Original article

Analysis of 12-lead electrocardiogram in top competitive professional athletes in the light of recent guidelines

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Abstract

Background: One of the most important aims of modern sports cardiology is prevention of sudden cardiac death among athletes. Adequate pre-participation screening is a crucial part of prevention, however, current ACC, AHA or ESC guidelines are not uniform in this context. There is recently ongoing discussion on implementation of 12-lead ECG to the screening protocol.

Aim: To assess the prevalence of alterations of resting 12-lead ECG in a population of top-level professional athletes – members of the Polish Olympic Team – using recently accepted criteria.

Methods: During the period of intensive training before the Summer Olympic Games in Beijing (2008), a 12-lead, resting ECG was performed in 73 members (20 women and 53 men) of the Polish Olympic Team. Commonly accepted criteria were used to assess the ECG, and alterations were divided into two groups according to recent publications: group I – 'benign', common – thought to be consistent with the athlete's heart syndrome (i.e.: sinus bradycardia, 1st degree atrioventricular block, early repolarisation, right bundle branch hemiblock, isolated signs of left ventricular hypertrophy); and group II – 'suspected', uncommon – which may occur due to organic heart disease (i.e. complete bundle branch block, ventricular arrhythmia, inverse T wave or pathological QRS axis deviation).

Results: Completely normal ECG was present in 11% of those examined, common (group I) findings were observed in 65% and 'suspected' (group II) in 23%. The most commonly occurring 'benign' findings were bradycardia incomplete, right bundle branch block and isolated left ventricular hypertrophy, found in 75, 71 and 41%, respectively. From 'suspected' (group II) the most frequent was left posterior fascicular hemiblock, present in 10% of those examined; other findings were complete right bundle branch block, left atrial hypertrophy, inverse T waves and left anterior fascicular hemiblock in single cases.

Conclusions: 1. Most of the observed alterations in resting ECG of professional athletes belong to the 'common' group and result from adaptation to exercise. 2. Frequent occurrence of left posterior fascicular hemiblock, which is thought to be 'potentially malignant', requires further investigation.

Key words: athlete's heart, ECG, pre-participation screening

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Introduction

Sudden cardiac death (SCD) of an athlete is always a very stressful and devastating situation because it usually affects a young and generally completely healthy person. It occurs very rarely, but it provokes strong emotions in society [1]. According to the European registries, the frequency of SCD in athletes is slightly higher than in the age-matched population and reaches 2-3/100 000 athletes/year [2]. This does not mean that sport activities trigger SCD, but they may reveal the pathology of the circulatory system, which is a potential primary cause of this event.

The last twenty years have significantly extended our knowledge about the causes of SCD in athletes, which allowed the development of recommendations finally

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published by the European Society of Cardiology (ESC) and American Heart Association/American College of Cardiology in 2005 [3, 4].

It is widely accepted that structured screening tests should serve as a primary prevention of sudden cardiac death. Physical examination together with personal and family history are without any doubt the key elements. The need for additional examinations (mainly 12-lead ECG) remains a controversial issue. From the European point of view, based on the Italian experience, resting ECG is a mandatory element of the screening protocol. The American societies of cardiology consider this examination as unjustified due to high costs and low efficacy [3, 4].

The main argument supporting the European approach is a multi-year observational study conducted by Italian investigators demonstrating the efficacy of resting ECG in terms of mortality reduction in the population of competitive athletes [5].

In the opinion of American experts, the main disadvantage of ECG is its low specificity which therefore leads to a high number of false positive results in athletes. They require further cardiological diagnostics (in around 15% of all examined athletes), making ECG-based screening programmes not cost-effective. This opinion is based on studies on small, selected groups, mainly competitive athletes [6, 7]. This critical view was addressed by the Italian authors, who in their study based on the analysis of more than 32 000 ECG tracings in athletes at different levels of training (mostly amateurs and those at the beginning of their career) demonstrated that with the correct application of the assessment criteria the frequency of results raising suspicion of heart disease at risk of SCD is lower than 10% [8].

