athletes can be used in master athletes older than 35 years of age. The International ECG criteria were the most accurate.

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Inferolateral T-wave inversion in athletes: phenotype-genotype correlation

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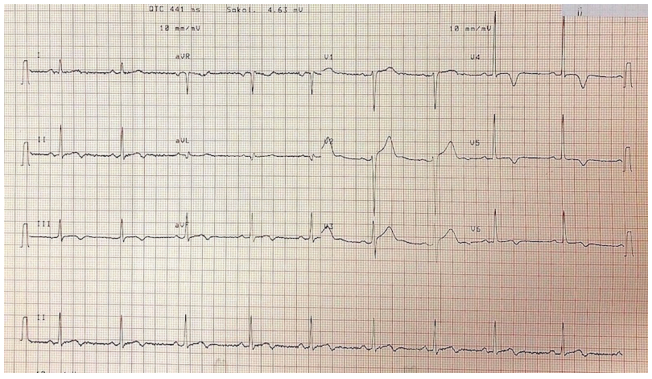
Introduction: Significant T-wave inversion in young asymptomatic athletes is rare, but poses a significant clinical challenge. Pre-participation sports screening programs can identify such subjects. The clinical suspicion is that such ECG changes represent an occult cardiomyopathy. It has been suggested that such ECG changes may be due to mutations in genes encoding myofilament proteins and forme fruste hypertrophic cardiomyopathy. We sought to genotype a prospective cohort of such subjects with no discernible phenotype identified in our unit over a 3 year period.
Methods: Ten athletes were referred from external pre-participation screening. All exhibited prominent deep symmetrical T wave inversion in the inferolateral leads. All had negative family history and a normal phenotype based on 2D echocardiography, Holter monitoring, stress testing and cardiac MRI. Next generation DNA sequencing was used to screen a panel of 133 cardiac-specific genes associated with cardiomyopathy and/or channelopathy, confirmed by Sanger sequencing.
Results: All subjects were male with a mean age of 39 years. 7 had no evidence of sequence variation in the genetic panel. 3 patients demonstrated variants of uncertain significance in 5 different cardiac genes: alpha-2-actinin (ACTN2), myopalladin (MYPN), the calcium channel genes CACNA1C and TRPM4 and potassium channel gene KCNQ1. Both ACTN2 and MYPN genes code for structural proteins in the sarcomere and other variants in these proteins have been described in hypertrophic and dilated cardiomyopathy cases. At 3 year follow up, one patient had undergone detraining and his ECG interestingly showed complete resolution of all T wave changes. He did not have any demonstrated variants.

Table 1. Gene table

Patient age	Mutation(s) identified	DNA	Protein(s)	Consequences	Classification
29	ACTN2	c.1058G>A	p. Arg353Gln	Missense	VUS
	MYPN	c.2829T>G	p. Ile943Met	Missense	VUS
54	KCNQ1	c.1246G>A	p. Val416Met	Missense	VUS
48	CACNA1C	c.2340G>A	c.2340G>A(p.=)	Splice region, synonymous	VUS
	TRPM4	c.2953+5G>C	–	Splice region, intron	VUS

VUS = Variant of uncertain significance.



Inferolateral TWI ECG

Conclusions: The substantial absence of mutations in cardiac myofilament genes and the heterogeneous sequence variations identified in this study suggest that inferolateral repolarization abnormalities in athletes without a phenotype do not represent HCM or a cardiomyopathy. Moreover, the absence of a family history and the benign clinical course of the subjects in this study also suggest that this is a benign repolarization syndrome. This was the first study to assess a phenotype-genotype correlation in this population. Further genetic studies are needed in this area.
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Age-specific prevalence of cardiac structural alterations in a large consecutive cohort of athletes by pre-participation screening

