)</td>
<td>1</td>
<td>0.09%</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Results
Abnormal T-wave inversion

High lateral, n=2 (<0.1%)

Lateral n=11 (1%)

Inferior, n=5 (0.4%)

V1-V3 n=13 (1.2%)

n=27 (2.5%)
1.3% inferior &/or lateral
Results

T-wave inversion isolated to V1-2

5% of athletes
More of endurance (12% vs. 6.4%)
….Training unrelated (?) changes in
26.4% of endurance

“post-pubertal persistence of T-wave inversion beyond V1 requires further evaluation”

Corrado et al EHJ 2010
Results
Follow up to date

101 abnormal ECGs

45 follow up

9 with deep TW-inversion
14 with RAD ≥ 110°
14 with RVH on voltage criteria
3 with RA enlargement
2 with LA enlargement
2 with RBBB
1 with WPW pattern

39 normal TTE
No further follow up

31 M footballer
RAD, RVH abnormal TTE

20 M cyclist
RVH, iRBBB abnormal TTE

21 M rower
Asymptomatic WPW

3 very abnormal ECGs
Normal TTE
Yearly review + ECG + TTE

56 follow up results TBC

TOE confirmed large ASD
Awaiting surgery
Temporary restriction

CMR non-diagnostic
2nd yearly CMR
No restriction

EP review currently
No restriction

3 very abnormal ECGs
Normal TTE
Yearly review + ECG + TTE

44 no restriction

1 temporary sports restriction for surgery (open ASD repair)
4 requiring yearly review
No permanent athletic restrictions
Conclusions

- Group 1 ECG changes very common; 92% endurance athletes
- Group 2 ECG abnormalities in 9.3% of 1,072 asymptomatic elite athletes, but 19% of endurance athletes
  - Truly “training unrelated” changes or a reflection of adaptation of the right ventricle to endurance exercise/training
- 1.3% with ECGs considered highly suspicious for cardiomyopathies
- Further refinement of current ECG criteria may improve the specificity of screening in highly trained, elite athletes
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**Methods**
Performance of 2010 ESC recommendations for athlete ECG interpretation

**Group 2**
Uncommon, “training unrelated”

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- Pathological Q waves
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- Ventricular pre-excitation
- Complete LBBB or RBBB

**Excluding III, aVR and V1/2**
- $< -30^\circ$ or $>110^\circ$
- $RV1 + SV5 \geq 10.5mm$
- $>470ms \, (M), \, >480ms \, (F), \, <340ms \, (M/F)$