Therefore, we sought to assess the frequency of ECG changes requiring further diagnostic procedures according to the current ESC recommendations in top Polish competitive athletes [4]. Another aim of the study was also to compare the frequency of ECG changes in our group and unselected group of athletes studied by the Italian experts, using their criteria [8].

Methods

Study group

The study was based on the analysis of resting ECG of 73 athletes – members of the Polish Olympic Team – routinely controlled in the Central Sports Medicine Centre between March and June 2008 during preparation for the Olympic Games in Beijing. All athletes gave informed consent for participation in the study. The group consisted of 20 women and 53 men aged 21-34 years (mean age – 26.8 years). The studied athletes represented 14 disciplines: handball – 15, kayaking – 12, athletics – 8, cycling – 7, sailing – 6, fencing – 5, modern pentathlon – 5, rowing – 4, weightlifting – 3, archery – 3, judo – 2, wrestling – 2, boxing – 2, gymnastics – 1.

Electrocardiography examination

A standard resting 12-lead ECG was recorded with a paper speed of 50 mm/s. The examination was performed at least 24 h after the last intensive physical activity.

To compare the ECG tracings the criteria used by the Italian authors for the group of athletes studied by them were chosen [8, 9]. The following ECG changes were considered abnormal: ST segment depression and/or deep negative T waves in at least 2 precordial and/or limb leads (with the exception of lead III); P wave duration > 120 ms in lead I and II together with a negative P wave phase of ≥ 0.1 mV amplitude and > 0.04 s duration in lead V_1 (as a reflection of left atrial enlargement); PQ interval shortened below 120 ms with wide QRS complex and the presence of delta wave as preexcitation; pathological Q wave defined as > 30 ms and > 0.1 mV; QRS complex with RSR‘ morphology and ≥ 120 ms duration in the anterior wall leads as a complete right bundle branch block (RBBB); heart axis deviation ≤ 30 degrees suggestive of left anterior fascicular block (LAFB). Complete left bundle branch block (LBBB) was diagnosed in the presence of wide QRS complex (≥ 120 ms) and characteristic morphology in the precordial leads; prolonged QT interval was defined as QTc > 0.44 s in men and > 0.46 s in women.

Additional assessment included: prolonged PQ interval (over 200 ms) as a first degree atrioventricular block; incomplete right bundle branch block (RBBB) – rSr‘ or RSR‘ complex in the anterior wall leads < 120 ms and features of early repolarisation (concave upward ST elevation with a high J point in ≥ 2 precordial and/or limb leads). Left ventricular hypertrophy was assessed with the Sokolow-Lyon index (S in V_1 + R in V_5 or V_6) > 3.5 mV and/or R wave amplitude ≥ 1.5 mV in limb lead I and/or ≥ 1.2 mV in aVL lead. The ECG tracings were also assessed for the presence of heart axis deviation > + 90 degrees. All tracings in athletes with pathological left or right heart axis deviation (which is a diagnostic criterion for left anterior fascicular block according to Italian investigators) were also analysed for the presence of fascicular blocks using the most common criteria of the LAFB and left posterior fascicular block (LPFB) (except heart axis deviation, QRS complex duration < 120 ms and for LPFB – q wave in II, III and aVF and r wave in I and aVL, and for LAFB – q wave in I and aVL and r wave in II, III and aVF) [10].

Sinus bradycardia was defined as < 60 beats per min. Other analysed parameters included: ventricular (also polymorphic) ventricular arrhythmias, supraventricular ventricular arrhythmias, non-sustained ventricular tachycardia, supraventricular tachycardia, atrial fibrillation/flutter and type I second degree atrioventricular block. The ECG abnormalities were divided into common (benign) and uncommon (potentially malignant) according to D. Corrado and W.J. McKenna (Table I) [11].

