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Extended Abstract

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Cardiology-2020: Current understanding of the electrocardiographic manifestations of the ?athlete?s heart?- Sanjay Sharma - St. George’s University of London,UK

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Introduction:

Individuals who engage in regular, moderate to intensive exercise for between 4-8 hours per week can develop a constellation of physiological adaptations in cardiac structure, function and autonomic tone, collectively referred to as ‘The Athlete’s Heart’. Recognised ECG manifestations in athletes are attributable to increased vagal tone and increased chamber size and include sinus bradycardia, sinus arrhythmia, voltage criteria for ventricular enlargement, incomplete right bundle branch block and the early repolarisation pattern. The electrocardiographic manifestations in athletes vary according to the type of sport and training intensity and also with the demographics of the athlete including; age, sex and ethnicity. Occasionally, the ECG changes in athletes overlap with those considered characteristic of cardiomyopathies and ion channelopathies, which are recognised causes of exercise-related sudden cardiac death (SCD) in young athletes. Although sudden cardiac death in sport affects approximately 1 in 50,000 athletes, the visibility afforded by these tragedies has led the European society of cardiology and several sporting organisations around the world to advocate cardiovascular screening to identify athletes who may be at risk of sudden death. The ECG is considered an important tool for detecting high risk athletes, therefore, differentiation of those ECG phenotypes that reflect cardiac adaptation to exercise from those that indicate quiescent cardiac pathology is crucial. Athletes with an abnormal ECG are subject to comprehensive evaluation including cardiac imaging, exercise testing, prolonged rhythm monitoring, familial evaluation, genetic testing and reassessment after a period of detraining, may be necessary to differentiate between cardiac physiology and pathology. The stakes of confirming or refuting the diagnosis of a potentially serious cardiac disease in an athlete are high. An incorrect diagnosis would not only cause unnecessary stress to the athlete but could result in erroneous disqualification and termination of a career. Of even greater concern, is the false reassurance of an athlete harbouring disease implicated in young sudden cardiac death. It is important to provide clear guidance of the interpretation of the athlete’s ECG to physicians involved in evaluating young athletes.

Training Related ECG Changes in Trained Athletes

The physiological adaptations namely high vagal tone, increased chamber size and wall thickness, that occur as a consequence of chronic regular training of 4-8 h per week, are manifest on the athlete’s ECG. In contrast, these changes in a sedentary individual, would be deemed abnormal and necessitate investigation to exclude cardiac pathology.

Vagotonia

Conditioned athletes develop higher vagal tone which results in a greater prevalence of benign conduction anomalies. These include; sinus bradycardia (as slow as 30 bpm), sinus arrhythmia, ectopic atrial rhythm, junctional rhythms, first degree atrioventricular (AV) block (PR interval<400 ms) and Mobitz type 1 second degree AV block. A finding in athletes not to be confused with complete heart block is AV mismatch, where as a consequence of high vagal tone, the AV node discharges and captures the ventricle faster than the sinoatrial node, with consequent AV dissociation. These changes are most prevalent in endurance athletes and resolve with both detraining and during sympathetic stress such as exercise. Unless accompanied by symptoms, they do not require any further work-up. Higher degrees of AV block such and Mobitz II and third degree heart block are extremely rare and always warrant further investigation.

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Voltage criteria for left ventricular hypertrophy (LVH)

An increased QRS voltage is detected in up to 50% of athletes, most often in young, slender males. The presence of Sokolow- Lyon voltage criteria for LVH i.e. sum of S wave in V1 and R wave in V5 or V6>3.5 mV, rarely correlates with increased LV wall thickness. Voltage criteria for LVH is also a recognised ECG manifestation of hypertrophic cardiomyopathy but, it is usually accompanied by ST-segment depression, inverted T-waves in the inferior-lateral leads and pathological Q-waves, which are not features of athletic training. Therefore, isolated voltage criteria for LVH are considered normal in athlete's but when accompanied by other pathological abnormalities warrants further investigation

Early repolarisation pattern (ERP)

The early repolarisation pattern (ERP) is defined as J-point elevation, notching of the J-point or slurring of the terminal QRS, with or without ST-segment elevation, specifically in the inferior and/or lateral leads. The ERP is recognised in up to 6% of the general population and between 23-44% of athletes, with a preponderance for young, black, male athletes and endurance athletes. Until recently the ERP was considered a benign phenomenon, however three studies in the general population demonstrated a significantly higher prevalence of ERP's, specifically in the inferior-lateral leads, amongst victims of idiopathic ventricular fibrillation. These studies failed however to demonstrate any association with increased recurrent events to support causality.

Long QT interval

The long QT syndrome (LQTS) is an inherited ion channel disease affecting predominantly potassium channels and should be considered in athletes with a long QT interval, in whom drug and electrolyte causes have been excluded. Although difficult to demonstrate, LQTS is likely to be implicated in a significant proportion of cases of sudden cardiac death with a structurally normal heart. The high circulating levels of adrenaline present during exercise may induce ventricular arrhythmias, as can intense emotion and fear. Young athletes generally have a longer QT interval compared with the sedentary population and this may be secondary to increased left ventricular mass. The QTc should be corrected using the Bazett's formula i.e. QTc=QT/√√RR. It is important to acknowledge that this method is inaccurate at heart rates <50 and >90 bpm and efforts should be made to perform the ECG at heart rates within these parameters. Other confounders to accurate determination of the QT interval common to athletes are; RR variability in sinus arrhythmia, with a need to average values, and prominent U waves, which should not be included in the measurement but can occasionally, is difficult to differentiate from the T wave. The QT interval should be systematically measured in lead II or V5 and physicians should adopt the 'teach the tangent' method for measurement, as illustrated in the image below. The cut off values for a long QT interval in athletes is set at the 99th percentile for the general population and is >470 ms in males and >480 ms in females

Conclusion:

This athlete's ECG is governed by several demographic factors including the age, sex, ethnicity and sporting discipline. T wave inversion is responsible for the commonest diagnostic challenge in differentiating athlete's heart from cardiomyopathy and largely affects black athletes and endurance athletes. Several large studies in young athletes have facilitated a better understanding of the electrical manifestations of the athlete's heart and led to contemporary interpretation criteria that have improved the specificity of ECG screening without compromising specificity. Ideally, the interpretation of the ECG in athletes should be performed by experts in sports cardiology to minimize the risk of false positive results. . Further studies are required to investigate the precise cause and significance of T wave inversion in black athletes but there should also be focus on other ethnic groups and studies in master athletes.

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