

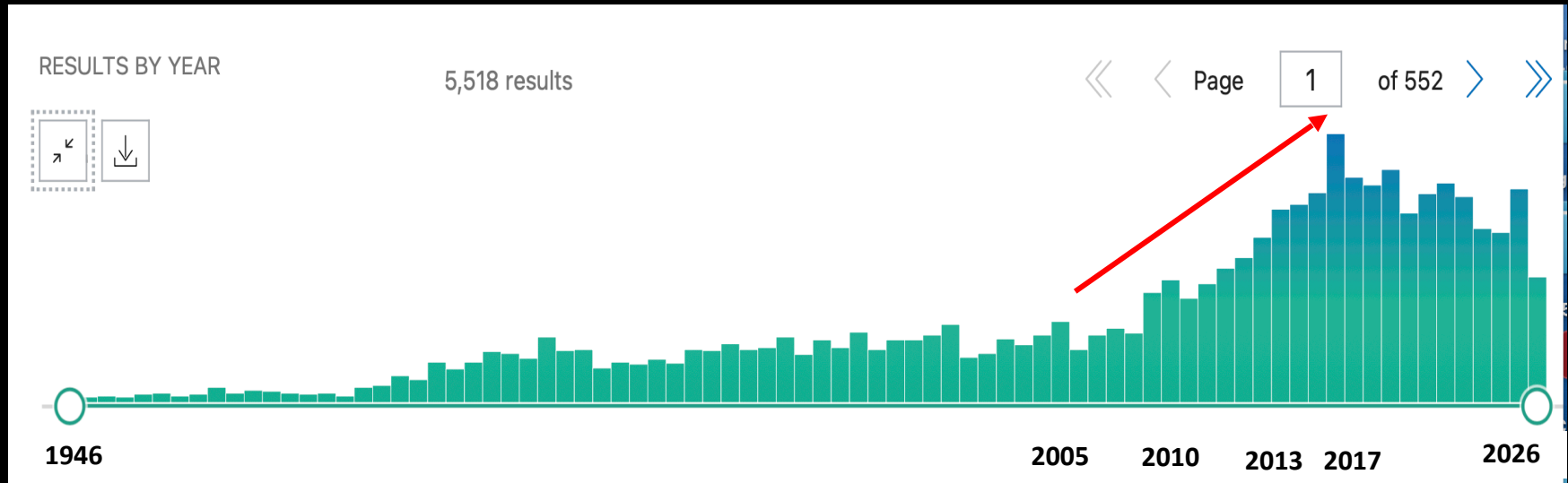
ELETTROCARDIOGRAFIA IN CARDIOLOGIA DELLO SPORT

Cosa c'è di nuovo nell'interpretazione dell'ECG dell'atleta

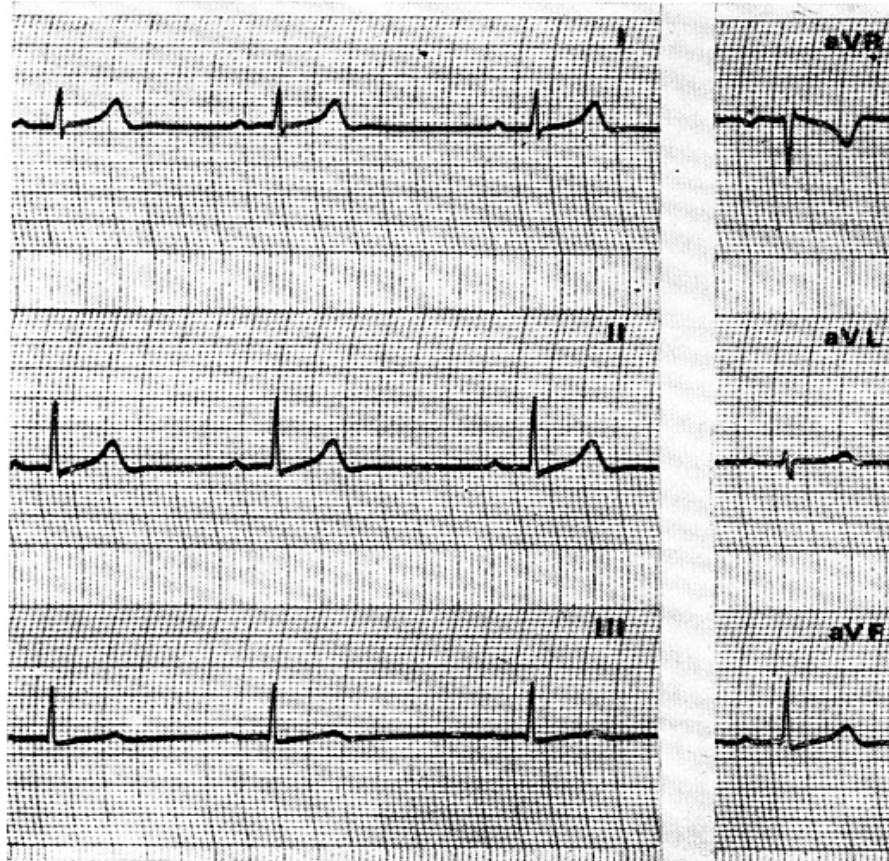
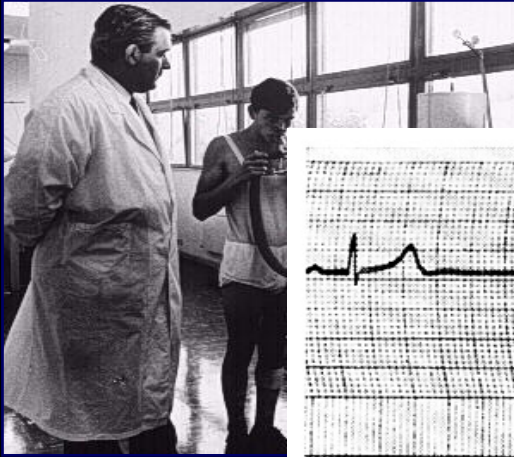
Antonio Pelliccia



Published paper on ECG patterns in athletes, 1946 to present



Specific features of 12-lead ECG in athletes



ISTITUTO DI CLINICA MEDICA E TERAPIA DELLA UNIV. DI ROMA

Direttore: Prof. G. DI GUGLIELMO

CENTRO MEDICO SPORTIVO DELLA F.M.S.I. DI ROMA

Direttore: Prof. G. LA CAVA

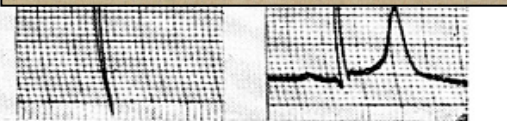
Dott. ROMEO BOLDRINI

Dott. ANTONIO VENERANDO

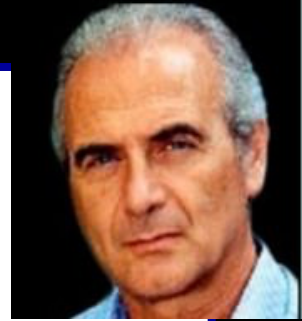
Analisi statistica comparativa fra gli elettrocardiogrammi
di cento soggetti allenati e cento non allenati

Estratto dagli «Atti del IX Congresso Nazionale della F.M.S.I.»

