ORIGINAL REPORT

Prevalence of Different Electrocardiographic Patterns in Iranian Athletes

Behzad Farahani[1], Mehrshad Poursaeid Esfahani[2], Mohammad Amin Abbasi[3], Farhad Moradi[1], and Ata Abbasi[4]

[1] *Department of Cardiology, Firoozgar Hospital, Tehran University of Medical Science, Tehran, Iran*

[2] *Department of Sport Medicine, Shahid Beheshti Medical University, Tehran, Iran*

[3] *Department of Internal Medicine, Shahid Beheshti Medical University, Tehran, Iran*

[4] *Department of Pathology, Tehran University of Medical Sciences, Tehran, Iran*

Received: 10 Aug. 2011; Received in revised form: 1 Apr. 2012; Accepted: 16 Jul. 2012

Abstract- To explore the abnormalities in Iranian athletes' electrocardiogram and find any relation with body fat. 239 international athletes were involved in this cross sectional study. Body-fat percentage and resting 12-lead ECGs were recorded from all participants. Of 239 participant athletes, 212 were male and 27 female. 60% of participants had sinus bradycardia. A total of 84% of the athletes demonstrated at least 1 abnormal ECG finding. Average values for the PR, QRS and QT intervals, P-wave duration and QRS axis were in normal range. Frequencies of various ECG abnormal findings in all athletes were as follows: right axis deviation 4.2%, left ventricular hypertrophy 6.2%, sinus arrhythmia 5.8%, right bundle branch block (RBBB) 24.2% (incomplete RBBB 16.8%, complete RBBB 7.4%), ST elevation 72.5%, prolonged QT interval 1.7%, T inversion 3.1% and Mobitz type I 1.2%. The athletes' ECG response to treadmill stress test was normal with no ischemia or arrhythmia. The means of BMI and body-fat percentage were 24.04 ± 3.5 kg/m² and 9.15 ± 2.12%, respectively. Pearson correlation coefficient between body-fat percentage and ST changes was 0.65 (P=0.008) in anterior leads and 0.198 (P=0.017) in lateral leads. Also, the correlation coefficient between the body fat percentage and right bundle branch block was 0.36 (P=0.013). The results of current study support the inclusion of ECG in athletes' cardiac screening before they engage in vigorous exercises in order to detect the potentially fatal arrhythmias.

Acta Medica Iranica, 2012; 50(8): 560-564.

Keywords: ECG; Athletes; Bradycardia; Sudden cardiac death

Introduction

Electrocardiogram (ECG) changes in athletes are common and reflect heart adaptation to regular physical training. The 12-lead ECG can show a broad range of abnormal patterns in trained athletes such as increased QRS voltages, which is suggestive of left ventricular (LV) hypertrophy, known as athlete's heart (1-3). Moreover, ECG patterns in trained athletes may mimic patterns similar to structural heart diseases such as hypertrophic cardiomyopathy (HCM) or arrhythmogenic right ventricular Cardiomyopathy (ARVC) which can cause sudden death during physical exertion (4-6). It is necessary to distinguish patterns resulting from exercise and those associated with an increased cardiovascular risk. Sinus bradycardia, first-degree atrioventricular (AV) block and early repolarization are patterns usually seen in trained athletes ECG. These changes should be discerned from exercise unrelated abnormalities such as ST repolarization, pathological Q waves, intraventricular conduction defects, ventricular pre-excitation, long and short QT interval, which are expressions of cardiovascular disorders (7). Although recent studies have demonstrated an association between ECG abnormalities and cardiovascular mortality and believe that despite the existence of multiple methods for identification of cardiovascular abnormalities, ECG still remains as a simple, low cost and widely available method to explore the changes (8,9) but some others believe in contrary (10). In addition, in contrast to public beliefs, there are studies showing the higher prevalence of metabolic syndrome or obesity among athletes comparing with normal population which make athletes more prone to develop cardiovascular disorders (11-13). The present study performed to explore the prevalence of abnormalities in Iranian athletes' ECG and also

Corresponding Author: Mohammad Amin Abbasi
Department of Internal medicine, Shahid Beheshti Medical University, Tehran, Iran
Tel/: +98 21 88330417, 912 2170930, Fax: +98 21 88330417, E-mail: amin.abbasi1314@gmail.com

explored any relation between body fat or BMI and ECG abnormalities.