The ECG was also analysed in terms of frequency of abnormalities requiring the extension of diagnostic workup

Table I. List of ECG changes in athletes according to the criteria proposed by D. Corrado and W.J. McKenna [10]

Group I	Group II
Common 'benign' ECG changes • sinus bradycardia • first degree AV block • incomplete right bundle branch block • early repolarisation • isolated voltage criteria for left ventricular hypertrophy	Uncommon 'potentially malignant' ECG changes • left atrial enlargement • T wave inversion (negative T wave) in at least 2 consecutive leads • pathological Q waves in at least 2 consecutive leads • complete bundle branch block (LBBB or RBBB) • left anterior fascicular hemiblock • left posterior fascicular hemiblock • prolonged or shortened QT interval • features of Brugada syndrome • pre-excitation syndrome (WPW) • ventricular arrhythmias

Abbreviations: RBBB – right bundle branch block, LBBB – left bundle branch block, AV block – atrioventricular block, WPW – Wolf-Parkinson-White syndrome

according to the current ESC recommendations [4]. The analysis also included (apart from the aforementioned ECG changes): severe sinus bradycardia < 40 beats per min, wandering pacemaker, PQ interval < 120 ms (as a feature of pre-excitation), abnormal QRS complex (S waves in V_1 or V_2 > 3.0 mV, R waves in V_5 or V_6 > 3.0 mV) and nodal or atrial arrhythmias.

The analysis of ECG was performed directly on the printed tracings and independently by two investigators. In case of discrepancies, ECG tracings were reviewed again and mutal agreement obtained.

Results

The analysis included 73 resting ECGs. Sinus rhythm was found in all assessed ECG (100%) and ranged from 35 to 80 beats/min (mean 54 beats/min). The mean duration of corrected QT interval (QTc) was 389 ms (range 445 ms – 340 ms). Detailed results are presented in Table II. Seven (11%) athletes did not demonstrate any of the analysed ECG abnormalities.

Comparison of ECG abnormalities found in our group of athletes and Italian athletes is shown in Table III. Benign as well as uncommon ECG abnormalities were more frequently encountered in Polish athletes.

Electrocardiographic changes requiring the extension of diagnostic workup according to the current ESC recommendations were present in 21 (28.9%) subjects. A detailed analysis is presented in Table IV. Examples of ECG tracings are demonstrated in Figures 1 and 2.

Table II. Changes in the ECG of 73 Olympic athletes

Analysed ECG changes	Number of patients, n (%)
Sinus bradycardia < 60/min	55 (75.3)
Severe sinus bradycardia ≤ 40/min	4 (5.5)
Prolonged QT interval (corrected – QTc)	0 (0)
Ventricular arrhythmias	0 (0)
Nodal arrhythmias	2 (2.7)
Atrial arrhythmias	1 (1.4)
Wandering pacemaker	5 (6.8)
Shortened PQ interval < 120 ms	4 (5.5)
Preexcitation	0 (0)
Prolonged PQ interval > 200 ms	6 (8.2)
Left bundle branch block	0 (0)
Right bundle branch block	2 (2.7)
Heart axis deviation > –30 degrees	2 (2.7)
Left anterior fascicular block	2 (2.7)
Heart axis deviation > +90 degrees	9 (12.3)
Left posterior fascicular block	7 (9.6)
Incomplete right bundle branch block	52 (71.2)
Early repolarisation	17 (23.3)
Isolated voltage criteria for left ventricular hypertrophy	14 (19.2)
Features of left atrial hypertrophy	1 (1.4)
T wave inversion (negative T wave)	1 (1.4)
R wave in V_5 or V_6 > 3.0 mV	2 (2.7)
S wave in V_1 or V_2 > 3.0 mV	4 (5.5)
Normal tracing	8 (11)

Discussion

Structured screening tests are the most important element of SCD prevention. Their aim is to exclude any cardiovascular disease which may be related to increased risk of SCD. As yet there is no consensus between different organisations dealing with sports medicine as to the screening method in athletes. The key role of physical examination supported by personal and family history in all competitive athletes remains undisputed [3, 4]. However, there is an ongoing discussion on the necessity of performing additional tests for screening purposes. The

Table III. Comparison between the results in Italian athletes and in Polish Olympic athletes

