Clinical significance of Early Repolarization (J-wave/QRS slurring) in athletes

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NO CONFLICT OF INTEREST TO DECLARE
Early repolarization and J-wave

- In 1961, Wasserburger et al. described the early repolarization as an elevated takeoff of the ST segment at the J junction, followed by concavity of the ST segment and tall, peaked T wave. This pattern was considered a normal variant.

- In 1999 Gussak and Antzelevitch, and in 2000 Kalla and Takagi defined early repolarization an elevated notch on the downsloping limb of the QRS, followed by upsloping ST segment elevation. They suggested that early repolarization may be malignant.
Contemporary definition of Early Repolarization

- Early Repolarization pattern, is the presence of J-point elevation of \( \geq 0.1 \text{ mV} \), in \( \geq 2 \) inferior and/or lateral leads on 12-lead ECG;
- Early Repolarization Syndrome is the presence of ER pattern in a patient resuscitated from VF, or in a SD victim with negative autopsy and previous evidence of ER pattern.
Clinical significance of Early Repolarization (J-wave/QRS slurring)

Several contemporary observations suggest that early repolarization pattern (J-wave/QRS slurring) may be malignant in humans (i.e., associated with idiopathic ventricular fibrillation).

Gussak I and Antzelevitch C, J Electrocardiology 2000;
Tagaki M et al. J cardiov Electrophysiol 2000;
Haissaguerre et al. NEJM 2008;
Antzelevitch C. Heart Rhythm 2010;
Sudden Cardiac Arrest Associated with Early Repolarization

Michel Haussaiguerre, M.D., Nicolas Derval, M.D., Frederic Sacher, M.D., Laurence Jesel, M.D., Isabel Deisenhofer, M.D., Luc de Roy, M.D., Jean-Luc Pasquié, M.D., Ph.D., Akihiko Nogami, M.D., Dominique Rabut, M.D., Sinikka Yli-Mayry, M.D., Christian De Chilliou, M.D., Patrice Scaru, M.D., Philippe Mabo, M.D., Seiichiro Matsuo, M.D., Vincent Probst, M.D., Ph.D., Solena Le Scouarier, Ph.D., Pascal Defaye, M.D., Juerg Schlæpfer, M.D., Thomas Rostock, M.D., Dominique Lacros, M.D., Dominique Lamaison, M.D., Thomas Lavergne, M.D., Yoshifusa Aizawa, M.D., Anders Englund, M.D., Frederic Anselme, M.D., Mark O’Neill, M.D., Meleze Hocini, M.D., Kang Teng Lim, M.B., B.S., Sebastien Knecht, M.D., George D. Veenvliet, M.D., Pierre Bordachar, M.D., Michel Chauvin, M.D., Pierre Jais, M.D., Gaelle Courtet, Ph.D., Genevieve Chene, Ph.D., George J. Klein, M.D., and Jacques Clémenty, M.D.

NEJM 2008; 358: 2016-23
Figure 1. Baseline Electrocardiograms from Four Case Subjects.

In each panel, early repolarization is evident in the varying patterns of QRS slurring or notching in inferolateral leads (arrows). Panel D shows a beat-to-beat fluctuation in this pattern.
During a 5-year follow-up period, ICD monitoring showed higher incidence of recurrent ventricular fibrillation in subjects with J-wave/QRS slurring.

Haïssaguerre M et al. NEJM 2008; 358: 2016-23
J-Point Elevation in Survivors of Primary Ventricular Fibrillation and Matched Control Subjects

Incidence and Clinical Significance

Raphael Rosso, MD,* Evgeni Kogan, MD,* Bernard Belhassen, MD,* Uri Rozowski, MD,* Melvin M. Scheinman, MD,** David Zeltser, MD,* Amir Halkin, MD,* Arie Steinvil, MD,* Karin Heller, MD,* Michael Glikson, MD,** Amos Katz, MD,** Sami Viskin, MD**
J-wave/QRS slurring is more frequent in athletes with cardiac arrest/sudden death than in control athletes.
Clinical significance of J-wave/QRS slurring in athletes?

- A silent marker of an electrical cardiac disease
- A benign expression of autonomic imbalance
Athlete’s Study Population

- 704 elite athletes evaluated as potential participants to the Olympics Games and/or World Championships
- 436 males (62%) and 268 females (38%)
- Mean age 25±5 (range 14-45, median 24)
- 30 different sport disciplines participated
Methods

- All athletes routinely performed a 12-lead resting and exercise ECG and Echocardiography.
- Athletes with supraventricular or ventricular arrhythmias on 12-lead ECG, or with history of palpitations, underwent 24-hour ECG Holter monitoring, which included their daily training session.
Results

704 athletes

- 102 (14%) J-wave/QRS slurring
- 602 (86%) No J-wave/QRS slurring

80% were elite athletes and 26% participated at ≥1 Olympic Games.
12-lead ECG from a 24-year male, elite swimmer, at 2012 pre-Olympic screening.
12-lead ECG from a 28-year male, elite cross-country skier, at 2013 pre-Olympic screening
Distribution of J-wave/QRS slurring in 102 athletes

- Anterior: 73 (72%)
- Lateral: 26 (25%)
- Inferior: 3 (3%)
Pattern of ST-segment in 102 athletes with J-wave/QRS slurring

86 (84%) ascending
18 (16%) horizontal
0 (0%) descending
### 12-lead ECG characterization