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Background: Systematic pre-participation screening (PPS) of all subjects embarking in sports activity has the potential to identify those athletes at risk and to reduce mortality. However, its efficacy, the impact of false positive and age-specific strategies are still strongly debated.
Purpose: To evaluate the real-world prevalence of cardiac abnormalities revealed by PPS in athletes referred to a peripheral sport cardiology centre and the age-specific usefulness of echocardiography in selected patients.
Methods: We evaluated 30109 consecutive elite and non-elite athletes who underwent a PPS between 2011–2017. The PPS included familial, clinical history, sport training habits and ECG. ECGs were analyzed according to the original ESC and refined Seattle Criteria as: 1) normal 2) training-related changes 3) abnormal. Patients with abnormal ECG, symptoms/signs of cardiovascular diseases (CVD) or risk factors for CVD underwent echocardiographic evaluation.
Results: A total of 30109 (19±12 years, range 6–85, 70% males) athletes were evaluated (99% Caucasians). Of these, 24640 (82%) were aged <18 years, 4449 (15%) were 18–55 years and 1020 (3%) were aged >55 years. A total of 1870 (6%) athletes were selected for echocardiography: 930 individuals (50%) for ECG abnormalities and 350 (20%) for physical examination abnormalities, 346 (20%) due to the presence of CV risk factors, 120 (7%) because of family history for sudden death/cardiomyopathy and 44 (3%) due to cardiac symptoms. Nine hundred ninety-five (53%) were <18 years; 583 (31%) between 18–55 years; 292 (16%) aged>55. Myocardial structural alterations were found in 284/30109 (0.95%) athletes, 194 (68%) referred due to physical examination abnormalities and 90 (32%) because of ECG alterations. No abnormalities were found in athletes with cardiac symptoms and family history of cardiomyopathy/sudden death. Specific alterations were: 102 (36%) aortic ectasia, 58 (20%) hypertensive heart disease, 48 (17%) mitral valve prolapse, 23 (8%) patent foramen ovale, 21 (7%) bicuspid aortic valve, 12 (4%) hypertrophic cardiomyopathy, 7 (2%) interventricular septal defect, 4 arrhythmogenic cardiomyopathy, 3 ischemic heart disease, 2 left ventricular non-compaction, 2 coronary-pulmonary fistulas, 1 patent ductus arteriosus and 1 pericardial agenesia. Structural alterations identified by Echo were more common in athletes aged >55 (133/1020, 13%), whereas rare in athletes aged 18–55 (96/4449, 2%) and very rare <18 (55/24640, 0.2%) (p for trend <0.01). Sixty-eight athletes (0.2%, 7 aged <18 years, 22 aged 18–55 and 39 aged >55, p<0.01) were disqualified because of structural alterations identified.
Conclusions: PPS proved to be effective in identifying athletes at risk, specifically in aged athletes. ECG and careful clinical evaluation were sensible in selecting subjects needing further evaluations. PPS yield in young athletes was poor, while structural alterations were over 50 times more common in older athletes.

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Outcome of exercise-related out-of-hospital cardiac arrest in correlation with location: sports arenas vs outside arenas

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Background: The chance of surviving an out-of-hospital cardiac arrest (OHCA) has increased over the years, although survival rates are still low. Prior studies have shown that the chance of survival is higher if the cardiac arrest takes place in relation to exercise. In recent years, medical action plans (MAP) has been increasingly recommended for the use in sports arenas. Hypothetically, an exercise-related cardiac arrest occurring at a sports arena would have an even better prognosis in comparison to an exercise-related arrest occurring outside of such facility.
Purpose: To compare survival rates between exercise-related sudden cardiac arrests occurring in sports arenas versus outside of sports arenas.
Methods: Data from all cases of treated exercise-related OHCA outside of home reported to the Swedish Register of Cardiopulmonary Resuscitation (SRCR) from 2011 to 2015 in 10 counties of Sweden were investigated (population 6 Million, representing 65% of Sweden's population). The SRCR has a coverage of almost 100% of all OHCAs occurring in the counties studied. A comparison was made between exercise-related OHCAs at sports arenas versus cardiac arrests occurring outside of sports arenas.
Results: In total, 3714 cases of OHCA occurring outside of home were identified. There were 268 cases of exercise-related OHCA and 164 (61.2%) of those occurred at sports arenas. Survival at 30 days was higher among OHCAs occurring at sports arenas compared to those occurring outside (55.7% vs 30.0%, p<0.0001). Patients presenting with OHCA at sports arenas were younger (mean age±SD 57.6±16.3 years compared to 60.9±17.0 years, p=0.05) and less likely to be female (4.3% vs 12.2%, p=0.02). Cases of OHCA at sports facilities were more often witnessed (83.9% vs 68.9%, p=0.007), received bystander CPR to a higher extent (90.0% vs 56.8%, p<0.0001) and the frequency of AED-connection before EMS-arrival was also higher in this group (29.8% vs 11.1%, p=0.009). There was a higher frequency of shockable rhythm for OHCA at sports arenas (73.0% vs 54.3%, p=0.004). Delay time from collapse to start of CPR (1 min vs 3 min, p<0.0001) and to defibrillation (10min vs 12.5 min, p=0.03) did also differ in favor of occurrence at sports facilities.