Pre-Participation ECG Screening in Military Recruits

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Abstract

Background: The findings and additional investigations required based on pre-participation electrocardiography (ECG) among military recruits are poorly defined in the literature.

Objectives: This study was designed to evaluate the rate of abnormal findings on pre-participation ECG in young adults and the additional evaluations required based on these findings.

Methods: A retrospective cohort study was performed in the Israeli Air Force (IAF) aero medical screening center for flight academy and elite units' candidates. Flight academy and elite units' candidates undergo pre-participation ECG prior to enlistment to the Israeli Defense Forces (IDF). Since 2010, all ECGS have been performed at the IAF aero medical center. All ECGs performed since January 2010 were analyzed by one of three cardiologists and all those in which significant findings were identified were referred to further evaluation upon the cardiologist's request. Causes of referral for further evaluation, the evaluations performed and the results of these evaluations are reported for the study population.

Results: 1455 ECGS were performed in the years 2010-2011. Of these, 1388 (95.39%) were interpreted as normal. 67 subjects were referred to further evaluation based on ECG findings. The most common findings leading to further evaluation were T wave changes (16 cases, 23.88%), pre-excitation pattern (14, 20.89%) and voltage criteria for left ventricular hypertrophy (11, 16.41%). Only 7 subjects (10.44%) had abnormal findings which were considered clinically significant at the end of the medical evaluation.

Conclusions: The rate of significant findings leading to disqualification from military activity is extremely low and referral to continued investigations based on 12-lead ECG findings should be judicious (Arq Bras Cardiol. 2013;100(3):269-273).

Keywords: Electrocardiography; Triage; Athletes, Cardiovascular Diseases.

Introduction

Sudden death in asymptomatic athletes is a rare event, but has significant impact[1-3]. Despite the large number of athletes undergoing pre-participation screening, there is a continuing debate regarding the optimal method of screening, based on both medical and economic issues. Professional guidelines in the US do not recommend using either electrocardiography (ECG) or echocardiography for screening college athletes[4]. On the other hand, 12-lead ECG has been supported for screening purposes in athletes by the Sports Cardiology section of the European Society of Cardiology and Medical Commission of the International Olympic Committee and has been shown to reduce mortality in this population[5]. The main concern in performing pre-participation ECG is the large amount of abnormal ECGs requiring additional and costly work-up. In this study, we describe a unique population of military recruits screened prior to participation in strenuous physical activity and describe the rate of abnormal ECGS identified on routine screening, the additional work-up required based on ECG findings and the results of this work-up.

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Materials and methods

Study population and screening process

Recruits to elite units in the Israeli Defense Forces (IDF) undergo routine ECG prior to their enlistment. Since January 2010, this examination is performed exclusively at the Israeli air force (IAF) aero medical center. All subjects undergo a preliminary screening process at the IDF recruitment center which includes a detailed history and physical examination. Only those who are considered healthy are referred to screening ECG at the IAF aero medical center. This population consists of 17-19 year olds, exclusively male subjects.

Electrocardiography

Standard 12-lead ECG is performed with the subject in the supine position during quiet respiration and recorded at 25mm/second. All tracings are reviewed immediately following their performance to rule out technical problems and a repeat study is performed in those whose ECG is considered technically poor.

ECG patterns were evaluated by one of three cardiologists according to common clinical criteria and were divided into 8 categories based on these criteria: 1) voltage criteria suspicious for left ventricular hypertrophy

(LVH) – defined as $S_1+R_{5,6}$ wave voltage greater than 35 mm in precordial leads and/or R-wave greater than 15 mm in peripheral lead I and/or 12 mm in aVL; 2) T wave abnormalities; 3) Early repolarization pattern- defined as upward ST-segment elevation in 2 or more peripheral or precordial leads, beginning from an elevated J point and continuing with an upsloping shape into the T-wave; 4) Long QT- defined as a corrected QT interval (QTc) greater than 440 milliseconds; 5) Suspected pre-excitation pattern — defined as a PR segment shorter than 120 milliseconds) with or without a delta wave; 6) Tachyarrhythmias — including atrial premature beats and ventricular premature beats; 7) Conduction disturbances — including atrioventricular (AV) blocks of all degrees, fascicular hemiblocks (anterior or posterior), left bundle branch block or right bundle branch block; 8) Sinus bradycardia — because of its frequency, only subjects with rates slower than 40 beats/minute were referred for further evaluation.