Perugia - Maggio 1955



The clinical approach to read the athlete's ECG



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doi: 10.
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William J. McKenna¹⁸, and Gaetano Thiene¹⁹

ECG abnormalities
in the athlete

(Group 1)
common (up to 80%)

- Sinus bradycardia
- First degree AV block
- Notched QRS in V1 or incomplete RBBB
- Early repolarization
- Isolated QRS voltage criteria for left ventricular hypertrophy

(Group 2)
Uncommon (< 5%)

- 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
- Complete LBBB or RBBB
- Long or short QT interval
- Brugada-like early repolarization
- Ventricular arrhythmias

of young
den
otocol
Cardiology

, Luc Vanhees⁴,
⁶,
Mellwig¹⁰,
Anastasakis¹³,
Priori¹⁵,
it¹⁷,

Evolving criteria to read the athlete's ECG

European Heart Journal (2005) 26, 516–524
doi:10.1093/eurheartj/ehi108



ESC Report

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 on Myocardial Revascularization of the European Society of Cardiology



European Heart Journal (2010) 31, 243–259
doi:10.1093/eurheartj/ehp473

ESC REPORT

2005

Recommendations
for the interpretation
of the electrocardiogram
in the athlete



Normal electrocardiographic findings: recognising physiological adaptations in athletes

Jonathan A. Rea

Br J Sports Med
doi: 10.1136/bjsm.2014.281111

April 29, 2014

Original Article

Comparison of Electrocardiographic Criteria for the Detection of Cardiac Abnormalities in Elite Black and White Athletes

Nabeel Sheikh, MRCP; Michael Papadakis, MRCP; Saqib Ghatge, MRCP; Sabiha Gati, MRCP; Paolo Adami, MD; François Carré, MD; Mathew Wilson, PhD; Paloma Avila, MD; William M. G. Meuwissen, MD; Sanjay Sharma, MD, FRCP, FESC



European Heart Journal (2017) 00, 1–19
doi:10.1093/eurheartj/ehw631

CURRENT OPINION

International recommendations for electrocardiographic interpretation in athletes

2014

2010

2013



2017

International criteria (2017) to interpret the ECG 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 old
- 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

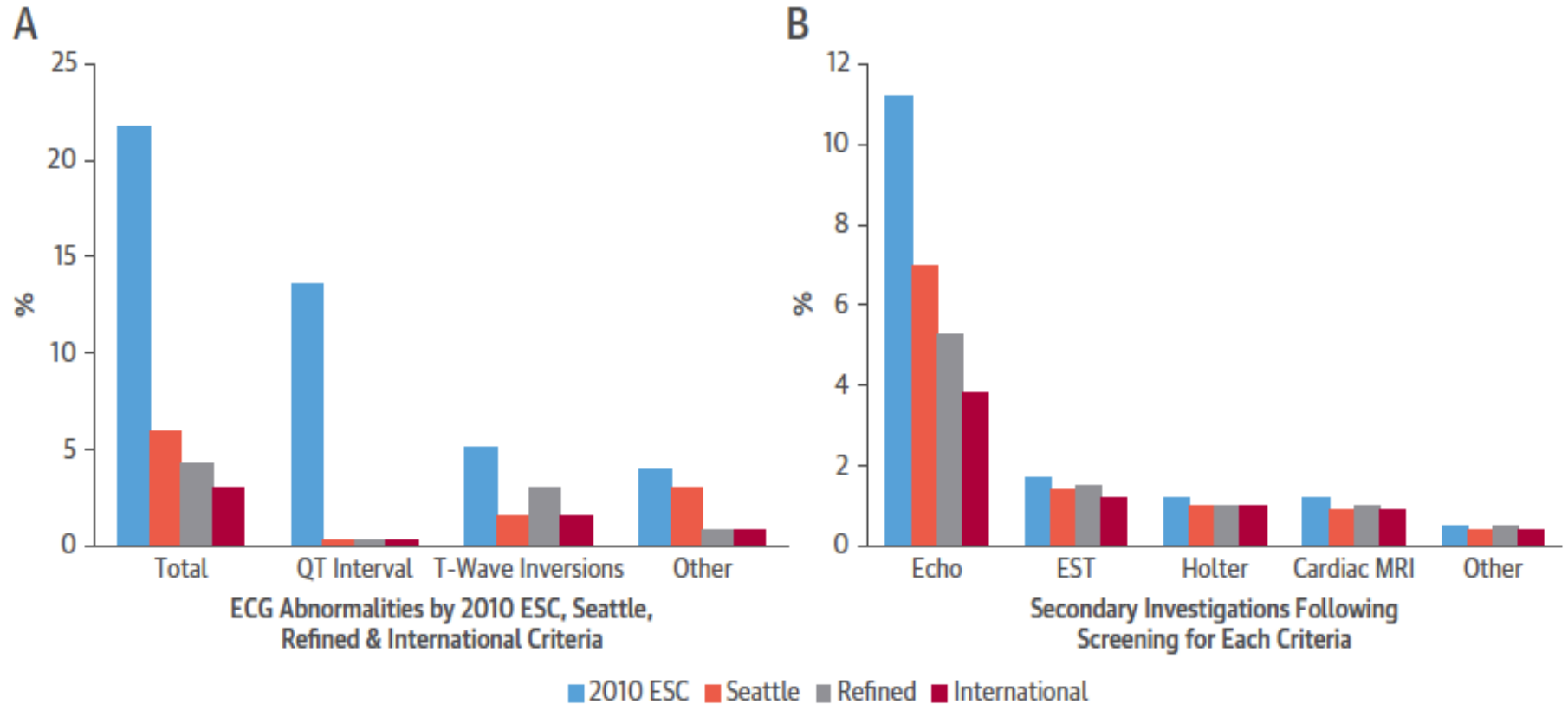
No further evaluation required
in asymptomatic athletes with no family history of inherited cardiac disease or SCD

In isolation

2 or more

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

Intl. ECG criteria criteria reduce false positives and need for additional testing



New International criteria for athlete's ECG

Seattle September 24-26, 2025



New International criteria for athlete's ECG. Seattle 2025



2025 International Criteria for ECG Interpretation in Athletes

NO FURTHER EVALUATION

ECG findings that are training-related or variants not generally associated with conditions at risk for SCD

- Increased QRS voltage for LVH or RVH
- Sinus bradycardia ≥ 30 bpm
- Sinus arrhythmia
- 1° AV block PR interval < 400 ms
- Mobitz Type I 2° AV block
- Ectopic atrial or junctional rhythm
- Premature atrial contractions
- Incomplete or complete RBBB < 140 ms
- Non-specific IVCD < 140 ms
- Left or right atrial enlargement
- Early repolarization/ST segment elevation
- Juvenile TWI V1-V3 (< 16 years)
- Male athlete repolarization variant (J-point and convex ST elevation followed by TWI confined to V1-V4)

No further evaluation required

in asymptomatic athletes with no family history of inherited cardiac disease or SCD

MAY REQUIRE EVALUATION

ECG findings have an unclear relationship with conditions at risk for SCD

- Female athlete TWI V1-V3 (≥ 16 years)
- Inferior TWI
- Low QRS voltage
- 1 PVC with inferior axis
- Axis deviation

Are there ≥ 2 'yellow box' findings or concerning personal or family history?