Electrocardiographic changes	Group of Italian athletes [%]	Group of Polish Olympic athletes [%]
Common (benign)		
sinus bradycardia (< 60/min)	1.0	75.3
first degree AV block		8.2
incomplete RBBB	7.0	71.2
early repolarisation		23.3
left ventricular hypertrophy (Italian criteria)	0.8	19.2
Uncommon (malignant)		
left atrial enlargement	0	1.4
T wave inversion	2.3	1.4
type I second degree AV block	0.04	0
LBBB	0.1	0
RBBB	1.0	2.7
LAFB (pathological left axis deviation)	0.5	2.7
preexcitation	0.1	0
prolonged QTc	0.003	0
ventricular arrhythmias	1.1	0
polymorphic ventricular arrhythmias	0.1	0
non-sustained ventricular tachycardia	0.01	0
Other		
supraventricular arrhythmias	1.1	4.1
supraventricular tachycardia	0.09	0
atrial flutter/fibrillation	0.02	0
proportion of athletes with ECG changes [%]*	11.8	89 (including the 'malignant'– 12.3)

Abbreviations: RBBB – right bundle branch block, LBBB – left bundle branch block, LAFB – left anterior fascicular block, AV block – atrioventricular block
** The number of athletes with ECG changes is lower than the sum of all ECG changes, because in some athletes there was more than one abnormality.*

most frequent causes of SCD in young athletes – hypertrophic cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy – together with the fact that 92-98% of direct causes of death are ventricular arrhythmias, support the role of ECG as a screening method [1, 12]. This point of view is represented by ESC, which working Group of Sports Cardiology recommends a 12-lead resting ECG as a screening test for the diseases which increase the risk of SCD. The American societies (AHA and ACC) take an opposite view – they do not recommend any type of additional examinations, including resting ECG, considering this type of management as ineffective and therefore economically unjustified. Uncertainties arise mainly from the large number of false positive results in the assessed ECG tracings which require an extended diagnostic workup in 15% of cases and make this management strategy not cost-effective [13, 14].

The European recommendations are mainly based on the screening of athletes which has been conducted systematically in Italy since 1982. This largest in the world, multi-annual experience proved that the screening protocol comprising not only physical examination and history, but also a 12-lead ECG, increases the detection efficacy of potentially deadly diseases and decreases the mortality in competitive athletes [5].

In 2007 Pelliccia et al. published a study on the ECG analysis in 32 652 athletes [8]. The study was conducted in 19 centres throughout Italy; mean age of participants was 17 years and 80% of the studied subjects were male. The participants were mainly young amateur athletes aged 8 to 20 years [8, 9]. The results of the study allowed a division of observed ECG changes into two groups (Table I) [10]:

- group I (benign changes) – ECG changes frequently related (up to 80%) to the adaptive remodelling of the heart muscle – the so-called 'athlete's heart',
- group II (potentially malignant changes) – ECG changes observed less often (< 5%) not following the pattern of 'athlete's heart' and suspicious of organic heart disease.

We compared the results derived from the analysis of the very large, but unselected group of amateur athletes with a homogeneous elite group of Olympic athletes at the highest level of training. The groups differed in terms of number of athletes, age and the level of training, but it may be assumed that top athletes form a group which is a natural continuation of the group of young people starting competitive sports. Therefore, we decided to compare those two groups despite the mentioned differences.

The large difference in the number of athletes with resting ECG changes in the two groups is not surprising. The extent of this difference should be however emphasised (12% in the Italian group and 89% in the Polish group of Olympic athletes). It should also be noted that only 12.3% of Olympic athletes had 'potentially malignant' changes. This is in line with the observations of the Italian researchers that 'benign' electrocardiographic changes including those suggestive of left ventricular hypertrophy are present more often in adult competitive

