CLINICAL AND ELECTROCARDIOGRAPHIC ASPECTS OF SPORTIVE HEART AT TEENAGERS

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Abstract: Sportive heart at teenagers is defined by cardiovascular adaptations produced by periodic and intense training (over 8 hours a week) and represents an actual subject for sportive medicine.
Starting from 2010, The European Society of Cardiologyrecommends before beginning a professional sports or a sportive competition, to perform a complete clinic exam and a repose electrocardiography, even from the age of 12 years. The biannual medical visit, as well as, the repose ECG, are part of the young sportsmen monitories and impose knowledge of specific aspects of ECG.
These cardiovascular changes produced by effort, determine an increase of sportive performance, but, in the same time, can be associated with apparition or aggravation of rhythm disorders. Sportive heart' differential diagnose with cardiopathies, especially, cardiomyopathy, which can lead to sudden death, need a better knowledge of athlete ECG physiological aspects.
The present paper aims to describe clinical and electrocardiographic aspects of sportive heat, well known at adults professional sportsmen, especially, males, and less studied for children and teenagers.
Keywords: *sportive heart, cardiovascular risk, teenagers.*

Introduction

Sportive heart at teenagers is defined by cardiovascular adaptations produced by periodic and intense training (over 8 hours a week) and represents an actual subject for sportive medicine.
Starting from 2010, The European Society of Cardiology recommends before beginning a professional sports or a sportive competition, to perform a complete clinic exam and a repose electrocardiography, even from the age of 12 years. The biannual medical visit, as well as, the repose ECG, are part of the young sportsmen monitories and impose knowledge of specific aspects of ECG[6].
Sportive heart is defined by chronic physiological cardiovascular changes due to periodic and intense physical activity (at least 3 trainings a week, for about 30-45 minutes, at an intensity of 60 – 80 % of maximum consumption of oxygen - VO2 max).
These adaptive responses (increase of cardiac mass, myocardia hypertrophy and cardiac cavities dilatation) have clinic, electric, echocardiographic, functional and morphologic expression and can be observed at professional sportsmen, which perform 6-10 hours of effort a week, respectively, 8 hours a week for teenagers [9].
These cardiovascular changes produced by effort, determine an increase of sportive performance, but, in the same time, can be associated with apparition or aggravation of rhythm disorders. Intense sportive effort, represents a high risk, especially for athletes diagnosed with chronic cardiopathy, which can generate rhythm disorders, responsible for approximately 90% of sudden deaths appeared on field [2,3].
Thus, is essential, that these chronic cardiopathies, frequently asymptomatic or accompanied of few symptoms, be precocious diagnosed, before a person be allowed to practice professional sports. Sportive heart' differential diagnose with cardiopathies, especially, cardiomyopathy, which can lead to sudden death, need a better knowledge of athlete ECG physiological aspects, well known at adults professional sportsmen, especially, males, and less studied for children and teenagers [5, 7].

Clinic manifestations of sportive heart at teenagers

For teenagers' sportive heart, as, for adults' one, is not accepted any sign of functional disorders, thus, any inexplicable decrease of professional performances or cardiac symptomatology during effort or even, during repose (dyspnea, thoracic pains, palpitations, syncope), needs an additional investigation for the detection of a possible cardiac pathology [3, 9].
Moreover, in case of sportive heart, the clinic exam emphasizes a normal blood pressure and a low cardiac frequency. At heart listening, are present II and IV cardiac noises and an ample apex shock.Also, the presence of a systolic functional blow, variable in time, is quite frequently at professional sportive teenagers [9].

Electrocardiographic aspects of sportive heat at teenagers

ECG during repose with 12 derivations (Fig. 1), recorded at sportive teenagers, can present some particularities, which must be interpreted, either in the context of sportsman' age, either as an adaptation of heart to periodic and intense professional training, both, must be differentiated by the characteristic anomalies of a cardiopathy. Numerous studies were made on the same theme for adult athletes, but, the specialty literature is less rich regarding children and teenager athletes.