Patients and Methods

Study population

Between 2000 and 2007, 239 elite international athletes were included in this study. The athletes engaged in 23 different sporting disciplines and had participated in vigorous training programs. Written informed consent was obtained from all of the athletes. Ethical approval was sought from the ethical guidelines of the 1975 Declaration of Helsinki and the local ethics committees approved the study. The evaluations consisted of physical examination, past medical history, 12-lead and exercise ECG and anthropometry. Also the athletes were asked to fill out a questionnaire with emphasis on cardiovascular symptoms.

Evaluation of ECG and body mass index (BMI)

Standard resting 12 lead ECG was performed in supine position, during quiet respiration using a Marquette Hellige recorder (Milwaukee, Wisconsin). The electrodes were placed carefully and ECGs were recorded at a paper speed of 25 mm/s. The following ECG variables were assessed: heart rate, rhythm, QRS Axis, P, Q, R, T wave voltage and morphology, right bundle branch block, PR interval, QT interval and ST elevation. ECGs were interpreted by an experienced cardiologist and the results were recorded.

Anthropometric measurements

Height and weight of participants were determined by the Martin metal anthropometer (0.1 cm) and clinical scales (0.05 kg), respectively, the body mass index (BMI) was then calculated (kg/m^2). For body fat percentage (BF%), air-displacement plethysmography (BOD POD Body Composition System; Life Measurement Instruments, Concord, CA) was used to generate an estimate of fat mass and fat-free mass components of total body mass, from which BF% was calculated.

Statistical analysis

The results were expressed as mean ± SD. Statistical analysis was performed using SPSS version 16.0.1 (SPSS Inc., Chicago, Illinois.). The statistical differences between proportions were determined by Chi-square analysis. Numerical data was evaluated using analysis of variance, followed by Tukey's post hoc test. *P*-value less than 0.05 was considered as significant.

Results

Of 239 athletes, 212 were male and 27 female. The Mean age was 26.2 ± 3.2 years. Distribution of athletes in different sport disciplines is shown in table 1. The mean heart rate of athletes was 62.92 ± 11.80 (range 33 to 130). More than 80% of athletes had heart rate less than 70/min and 60% had sinus bradycardia. A total of 84% of the athletes demonstrated at least 1 abnormal ECG finding. Right Axis deviation was observed in 4.2% and 6.2% of them had left ventricular hypertrophy. Average values for the PR QRS and QT intervals, P-wave duration and QRS axis were (0.16±0.04 s), (0.08±0.03 s), (0.36±0.06 s), (0.09±0.03 s), (82.2±16.8 degrees) which all were in normal range. Frequencies of various ECG abnormal findings were as follows: sinus arrhythmia 5.8%, right bundle branch block (RBBB) 24.2% (incomplete RBBB 16.8% and complete RBBB 7.4%), ST elevation 72.5%, prolonged QT interval1.7%, T inversion 3.1% and Mobitz type I 1.2%.

Table 1. Athletes in different sport disciplines.

Sport Discipline	Athlete (%)	Sport Discipline	Athlete (%)
Basketball	6.7	Fencing	5
Handball	6.2	Gymnastic	2.1
Football	4.6	Wrestling	6.1
Volleyball	6.4	Judo	4.5
Water polo	6.3	Karate	3.1
Badminton	1	Shooting	9.7
Cycling	5.3	Kabaddi	4.7
Body Building	4	Rowing/canoeing	3.7
Swimming	3.3	Taekwondo	5
Wushu	3.6	Track and Field	4.2

Table 2. Body-fat percentage and ST elevation in anterior &lateral leads.

Sport Discipline	Body Fat Percentage	STE Anterior	STE Lateral	Sport Discipline	Body Fat Percentage	STE Anterior	STE Lateral
Volleyball	9.81	87.5	81	Judo	5.42	73	82
Basketball	11.13	70.6	82.4	Kabaddi	9.17	63	55
Cycling	7.73	50	58	Karate	9.92	80	80
Body building	5.98	37.5	12.5	wushu	6.53	100	80
Rowing/canoeing	8.42	100	100	Football	9.75	100	82
Fencing	13.99	45	82	Sepak takraw	3.34	80	80
Gymnastic	5.85	40	60	Swimming	8.57	100	100
Wrestling	10.30	50	35.7	Taekwondo	7.49	92	67
Water polo	12.35	94	69	Track and Field	6.68	71	73
Handball	11.75	86.7	93				

The athletes' ECG response to stress which were examined by treadmill stress test were normal with no evidence of ischemia or arrhythmia.