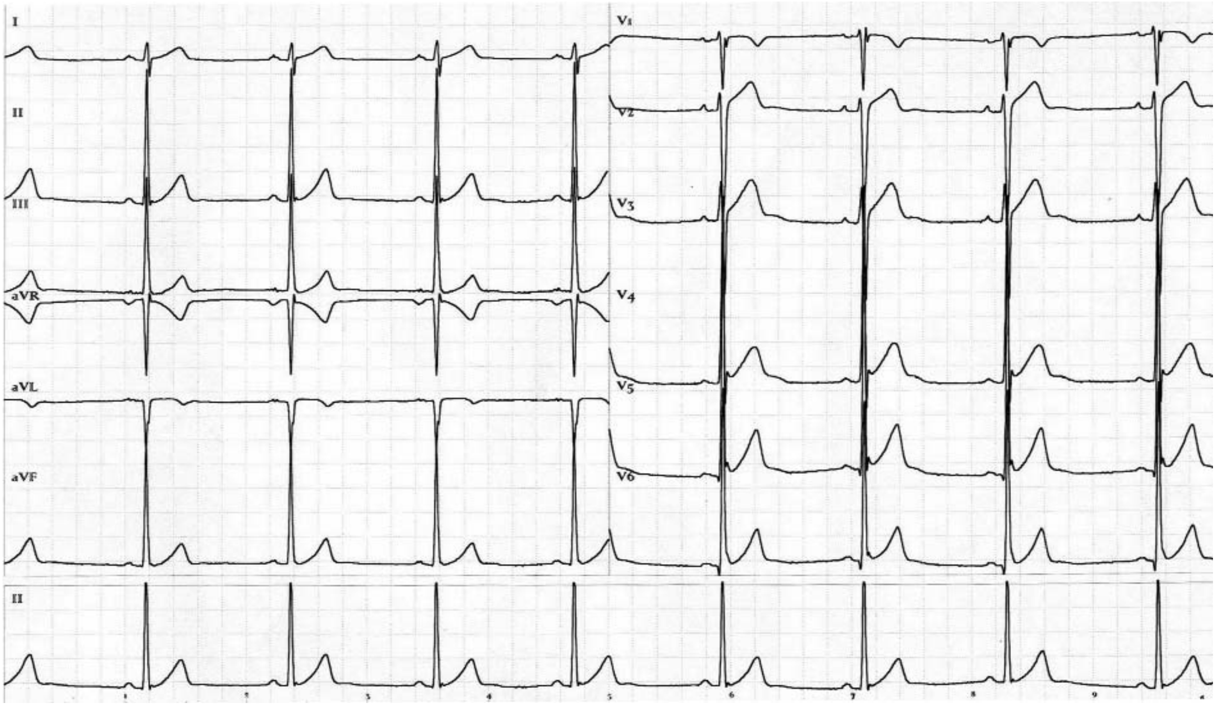

Figure 1. A 27-year-old rower. Sinus bradycardia 49/min, early repolarisation with marked J wave, features of left ventricular hypertrophy

athletes in comparison to young competitors starting regular sports activity [8]. According to the observations of D. Corrado and W.J. McKenna 'benign' changes constitute around 80% of the observed ECG changes, which is a number similar to the one detected in the group of Olympic athletes [10]. This is undoubtedly related to the more advanced cardiac remodelling as an effect of multi-annual intensive physical training. However, the classification of 'isolated voltage criteria for left ventricular hypertrophy' as 'benign' changes by these authors is disputable. It is most certainly a simplification derived from the fact that it is unknown which of the diagnostic criteria used for left ventricular hypertrophy should be applied in the case of the 'athlete's heart'. The complex assessment of changes encompassing the features of hypertrophy, ST segment and/or T-wave abnormalities and the presence of negative T waves seem to be the most suitable. These types of changes were found most frequently in athletes with cardiomyopathies who died. However, we did not observe this type of changes in our group of top athletes. Therefore, the Italian criteria were applied, which revealed the isolated voltage criteria for left ventricular hypertrophy, qualified as a 'benign' change, in 19.2% of subjects. Application of the ESC criteria showed changes potentially representative of left ventricular hypertrophy in 8.2% of the studied athletes.