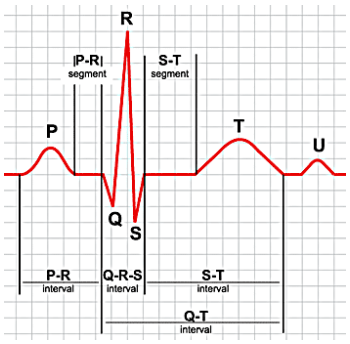

Figure 1. Normal ECG

Repose cardiac frequency

Both for teenagers athletes, as for adult' ones, is frequently observed a sinus bradycardia, defined by a repose cardiac frequency under 60 beats a minute, as a sinus arrhythmia. Sharma et all (1999), in a study performed on 1000 athletes, with ages under 18 years and on 300 sedentary peoples, emphasized the presence of sinus bradycardia, at 80% of sportsmen and at 19% of the sedentary ones. Cardiac frequency decreases with age and is more decreased at boys and athletes which practice endurance sports. Before puberty, the dynamic professional training produces a change of vagal tonus response with more important sinus variability [10].

PR interval

In the specialty literature is frequently described the increase of PR interval duration at teenagers athletes in comparison with the sedentary peoples of the same age. The study performed by Sharma et all (1999) showed a significant difference between PR interval of sportsmen (PR interval =152 ms) and control group one (PR interval =140 ms). The duration of PR interval increases with age and is associated with an increase of vagal tonus. These changes of the autonomous nervous system are responsible equally, for sinus bradycardia and atrioventricular blocks of low degree. The mentioned study reveals the presence of first - degree atrioventricular block at 5,3% of sportsmen, a significant difference, in comparison with the one of sedentary peoples and proves the low presence of atrioventricular block of high degree at the same sportsmen, giving to these anomalies a pathological signification, except for second - degreeatrioventricular blocks, Mobitz 1. The presence of first - degree atrioventricualr block at teenagers athletes is frequently reported[8, 10].

QRS complex

QRS axis

The performed studies did not reported significant differences between sportsmen and non-sportsmen, with the possibility of a right axial deviation presence. There were not meet cases of left axial deviations at healthy sportsmen.

Q wave

The presence of abnormal Q waves (wide and deep), with a duration of 0,04 seconds and an amplitude bigger with 25% than the one of R wave, is suggestive for a cardiopathy, especially the hypertrophic one [10].

Regarding the ORS complex duration, certain studies did not show significant differences between sportsmen and sedentary peoples, while, others (Sharma et all, 1999), pointed an increase of ORS complex duration (93 ms to 88 ms) [8, 10].

On the contrary, the prevalence of incomplete right bundle branch block is much more higher at sportsmen (30%) and can be explained by the increase of right ventricle cavity size, hypothesis sustained by the high frequency of right axial deviations at athletes. Thus, this aspect is considered as a witness of heart adaptation at periodic physical effort [10].

Complete right bundle branch block BRD is rarely at sportsmen, as at sedentary peoples, its diagnosis needs additional investigations, as well as for incomplete or complete left bundle branch block diagnostic, which had not been diagnosed at any healthy athletes, so, having a pathologic feature [10].

ORS complex amplitude

Electric left ventricle hypertrophy is defined most frequently through Lyon Sokolov index, represented by the sum of S wave (V1 derivation) and R wave (V5 derivation) and considered positive, if this sum exceeds 3,5 mV(35 mm), for sedentary people and 45 mm for athletes under 35 years.

Different studies pointed that Lyon Sokolov index is significantly higher at sportsmen in comparison to sedentary people. According to this index, electric left ventricle hypertrophy is much more

frequent at athletes, as was shown by Sharma et all in a study, made on 1710 sportsmen, ageunder 18 years, where its prevalence was of 45%, in comparison with 23% for sedentary peoples. Additionally, the thoracic cage shape and height of athletes, represent factors that can be implied in the increase of ORS complex amplitude(8,10). According to Romhilt Estes score (positive if it is >/= 5), electric left ventricle hypertrophy's prevalence is 0 at sedentary peoples and 10% at sportsmen, that proves the low reliability of Lyon Sokolovindex, for the appreciation of left ventricle hypertrophy, its values must be correlated with electrocardiographic data. These studies showed that only 5% of girls presented left ventricle hypertrophy, using Lyon Sokolov index and none, using Romhilt Estes score.