No

Yes

FURTHER EVALUATION

ECG findings that are associated with conditions at risk for SCD

- Lateral, inferolateral, or anterolateral TWI
- Anterior TWI (excluding green and yellow box patterns)
- ST segment depression
- Pathologic Q waves
- Complete LBBB
- Complete RBBB or IVCD ≥ 140 ms
- ≥ 2 PVCs of any morphology
- 1 PVC with non-inferior axis or short-coupling
- Ventricular pre-excitation
- Prolonged QTc interval
- Brugada Type 1 pattern
- PR interval ≥ 400 ms
- Mobitz Type II 2° AV block
- 3° AV block
- Atrial or ventricular tachyarrhythmias

Further evaluation required

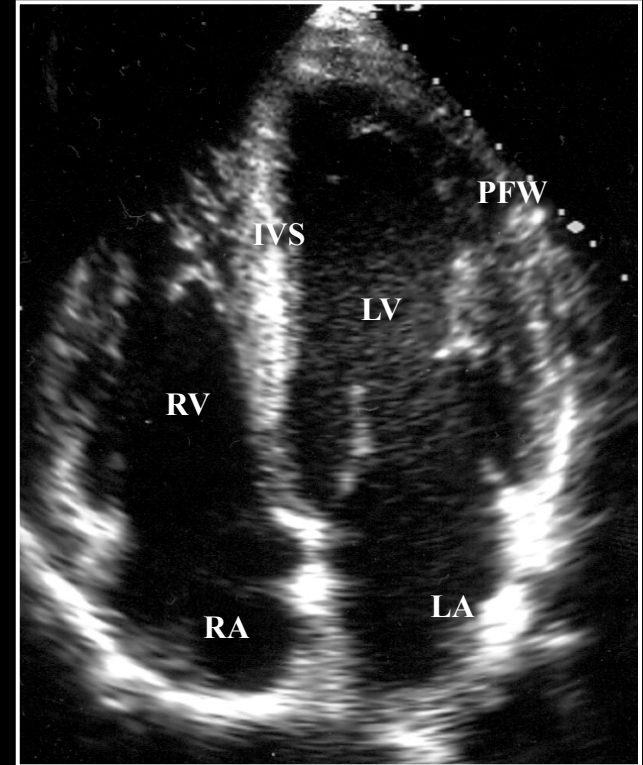
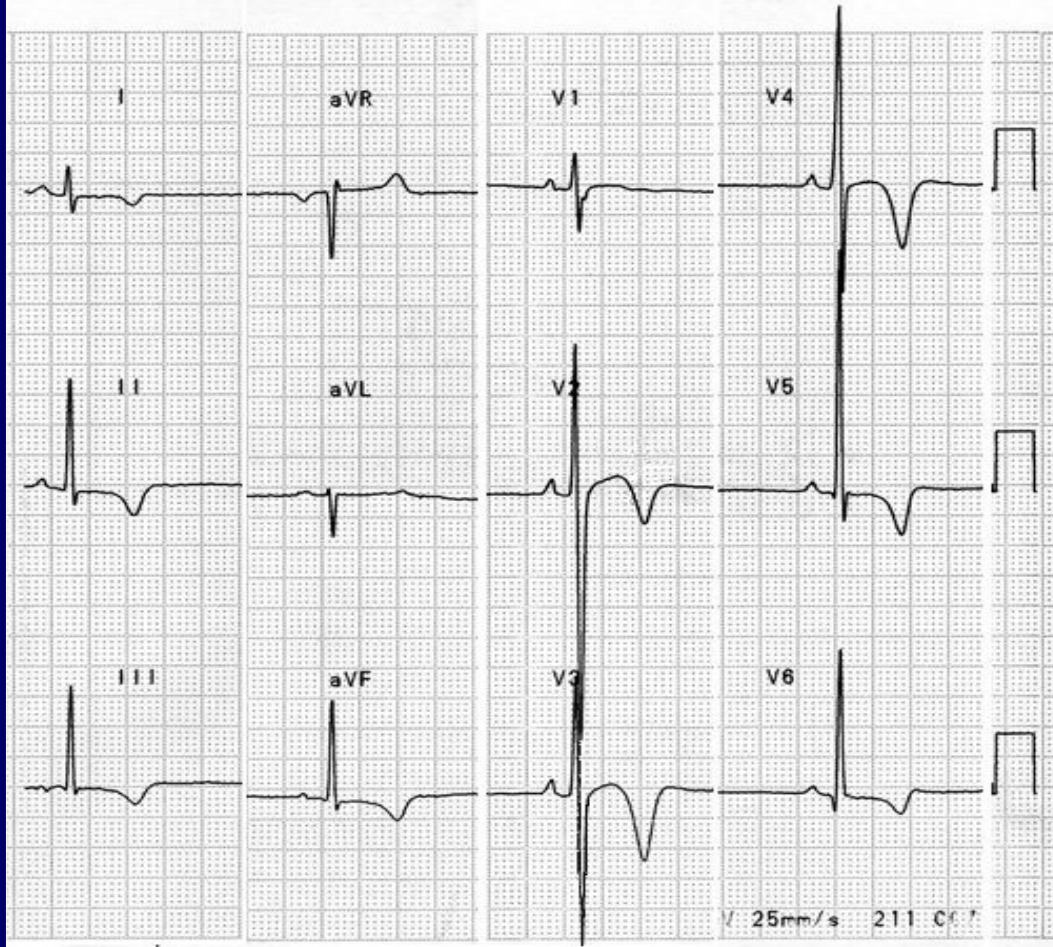
to investigate for pathologic cardiovascular disorders associated with SCD in athletes

Abnormal ECG Findings in Athletes: new emphasis on

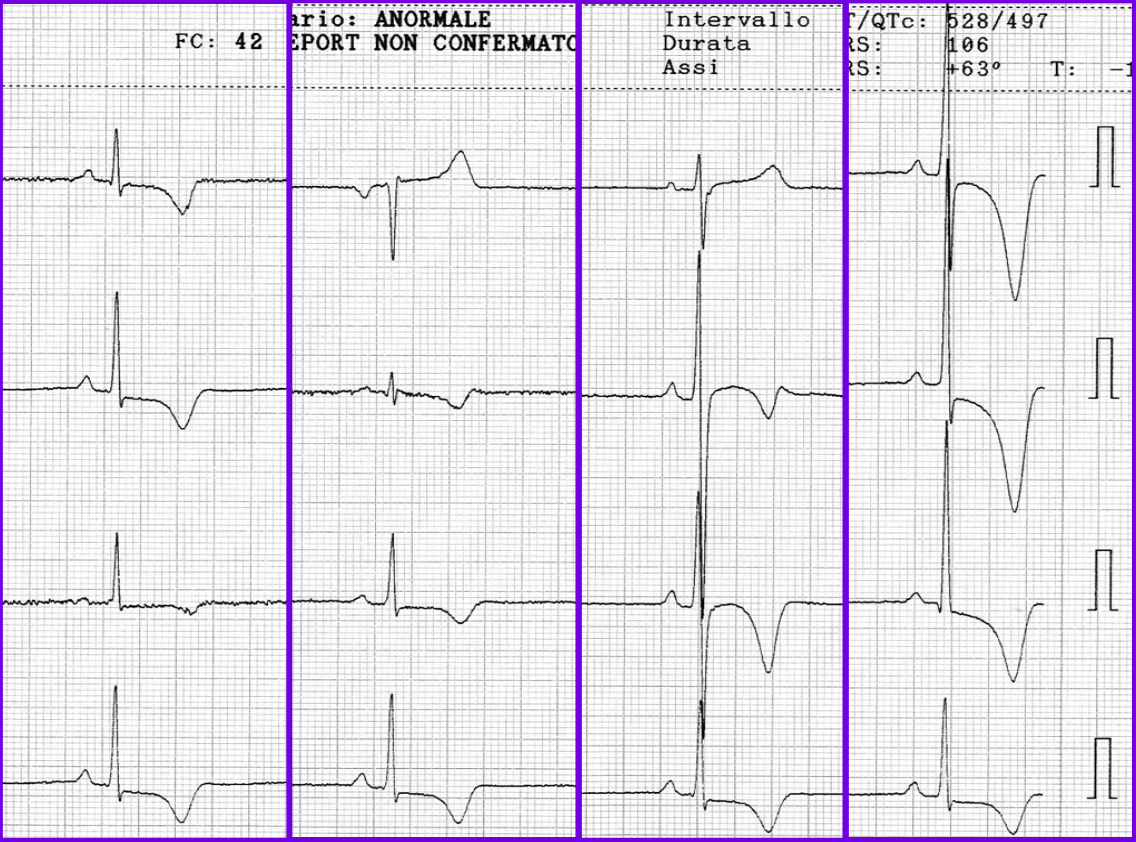
- Lateral/Infero-lateral TWI
- Anterior TWI (with some exception)
- ST-segment depression