Subjects who had one of the above ECG abnormalities were referred to further evaluation upon cardiologist's recommendation. Some of the subjects were referred to several investigations. Echocardiographic LVH was defined as either an IVS thickness of 12 mm or greater, PW thickness of 12 mm or greater or LVM of 132 g/m^2 or greater[6].

Statistical analysis

The findings on 12-lead ECG are shown as a percentage of the total ECG findings and as a percentage of the entire study population. The evaluations performed based on ECG findings are shown in absolute numbers and as a percentage of the total reasons for referral to this test. The study was approved by the ethics committee of the Medical Corps of the Israeli Defense Forces.

Results

1,455 subjects underwent routine ECG prior to their enlistment in the years 2010-2011. All were 18-19 years old healthy male subjects. 1,388 (95.39%) of the examinations were interpreted as normal. Sixty-seven subjects were referred to additional investigations and the abnormal ECG findings are shown in Table 1. The most common finding on 12-lead ECG were: T wave changes (16 cases, 23.88%), signs of pre-excitation (14 cases, 20.89%) and voltage criteria for LVH (10 cases, 14.92%). Additional investigations based on ECG findings are shown in table 2. Some of the candidates were referred to several investigations. Echocardiography was the most common additional investigation performed (46 subjects) and was performed mainly in subjects with voltage criteria for LVH or T wave alterations. Exercise test was performed in 38 subjects, particularly those with T wave changes, sinus bradycardia and suspected pre-excitation. Holter monitoring was performed in 22 subjects, mainly in those with sinus bradycardia or suspected pre-excitation.

Only 7 subjects had clinical findings on follow-up examinations, which were considered significant. These are shown in table 3 according to the cause for referral. All significant clinical findings were identified by echocardiography.

Discussion

Screening for cardiovascular disease among athletes and military candidates is imperative as sudden death is obviously tragic and potentially preventable. Debate continues regarding the optimal method of screening, ranging from reliance solely on history and physical examination, to performance of 12-lead ECG and echocardiography. This study reviews both the causes for referral to continued investigations among healthy subjects undergoing screening ECG and the significant identified findings.

The total rate of ECGS defined as abnormal in this cohort was 4.6%, a percentage much lower than that previously reported[7,8]. Yet, even in a previous report by Pellicia et al[8] in which 11.8% of ECGs were interpreted as abnormal, additional evaluation was requested in only 4.8% of ECGs, disregarding some of the findings noted on routine ECG. This rate is similar to that reported in this study and probably represents the true rate of ECG findings requiring further evaluation in young athletes.

It is not surprising that one the most common causes for referral to continued investigations was T wave changes, which is a non-specific finding. Signs of pre-excitation were identified in 14 subjects, who comprised 0.96% of the study population. This is a higher percentage than the one previously reported[9] and probably results from the high awareness to this condition among the cardiologists interpreting these ECG tracings. Signs of LVH were identified in only 7.56% of the study population, which also is significantly lower than reported in previous studies[10] but is in accordance with other reports[8].

Significant clinical findings were most commonly identified in subjects with T wave alterations. This highlights the fact that T wave alterations should be regarded with caution, despite their relatively high prevalence, and should prompt a search for structural heart disease even in young athletes.

The lack of correlation of echocardiography-proven LVH and voltage criteria for LVH is not surprising and has been previously reported[11]; yet, two significant medical conditions were identified in those referred for evaluation based on ECG voltage criteria for LVH. Therefore we believe that despite the low specificity of voltage criteria for LVH on 12-lead ECG, these subjects should undergo complete work-up by echocardiography.

Early repolarization pattern on ECG probably does not lead to a significant increase in the risk of fatal arrhythmia[12], but because the number of subjects referred for further evaluation based on this finding in the present cohort was small, it is difficult to make recommendations regarding the significance of this finding in athletes.