Right bundle branch block (RBBB) and left anterior fascicular block (LAFB) were the most frequently found 'potentially malignant' changes in the Polish Olympic

Table IV. Electrocardiographic indications for the extension of cardiological work-up in our group of athletes (according to ESC) [4]

	Frequency [%]
P wave	
• features of left atrial hypertrophy	1.4
• features of right atrial hypertrophy	-
QRS complex	
• pathological left or right axis deviation	12.3
• S wave in V_1 or V_2 > 3.0 mV	5.5
• R wave in V_5 or V_6 > 3.0 mV	2.7
• pathological Q waves	–
• complete RBBB or LBBB	2.7
ST-T segment	
• ST segment depression or negative T waves in two consecutive leads	1.4
• QTc > 0.44 in men and > 0.46 in women	0
Cardiac rhythm	
• VE or more complex ventricular arrhythmia	0
• AF, AFl	0
• shortened PQ interval < 120 ms with or without delta wave	4,1
• bradycardia < 40/min	5.5
• first (> 210 ms), second or third degree AV block	0
Sum of all athletes with ECG changes*	28.9

Abbreviations: RBBB – right bundle branch block, LBBB – left bundle branch block, AV block – atrioventricular block, AF – atrial fibrillation, AFl – atrial flutter

** The sum of ECG changes is not a simple sum of individual changes, because in some athletes there was more than one ECG abnormality.*

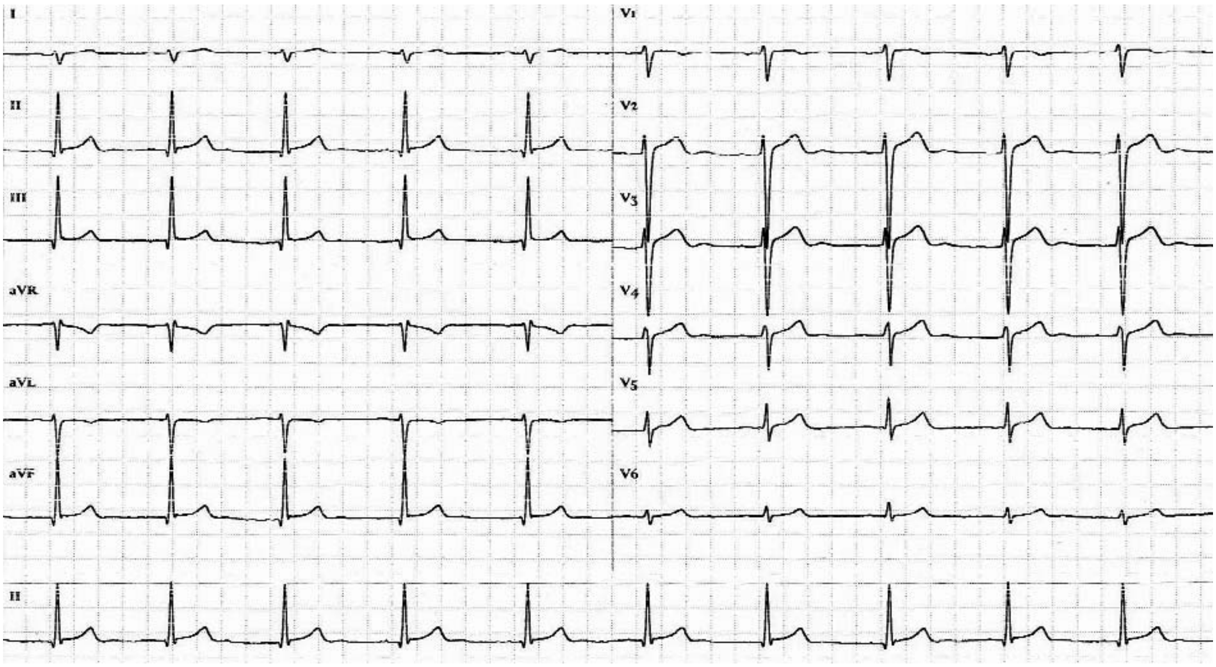

Figure 2. Electrocardiogram of a 27-year-old cyclist. Regular sinus rhythm 61/min, right axis deviation with non--pathological Q waves in leads II, III, aVF – features of left posterior fascicular block. R wave regression in the precordial leads may reflect an extremely vertical position of the heart significantly influencing the axis deviation