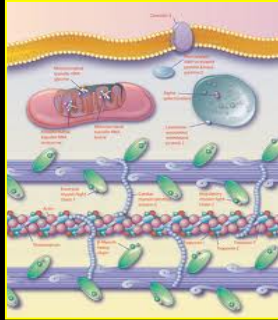
MM, soccer player at age of 28 years



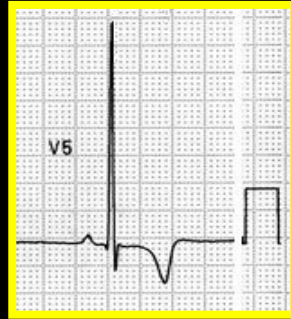
Same athlete, at the age of 33 years



ECG abnormalities precede LVH



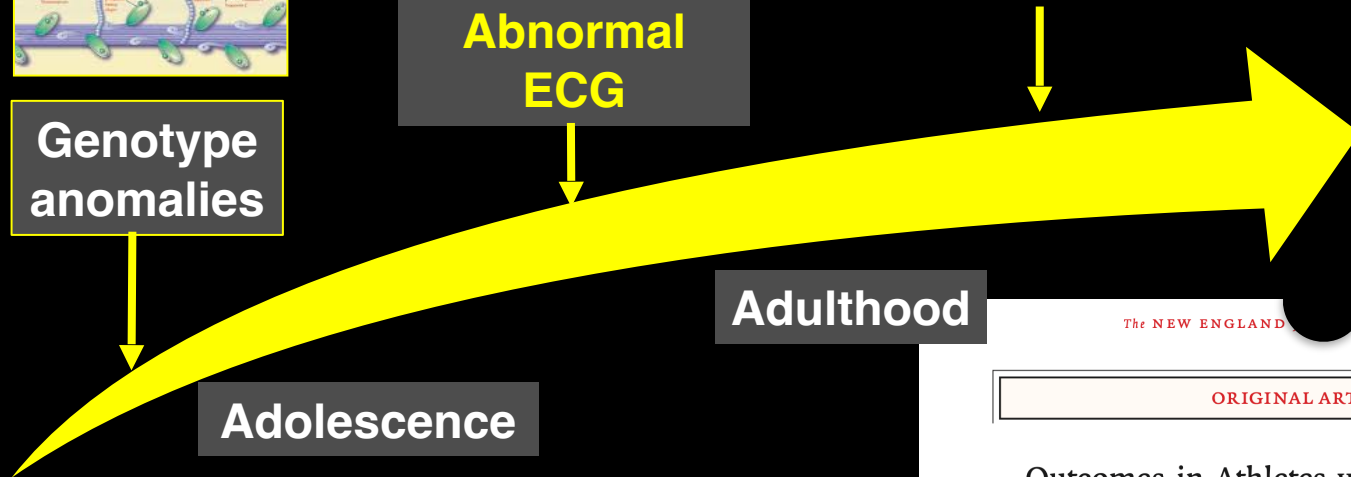
**Genotype
anomalies**



**Abnormal
ECG**



LV Hypertrophy



Adolescence

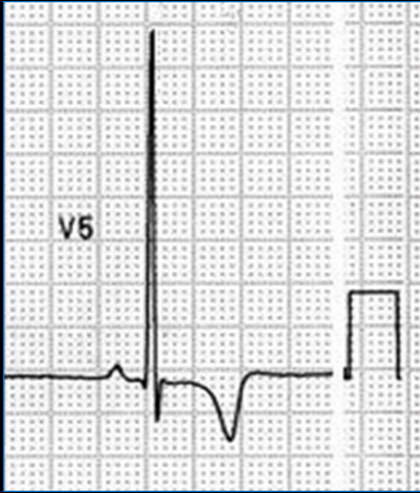
Adulthood

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

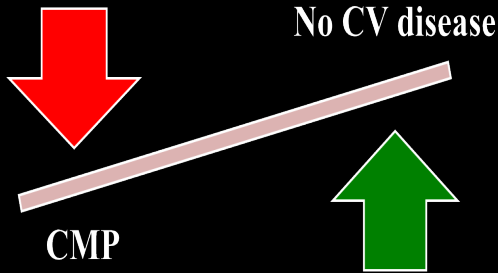
Outcomes in Athletes with Marked ECG Repolarization Abnormalities

Antonio Pelliccia, M.D., Fernando M. Di Paolo, M.D., Filippo M. Quattrini, M.D., Cristina Basso, M.D., Franco Culasso, Ph.D., Gloria Popoli, M.D., Rosanna De Luca, M.D., Antonio Spataro, M.D., Alessandro Biffi, M.D., Gaetano Thiene, M.D., and Barry J. Maron, M.D.



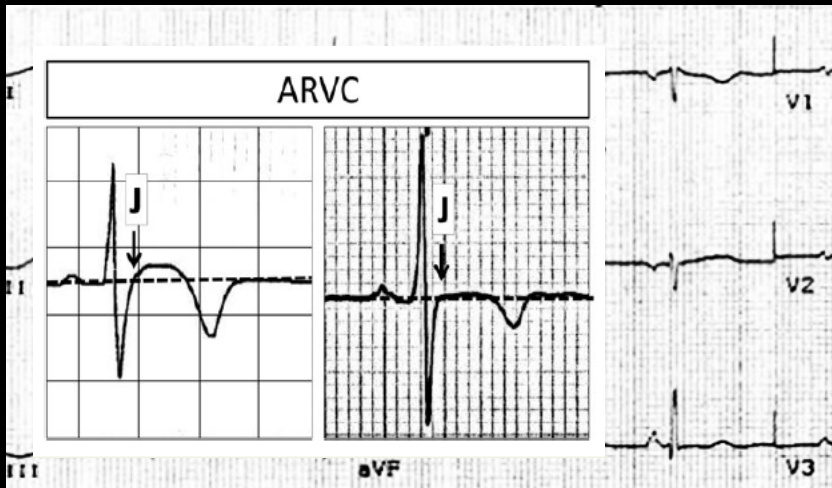
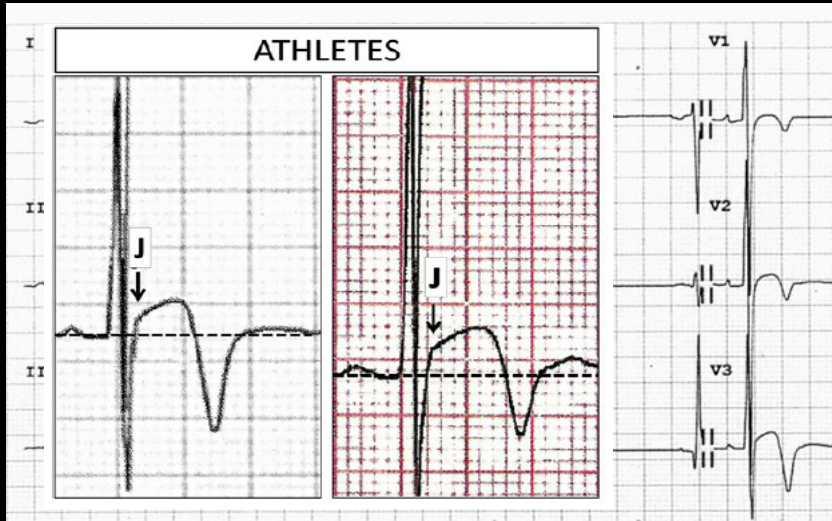
Lateral and inferior-lateral TWI require extensive investigation searching for underlying CMP (usually, HCM)

- *CMR with LGE (echocardiography usually not sufficient)*
- *Serial evaluations in case of negative findings*
- *Family screening (at least, 12-lead ECG)*
- *Gene testing not advised*