<table>
<thead>
<tr>
<th>Metric</th>
<th>Athletes J-wave/QRS slurring (n = 102)</th>
<th>Athletes without J-wave/QRS slurring (n = 602)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>25.0±4.9</td>
<td>25.2±5.4</td>
<td>ns</td>
</tr>
<tr>
<td>Male gender (%)</td>
<td>83 (74%)</td>
<td>380 (59%)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>BSA (m²)</td>
<td>1.90±0.20</td>
<td>1.92±0.24</td>
<td>ns</td>
</tr>
<tr>
<td>BP (mmHg)</td>
<td>116±9/75±7</td>
<td>117±10/75±7</td>
<td>ns</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>54±10</td>
<td>58±11</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>QRS duration (s)</td>
<td>0.093±0.010</td>
<td>0.093±0.012</td>
<td>ns</td>
</tr>
<tr>
<td>Sokolow criteria for LVH</td>
<td>78 (76%)</td>
<td>184 (31%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ST-segment elevation (n; %)</td>
<td>86 (84%)</td>
<td>400 (66%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Q-waves (n; %)</td>
<td>30 (27%)</td>
<td>91 (14%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Inverted T-waves (n; %)</td>
<td>6 (5%)</td>
<td>19 (3%)</td>
<td>ns</td>
</tr>
<tr>
<td>IRBB (n; %)</td>
<td>28 (25%)</td>
<td>236 (37%)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>PR interval (s)</td>
<td>0.16±0.03</td>
<td>0.16±0.03</td>
<td>ns</td>
</tr>
<tr>
<td>QTc interval (s)</td>
<td>0.40±0.03</td>
<td>0.40±0.02</td>
<td>ns</td>
</tr>
</tbody>
</table>
Arrhythmias

Athletes with J wave/QRS slurring

VPBs: n=14; 11 with isolated PVBs; 3 with couplets. None with VT

SVPBs: n=11; Only isolated SVPBs

% of Athletes
## Echocardiographic characterization

<table>
<thead>
<tr>
<th></th>
<th>Athletes J-wave/QRS slurring (n = 102)</th>
<th>Athletes without J-wave/QRS slurring (n = 602)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV cavity dimension (mm)</td>
<td>53.5±3.9</td>
<td>52.7±4.8</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Max LV Wall thickness (mm)</td>
<td>10.1±1.2</td>
<td>9.8±1.3</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>LV Mass (g)</td>
<td>199±48</td>
<td>188±56</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Left atrium (mm)</td>
<td>35.4±4.1</td>
<td>34.9±4.3</td>
<td>ns</td>
</tr>
<tr>
<td>PW E-wave (mm/s)</td>
<td>88±14</td>
<td>87±16</td>
<td>ns</td>
</tr>
<tr>
<td>PW A-wave (mm/s)</td>
<td>46±9</td>
<td>47±10</td>
<td>ns</td>
</tr>
<tr>
<td>TDI e-wave (mm/s)</td>
<td>14.1±2.2</td>
<td>13.9±2.3</td>
<td>ns</td>
</tr>
<tr>
<td>TDI a-wave (mm/s)</td>
<td>7.0±1.7</td>
<td>7.3±1.8</td>
<td>ns</td>
</tr>
<tr>
<td>TDI s-wave (mm/s)</td>
<td>9.2±1.1</td>
<td>9.1±1.3</td>
<td>ns</td>
</tr>
<tr>
<td>EF (%)</td>
<td>64±5</td>
<td>64±5</td>
<td>ns</td>
</tr>
</tbody>
</table>
ECG/Echo features

![Bar chart showing percentages of athletes with various ECG/Echo features.](chart.png)

- **LVH**
- **ST-segm.**
- **heart rate**
- **LV mass**

Color codes:
- **Green**: J wave/QRS slurring
- **Purple**: NO J wave/QRS slurring

Section of Sports Cardiology
European Association for Cardiovascular Prevention & Rehabilitation (EACPR)
www.sportscardiology.eu
Clinical Outcome

1 - 18 years (mean, 6) follow-up

J-wave/QRS slurring

No CV events, symptoms, or evidence of CV disease

102

NO J-wave/QRS slurring

Death (car accident) = 1
Atherosclerotic CAD = 1
Systemic hypertension = 1
RF ablation for AVRNT = 2

602
J wave/QRS slurring changing over time

38% of athletes showed increased height/distribution of J-wave/QRS slurring pattern, associated with reduction of heart rate, in comparison to those without changes.
27-year old female middle-distance runner at the time of the peak training (Panel A) and after detraining (Panel B).
12-lead ECG in a 20-year old male rower at (C) low-level training and (D) peak-training.
Characteristics of benign vs. malignant early repolarization
Characteristics of benign ER
(Pelliccia and Quattrini, Heart Rhythm 2015)

- Distribution in anterior and lateral leads
- Low amplitude of J-wave (≤0.2 mV)
- ST-segment morphology (ascending with positive, peaked T-wave), increased R/S-wave voltages
- Modest dynamic changes over time
- No symptoms, no family Hx of SD
Characteristics of malignant ER
*(Tikkanen JT and Huikuri VH J Electrocardiol 2015)*

- Distribution in inferior and lateral leads
- Amplitude of J-wave (>0.2 mV)
- Dynamic, marked changes (increased amplitude precedes VF)
- ST-segment morphology (horizontal or descending)
- Associated short-coupled PVBs
- Unexplained syncope
- Family Hx of sudden death
In conclusion,

- ER pattern in trained athletes has specific characteristics (amplitude, distribution, dynamicity, ST-segment).
- ER pattern is not associated with incidence of threatening arrhythmias or adverse clinical events over a medium follow-up period.
- Therefore, no additional testing are required in case of isolated J-wave/ST elevation in a trained athlete.
Thank you for your attention

See also: www.antoniopelliccia.it