The means of BMI and body-fat percentage were 24.04±3.5 kg/m² and 9.15±2.12%, respectively, which were in normal range. Pearson correlation coefficient between body-fat percentage and ST changes was 0.65 (P=0.008) in anterior leads and 0.198 (P=0.017) in lateral leads. Also, the correlation coefficient between the body-fat percentage and right bundle branch block was 0.36 (P=0.013). No correlation was found between BMI or body fat percentage with other ECG changes in this study. Table 2 demonstrates the athletes' mean body fat percentage and prevalence of ST changes in each sport discipline.

Discussion

According to our results ST changes was observed in a high proportion of athletes. Although it is an uncommon finding in non-athletes but is prevalent in athletes with high enduring capacity and unawareness of this fact may cause unreasonable clinical referring. Also we found that there is a positive correlation between body fat percentage and ST changes in anterior and lateral leads and also RBBB, which are not mentioned in other studies. These findings can help us to correctly interpret the athletes' ECG and may decrease diagnostic mistakes. According to our results sixty percent of participants had sinus bradycardia, which was similar to other studies showing the prevalence 20-70% (14,15). This finding can be due to increased vagal tone in athletes which can increase the risk of sinus bradycardia and heart block by suppressing the SA and AV nodes. Although bradycardia is recognized as an adaptive response in athletes, but is sometimes associated with acute cardiovascular events, e.g. syncope, particularly when is associated with atrioventricular block pattern (1). According to previous studies, the prevalence of sinus bradycardia ranges from 2.75% to 7% in non athletes (15). About 6.2% of Iranian athletes had left ventricular hypertrophy whereas 47.3% of the athletes and 29% of the non-athletes met the ECG criteria for LVH in other studies (15). According to this finding the number of Iranian athletes exhibiting LVH is lower than in non-athletes and athletes of other countries. In comparison to other studies, our results show that the prevalence of sinus bradycardia, Axis deviation, rhythm alteration, incomplete right bundle branch block, Mobitz type I and ST changes are similar to other athletes of other countries but abnormalities such as ventricular hypertrophy, T abnormalities and QT changes differ significantly from those of other countries. The results of current study support the inclusion of ECG in athletes' cardiac screening before involving in vigorous exercises to detect the mentioned potentially fatal arrhythmias. Identifying the fatal cardiac abnormalities among athletes of different sport disciplines before their engagement in vigorous exercises has become an interesting topic of discussion in recent decades. Although there have been so many studies which performed to explore the role of ECG and its benefits on decreasing sudden cardiac death in athletes but still there is controversies. Some studies show that the pre-participation screening of athletes decreases the rate of sudden cardiac death among them and recommend ECG to be added to the athletes screening program in order to reduce the risk of cardiovascular accidents (16-19). But some other studies have mentioned that use of ECG for athletes' cardiac screening is not cost effective and is of

less benefit. They have mentioned that use of ECG in athletes gives us so many borderline results which lead to additional diagnostic tests, worry and stress for participants and surplus financial costs (10). As screening methods in various countries have different financial costs, it can be suggested that each country should choose a screening method according to the prevalence of the abnormal findings in their research and also it's cost in their own country. In conclusion, according to our results and considering previous studies, it can be concluded that presence of sinus bradycardia, right axis deviation, ST changes particularly in anterior and lateral leads, Mobitz type I, right bundle branch block in ECG can be considered as a normal finding. On the other hand, incorporation of prolonged Wolff-Parkinson-White (WPW) syndrome, atrial fibrillation, tachycardia and atrial flutter have important implications since they usually indicate a state of increased vulnerability to malignant ventricular arrhythmias, syncope and sudden death. The results of current study support the inclusion of ECG in athletes' cardiac screening before involving in vigorous exercises to detect the potentially fatal arrhythmias.

Limitations

This study was an observational study, so we were unable to demonstrate if our findings and use of ECG as athletes screening test have reduced the cardiac accident risks or not. In addition, we had a very brief focus on the body fat percent and its relation with ECG abnormalities and because of lack of control group from normal population we were unable to find a more precise relation between ECG abnormalities and body fat percentage.

Thus, a prospective study with a control group from normal population is needed to have a better analysis of the results.

Acknowledgments

This study was supported by Tehran University of Medical Sciences Research Fund. We also thank the athletes who participated in this study.

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