Anterior TWI in Athlete

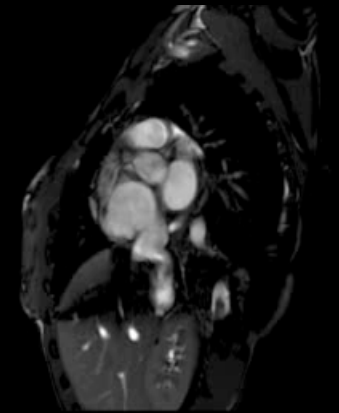
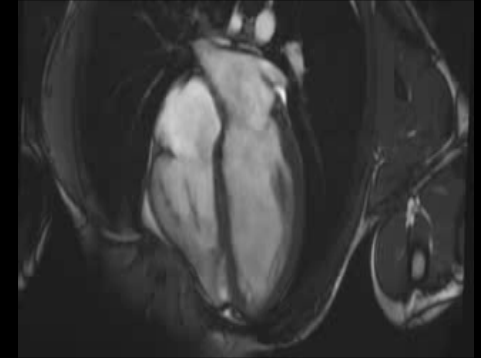
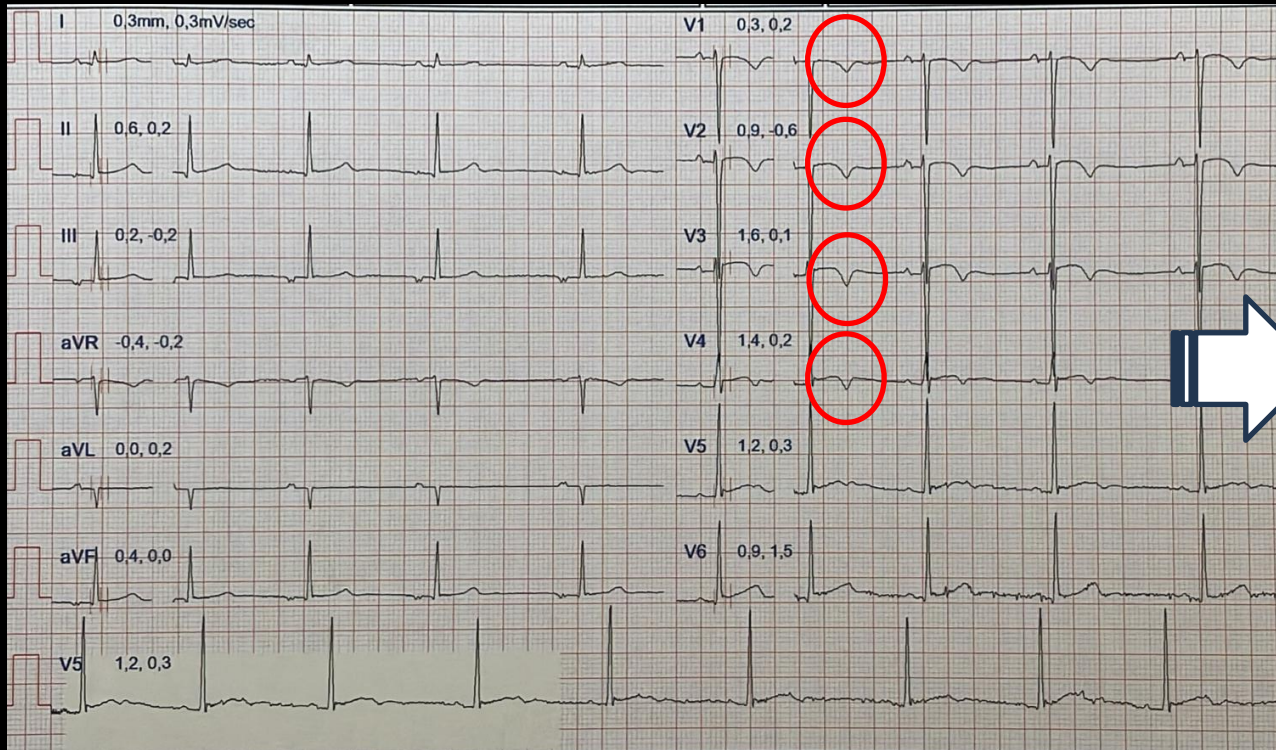


Anterior TWI in ARVC

Vast majority of anterior TWI observed among healthy athletes (both Caucasian and Afro-Caribbean) was preceded by J-point elevation. This marker was never observed among patients with ARVC.

J-point elevation <1 mm and TWI extending beyond V4 showed a sensitivity for RV cardiomyopathy of 100%.

First Evaluation in 2017



No abnormal findings at Echo and CMR

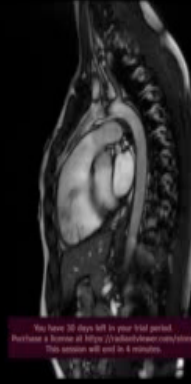
The athlete continued in competitive sport

Serial evaluations from 2017 to 2024

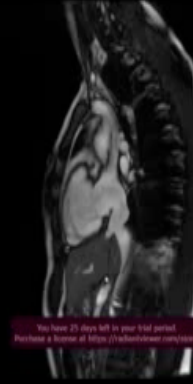
2017



2021

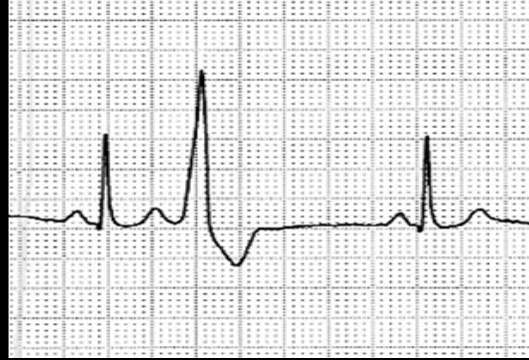


2024



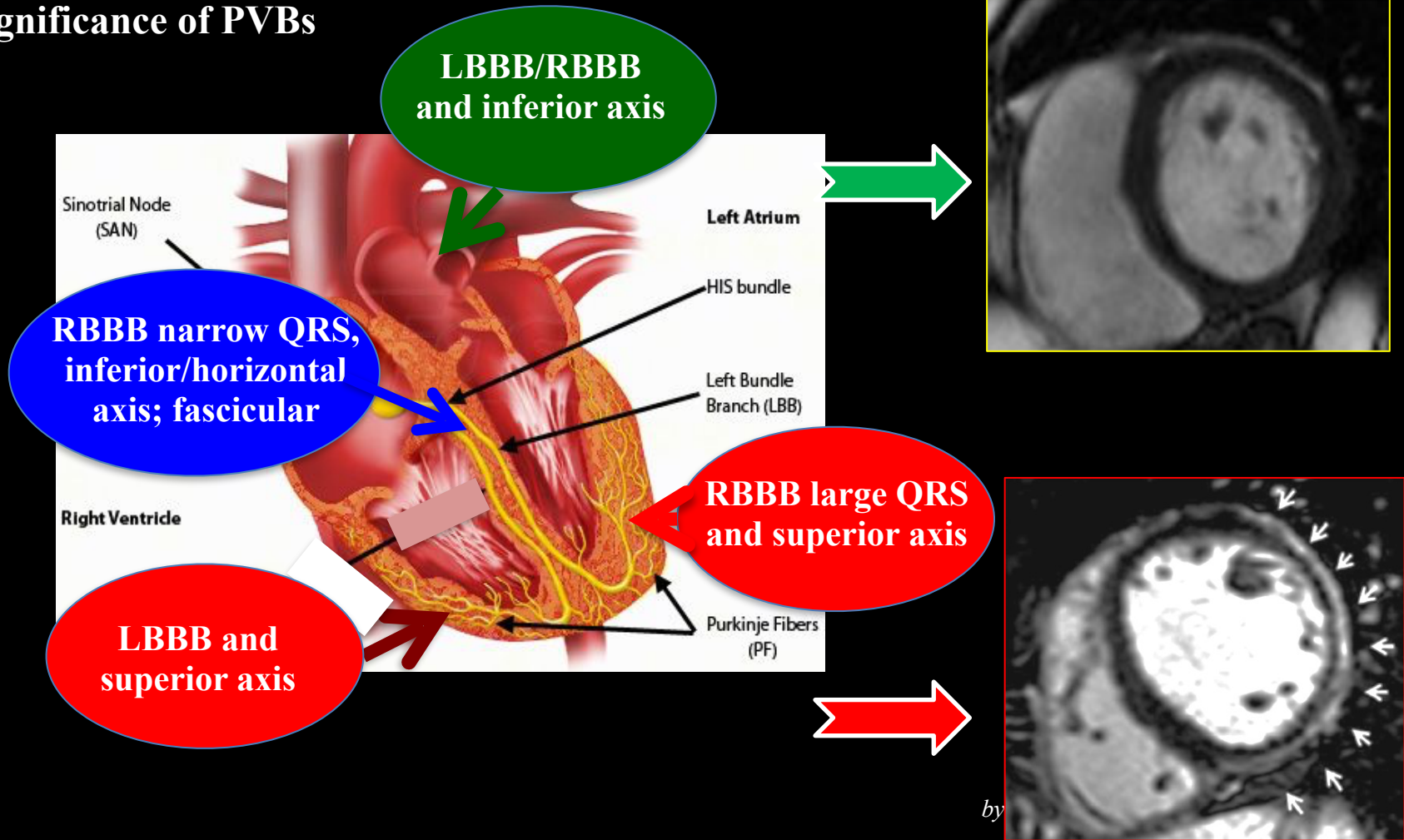
ECG abnormalities precedes morphologic changes in ARVC