The criteria used in this study for referral to further evaluation were similar to those used in a previous study by Pellicia et al[8]. Whether these criteria should be the ones used as basis for further evaluation referral in athletes requires more extensive research, including clinical follow-up of subjects to evaluate cardiovascular outcomes. The required additional evaluation based on these ECG findings is unclear and also requires larger scale studies. The lack of significant findings in subjects with suspected pre-excitation, conduction disturbances, early repolarization pattern and sinus bradycardia highlight the benign nature of these findings on 12-lead ECG in young healthy subjects. We believe that because pre-excitation syndrome is potentially fatal,

Table 1 - ECG findings leading to additional investigations in elite unit candidates

ECG findings	Number	Percent of findings	Percent of total subjects
T wave changes	16	23.88	1.1
Short PR-suspected pre-excitation pattern	14	20.9	0.96
LVH	11	16.41	0.76
Sinus bradycardia	9	13.43	0.62
Conduction disturbances	6	8.95	0.41
Tachyarrhythmias	5	7.46	0.34
Early repolarization	3	4.48	0.21
Long QT	3	4.48	0.27
Total	67	100	4.6

Table 2 - Additional investigations based on 12-lead ECG findings

ECG findings	Echo	Stress	Holter	Adenosine Test
T wave changes	17	8	1	0
Early repolarization	2	2	1	0
Long QT	1	2	2	0
Short PR Suspected pre-excitation pattern	1	7	7	11
Tachyarrhythmias	2	3	2	0
LVH	16	1	0	0
Conduction disturbances	7	7	3	0
Sinus bradycardia	0	8	6	0
Total	46	38	22	11

Table 3 - Significant clinical findings according to cause of referral

ECG finding	Medical findings (#)
T wave changes	BAV (1) Small VSD with left to right shunt (1) LVH (1)
Early repolarization	LVH (1)
Long QT	None
Suspected pre-excitation pattern	None
Tachyarrhythmias	Dilated left ventricle (1)
LVH	LVH (1) Non-compaction of apex (1)
Conduction disturbances	None
Sinus bradycardia	None
Total	7

BAV: bicuspid aortic valve; VSD: ventricular septal defect; LVH: left ventricular hypertrophy was defined as either an IVS thickness of 12 mm or greater, PW thickness of 12 mm or greater or LVM of 132 g/m^2 or greater.

those with such pattern on 12-lead ECG should undergo a complete evaluation, preferably by adenosine testing as previously described[13], but those whose ECG demonstrates low degrees of AV block or sinus bradycardia, even at extremely low rates , probably have an increased vagal tone and require no further evaluation.

This study has several limitations. First, all ECGS were interpreted by a single cardiologist, which may have caused 'misdiagnosis' of certain abnormalities. Yet, because the interpreting cardiologist was experienced in ECG interpretation in young athletes and used well-defined criteria, we believe this should not have been a cause for underdiagnosis of potentially fatal conditions. The second limitation is the fact that the cohort consisted of subjects who underwent preliminary exclusion by history and physical examination and most of whom were healthy athletes. Thus, most of them probably had undergone screening ECG in previous years. Therefore, the cohort may not be representative of the general athlete population. This may account for the relatively low rate of significant findings on the additional testing in this cohort. Another limitation is the fact that the subjects were not followed prospectively for the development of adverse cardiovascular outcomes. Thus, the true effectiveness of this screening process cannot be evaluated. Despite these limitations, we believe that this cohort is fairly representative of the general athlete population and its results may aid in drawing conclusions regarding this population.

Conclusions

ECG has a role in the screening process of athletes and military personnel for cardiovascular conditions, as it may identify conditions which may prove fatal during exercise. Yet, referral to continued investigations based on ECG findings should be judicious in order to decrease costs and to make this screening method more technically applicable to large populations.

Author contributions

Conception and design of the research, Analysis and interpretation of the data, Writing of the manuscript and Critical revision of the manuscript for intellectual content: Grossman A; Acquisition of data and Statistical analysis: Prokupetz A; ECG interpretation: Lipchenca I.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

This study is not associated with any post-graduation program.

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