athletes. However, each of these abnormalities was found in only two athletes, therefore preventing definitive conclusions. It is worth noting that changes of repolarisation period (negative, symmetrical, deep T waves in two consecutive leads), which may suggest the presence of organic heart disease, were found less frequently in the group of Olympic athletes (one athlete) than in the Pelliccia et al. study. These changes are of great significance, as demonstrated by a recently published study relating them to increased risk of SCD and later development of hypertrophic cardiomyopathy despite initially normal results of echocardiographic examination [15]. Other ECG abnormalities were found with similar frequency in both groups.

It was surprising to find an ECG pattern of LPFB in a large percentage of Olympic athletes, an abnormality not analysed in the study by Pelliccia et al. In our group of athletes, 9 had a pathological right axis deviation including 7 with full pattern of LPFB. Left posterior fascicular block is a rare finding and in the presented classification of ECG changes in athletes is considered as a 'potentially malignant' abnormality. Athletes presenting with the pattern of LPFB were further examined to exclude other causes of these ECG changes (lung diseases, shift of the transition zone in the precordial leads, vertical position of the heart, chest morphology, lateral wall myocardial infarction). The pattern of LPFB was also not related to the left ventricular hypertrophy. Despite a different scope of the comparative analysis, we have also studied the Olympic group for the presence of right ventricular hypertrophy with the use of the following criteria (except the QRS axis): right axis deviation, R wave in V_1 > 0.7 mV, R wave in aV_R > 0.5 mV or R/S waves in V_1 > 1 and R wave in V_1 > 0.5 mV and changes of the ST-T segment [11]. These features were not present in any of the athletes. However, it is true that the right ventricle is enlarged in some of the athletes when assessed using echocardiographic criteria with retrograde tricuspid valve gradient exceeding 30 mmHg. This observation has been used by some authors to explain the presence of ECG pattern of LPFB in athletes [9]. It is also possible that the criterion of axis deviation > 90 degrees is too liberal. When the criterion of QRS axis deviation > +110 degrees was used, only one athlete fulfilled the criteria of LPFB. Overestimation of the presence of LPFB or pseudo-LPFB in our group requires, however, further studies, which are ongoing.

The application of criteria proposed by the Italian investigators would lead to identification of ECG changes requiring an extended diagnostic workup in 12.3% of the Olympic athletes. However, it should be noted that these criteria are much less strict than the screening recommendations for athletes proposed by the ESC Study Group of Sports Cardiology [4]. In line with the latter, as many as 28.9% of the analysed ECGs of Polish Olympic athletes would have to be considered as requiring further workup. This is mainly related to the fact that the ESC considers a pathological QRS axis deviation as an abnormality requiring further workup (most of the axis deviations in our group were related to LPFB or LAFB).

The presented results partially support the thesis of ACC/AHA that more than 15% of athletes with ECG changes may require further cardiological diagnostics. A significant difference derives from the fact that in this situation we are not considering a pre-participation medical screening but a group of the highest level athletes. These results confirm the necessity of periodic ECG examinations in this elite group of athletes. They also emphasise the difference between the highest level competitive athletes and amateur athletes, in whom resting ECG changes are less frequent (around 12%) and extended cardiological workup is required in 5% of them. This should support the use of ECG in the pre-participation medical screening as a potentially cost-effective method.

One of the limitations of the current study is the fact that the examined group consisted of representatives of various sports disciplines, which may influence the pattern of ECG abnormalities. The number of studied athletes is not comparable with that of the cited Italian study – by definition Olympic athletes are a selected sports elite. In the presented study we analysed the examinations of 'only' 73 athletes, but it should be noted that this constitutes 1/3 of all members of the Polish Olympic Team for the Summer Olympic Games in Beijing. Top level professional athletes are hard to persuade to undergo specialist examinations, thus, we examined a 'selected' group and not consecutive athletes.