Abnormal ECG Findings in Athletes: new emphasis on

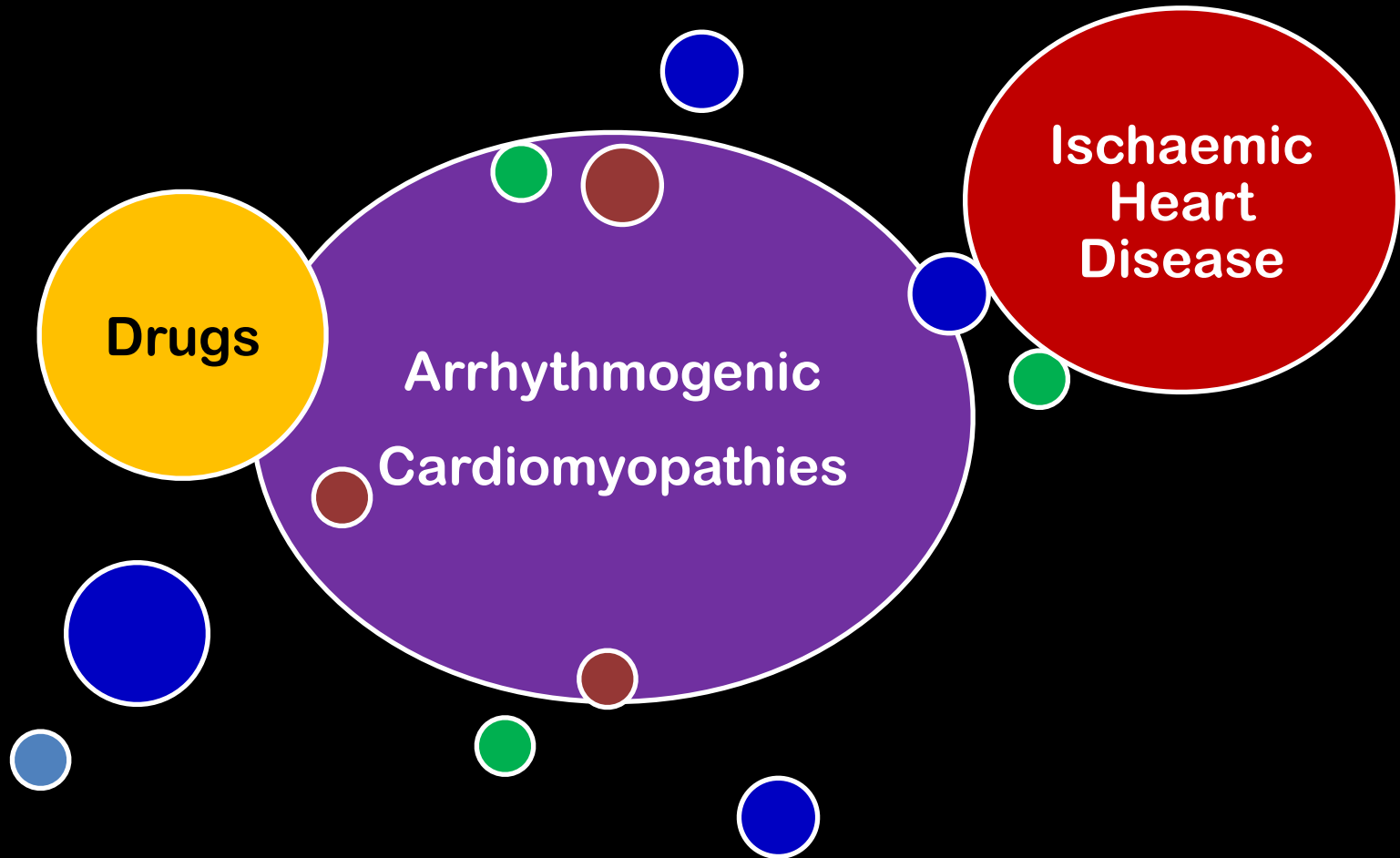


- ≥ 2 PVCs of any morphology
- 1 PVC with superior axis or short-coupling
- Atrial or ventricular tachyarrhythmias

Evolving criteria on significance of PVBs

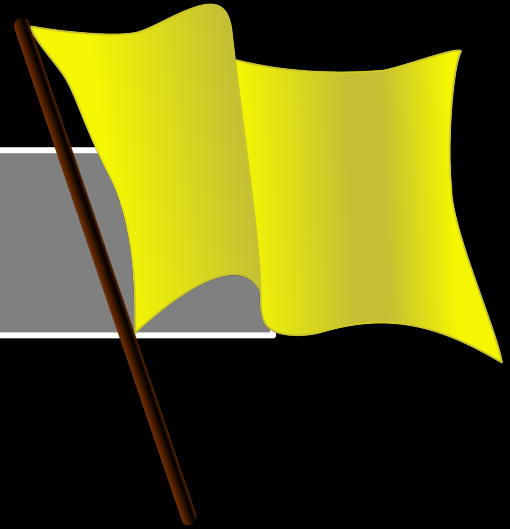


Clinical correlates of PVBs in athletes



Borderline ECG Findings in Athletes: new emphasis on

- Low QRS voltages
- Axis Deviation





ESC

European Society
of Cardiology

Europace (2022) 00, 1–12

<https://doi.org/10.1093/europace/euab330>

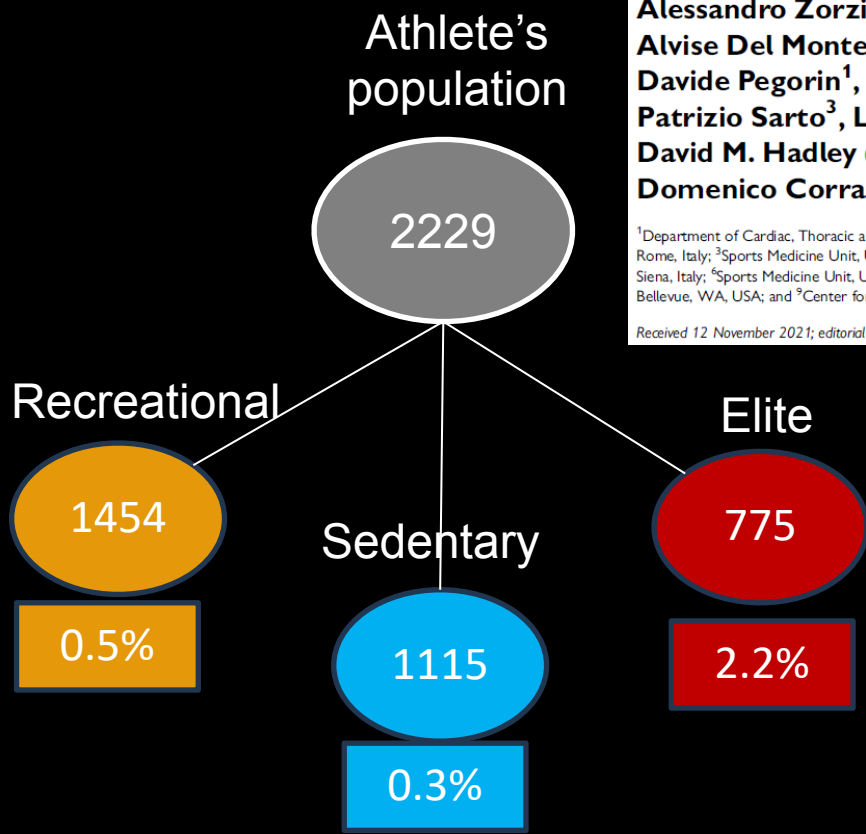
CLINICAL RESEARCH

Prevalence and clinical significance of isolated low QRS voltage

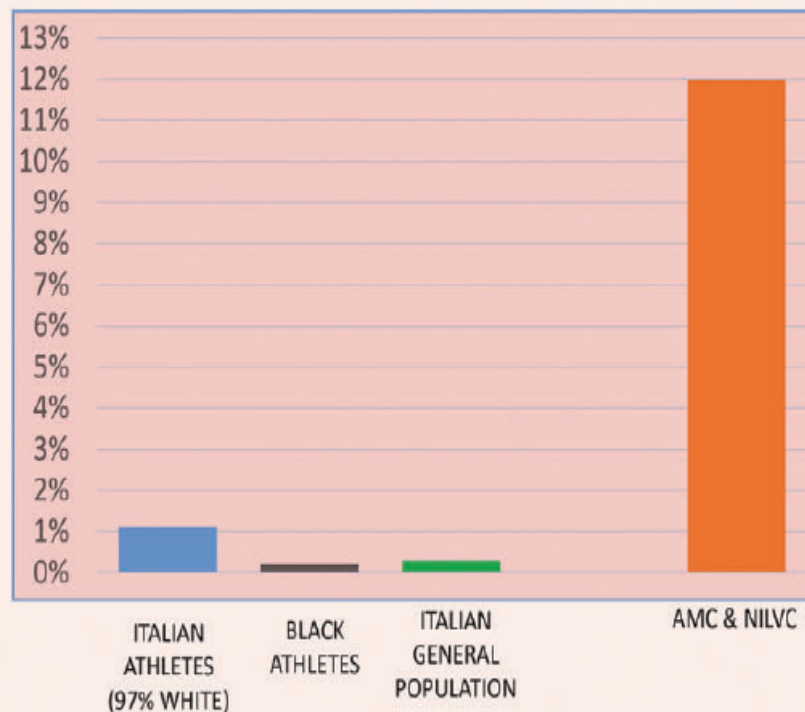
Alessandro Zorzi ^{ID}
 Alvise Del Monte ^{ID}
 Davide Pegorin¹, Flavio
 Patrizio Sarto³, Leo
 David M. Hadley ^{ID}⁸
 Domenico Corrado

¹Department of Cardiac, Thoracic and Vascular Medicine, Rome, Italy; ³Sports Medicine Unit, ULSS2
 Siena, Italy; ⁵Sports Medicine Unit, ULSS3
 Belluno, Italy; ⁸Center for Sports Medicine, Bellevue, WA, USA; and ⁹Center for Sports Medicine, Rome, Italy

Received 12 November 2021; editorial decision 12 December 2021; accepted 12 December 2021



PREVALENCE OF ISOLATED LOW QRS-VOLTAGES:
COMPARISON WITH CONTROL GROUPS



Low QRS voltage

KEY QUESTIONS

- 1) What is the prevalence of low QRS-voltages in limb leads (LQRSV) in isolation on the electrocardiogram of athletes?
- 2) What is their clinical meaning?

KEY FINDINGS

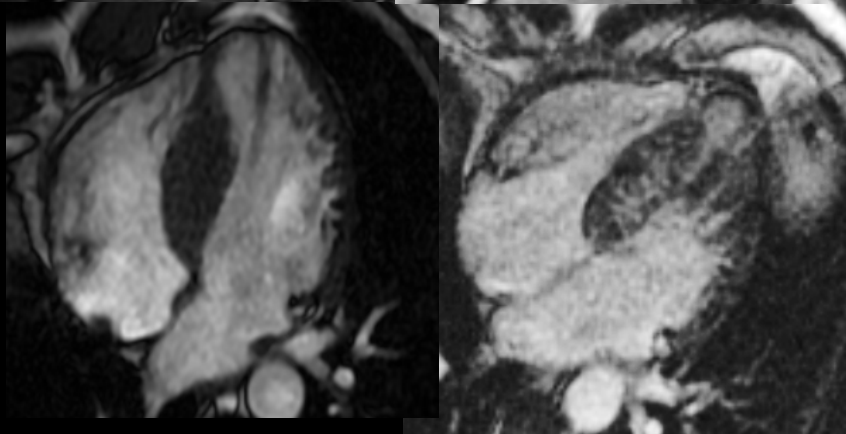
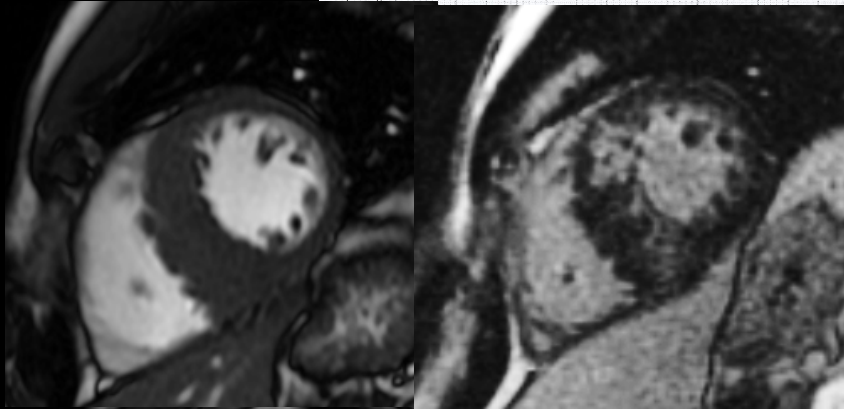
- 1) The prevalence of LQRSV in athletes was low
- 2) LQRSV may represent the ECG hallmark of an underlying left ventricular scar at risk of ventricular arrhythmias

LQRSV should never be considered a benign ECG change.