Conclusions

1. The majority of the changes observed in the resting ECG in competitive athletes are 'mild' and reflect adaptation to the physical activity.
2. ECG is an essential method of periodic assessment in competitive athletes, but it often requires verification with other additional examinations.
3. The frequent presence of ECG pattern of left posterior fascicular block in the top Polish athletes, which is considered as a 'potentially malignant' abnormality, requires further studies.

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Analiza spoczynkowego elektrokardiogramu u sportowców wyczynowych szczebla olimpijskiego w świetle aktualnych zaleceń

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Streszczenie

Wstęp: Podstawowym zadaniem kardiologii sportowej jest zapobieganie nagłym zgonom sercowym u sportowców. Kwalifikowane badania przesiewowe są najważniejszym elementem prewencji, jednakże w aktualnych wytycznych ACC/AHA/ESC nie ma konsensusu co do tego, jak powinny one wyglądać. Obecnie toczy się dyskusja nad wykorzystaniem badań dodatkowych, a w szczególności zasadnością i opłacalnością stosowania spoczynkowego EKG u wszystkich osób uprawiających sport w formie zorganizowanej.

Cel: Określenie częstości występowania zmian w spoczynkowym zapisie EKG u sportowców o najwyższym stopniu zaawansowania, przy zastosowaniu proponowanych kryteriów oceny.

Metody: W okresie intensywnych przygotowań do Igrzysk Olimpijskich w Pekinie (2008) wykonano i przeanalizowano spoczynkowe 12-odprowadzeniowe zapisy EKG u 73 członków kadry olimpijskiej (20 kobiet i 53 mężczyzn) reprezentujących różne dyscypliny sportowe. W ocenie EKG stosowano powszechnie przyjęte kryteria, ponadto zmiany podzielono zgodnie z aktualnymi publikacjami na: grupa I – częste, dopuszczalne, „łagodne", uważane za powiązane z zespołem serca sportowca (np. bradykardia zatokowa, blok przedsionkowo-komorowy I stopnia, cechy wczesnej repolaryzacji, niezupełny blok prawej odnogi pęczka Hisa, izolowane amplitudowe cechy przerostu lewej komory); grupa II – rzadkie, „niepokojące", mogące wynikać z obecności organicznej choroby serca (np. zupełne bloki odnóg pęczka Hisa, komorowe zaburzenia rytmu, ujemne załamki T w co najmniej dwóch sąsiednich odprowadzeniach czy patologiczne odchylenie osi elektrycznej serca).

Wyniki: Całkowicie prawidłowy zapis EKG obserwowano u 11% badanych, zmiany „łagodne" obserwowano u 65%, a „podejrzane" u 23%. Najczęstszymi zmianami „łagodnymi" były bradykardia zatokowa, niezupełny blok prawej odnogi pęczka Hisa oraz izolowany przerost mięśnia lewej komory, które wystąpiły odpowiednio u 75, 71 i 41% badanych. Wśród zmian „podejrzanych" najczęstsze było patologiczne odchylenie osi elektrycznej serca w prawo z elektrokardiograficznymi cechami bloku tylnej wiązki lewej odnogi pęczka Hisa, który obserwowano u blisko 10% badanych. Ponadto odnotowano pojedyncze przypadki pełnego bloku prawej odnogi pęczka Hisa, przerostu lewego przedsionka, ujemnych załamków T czy bloku przedniej wiązki lewej odnogi pęczka Hisa.

Wnioski: 1. Większość zmian obserwowanych w spoczynkowym zapisie EKG u sportowców wyczynowych należy do tzw. „łagodnych", stanowiących odzwierciedlenie adaptacji do wysiłku fizycznego. 2. Badanie EKG jest niezbędną metodą okresowej oceny sportowców wyczynowych, jednak wymaga stosunkowo częstej weryfikacji w innych badaniach dodatkowych. 3. Częste występowanie w grupie olimpijczyków elektrokardiograficznego obrazu bloku tylnej wiązki lewej odnogi pęczka Hisa, uważanego za nieprawidłowość „potencjalnie złośliwą", wymaga przeprowadzenia dalszych badań.

Słowa kluczowe: serce sportowca, EKG, badania przesiewowe

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