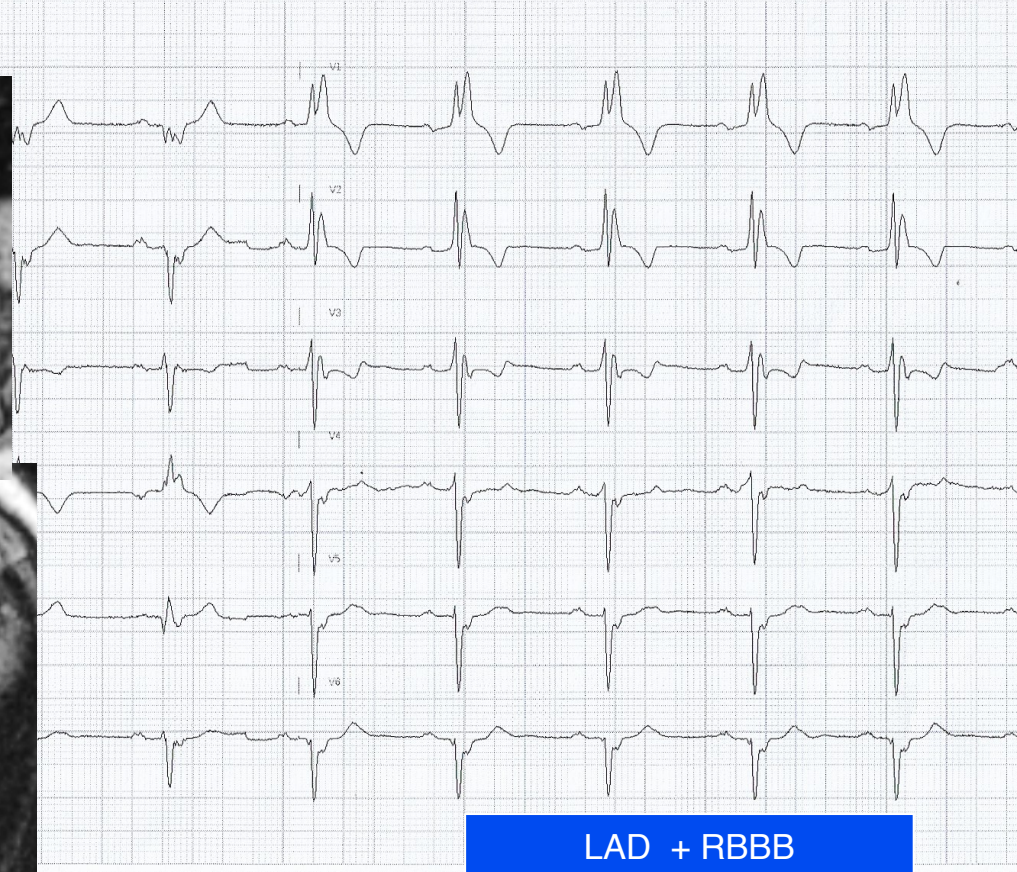
LQRSV may be a 'red flag' for an arrhythmogenic condition

- Left axis deviation in association withRBBB

GM, 55 years, male, asymptomatic
Running and Trekking

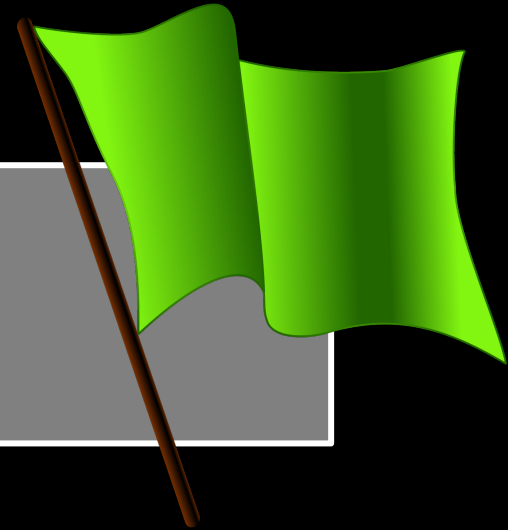


Filter: 0.67-150Hz - 11



Normal ECG Findings in Athletes: new emphasis on

- RBBB <140 ms and
- Any aspecific IVD ≤ 130 ms
- Early repolarization





European Society
of Cardiology

European Journal of Preventive Cardiology (2025) 32, 1054–1061
<https://doi.org/10.1093/eurjpc/zwae082>

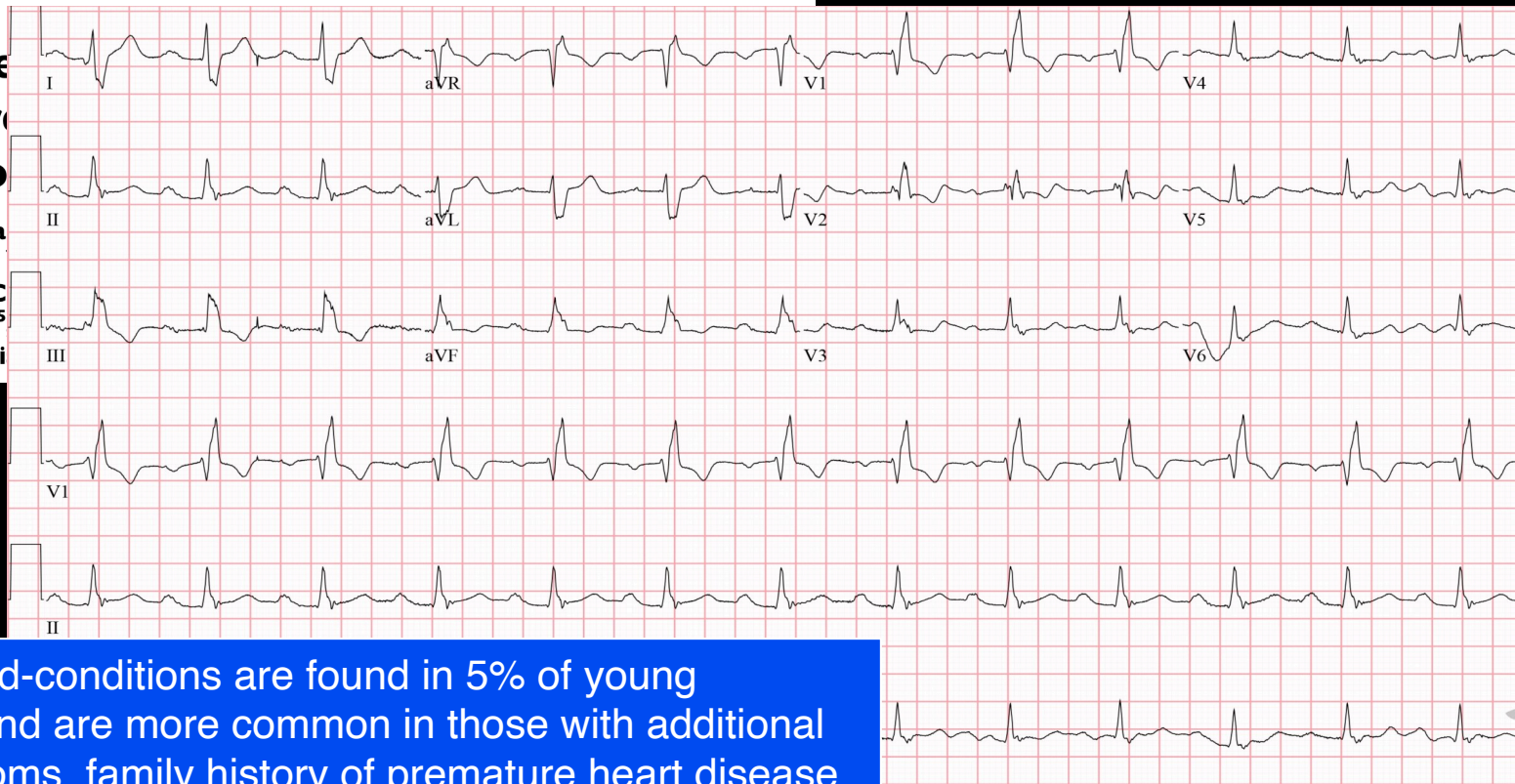
FULL RESEARCH PAPER

Prevention in practice

RBBB <140 ms

Prevalence electrocardiogram branch block

Hamish MacLachlan
Nikhil Chatrath
Joyee Basu ^{1,2},
Navin Chandra^{1,2,5}
Gherardo Finocchiaro



RBBB-related conditions are found in 5% of young individuals and are more common in those with additional heart symptoms, family history of premature heart disease, other abnormal ECG findings, when ≥ 130 ms.



Thank you for your attention

See also: www.antoniopelliccia.it