So, electric left ventricle hypertrophy, is more frequent at male teenagers sportsmen an are, also required other criteria, beside the electrocardiographic ones (especially, electrcardiography), before diagnosis left ventricle hypertrophy [6].

In the mentioned studies, there are no references about the influence of sports disciplines over the electrocardiographic aspects and neither to Cornell index (sum of R wave – aVL derivation + S wave - V3 derivation, is positive, if it is> 20 mm at women and >28 mm at men), which has a higher sensibility than Lyon Sokolov index, for the diagnosis of left ventricle hypertrophy.

QT interval

The recent results regarding OT interval duration and length at teenagers athletes are very different. All studies use the correct value after the Bazzetformulaof OT interval: QTc = QT / √RR, where: QT = QT interval (ms), RR = cardiac frequency/ 60, QTc = QT interval corrected according to cardiac frequency. The maximum admitted physiologic limit at sportsmen under 16 years is 450 ms. At adult, OTc values that overcame 440 ms at men and 460 ms at women are considered abnormal [1, 12].

Thus, certain authors had observed an increase of QTc interval at athletes under 16 years, in comparison to the sedentary peoples of same age (8,10), while, others discovered a shortened QTc interval (406 ms) at athletes and for control group, a value of 421 ms, difference due to vagal hypertony, determined by the professional training.

Besides, QTc values are for most of the cases, normal at sportsmen under 16 years and under 450 ms[8, 10].

However a study performed in 2007, on 2000 athletes with ages between 14-35 years (an average age of 20 years), emphasizedvalues of QTc interval between 460 – 570 ms and a prevalence of 0,4% of the isolated increase of QTc interval, in the absence of family antecedents (congenital long QT syndrome, sudden death or syncope). This study concludes, that QTc values over 500 mshave pathological significance, imposing additional investigations, in order to discover a possible congenital long QT syndrome, while, high values of QTc, but, under 500 ms, have unclear pathological significance at teenagers sportsmen, being correlated to a low probability of the presence of some affections [1].

Reversed T waves

Are defined by the presence of negative T waves, with an amplitude of at least 0,2 mv, for at least 2 derivations. Are named profound, when their amplitude measures over 0,2 mv.

This electric aspect is difficult to be interpreted, because these waves can be met on ECG line at teenagers or at sportive heart, but, can reveal, in the same time, a cardiomyopathy, especially a hypertrophic one or an arrhythmogenic right ventricularcardiomyopathy. Prevalence of this atypia at sportive adult is of 3-4 % (8). According to recent studies, this prevalence is not significantly different at teenagers.The study made by Sharma et al (2009), on 1710 sportsmen, with ages between 14-18 years, mostly, males, Caucasian type, revealed:

-The physiologic and common feature of negative T waves in V1, V2, V3 derivations, at sportsmen under 16 years is an aspect connected more to the age, than physical training [8].

- The rare and suggestive aspect of negative, profound T waves for cardiomyopthy, whatever are the derivation and age of athlete.

Negative and profound T waves' prevalence is significantly higher at adults than teenagers, difference correlated to a bigger level of physical maturity and to a longer period of exposure to an intense professional training of adult sportsmen.

Regarding the presence of T waves, were not recorded significant differencesdepending on age, sex and type of practiced sports.

The results of this study performed on an important sample of teenagers' sportsmen, 17 % females, are in concordance to the ones from other studies [8].

ST segment depression

The specialty literature never presented any healthy athlete with ST segment depression, so, its presence imposes the research of a cardiomyopathy, in particular, of the hypertrophic cardiomyopathy [3, 10].

Early repolarization syndrome

Is defined as the association of a ST segment elevation with positive T waves, for at least 2 adjacent precordial derivations. Is frequently meet at teenagers sportsmen [4].

The specialty studies made on teenagers had revealed a high frequency of ST segment elevation at sportsmen, associated with positive and ample T waves [4].

Conclusions

On teenager sportsmen' ECG line are present: sinus bradycardia, first - degree atrioventricular block, incomplete right bundle branch block, isolated, a Sokolov Lyon index, over 35 mV and an early repolarization syndrome.

All the others unusual and abnormal aspects are not characteristic to sportive heart and impose additional investigations, in order to exclude a possible cardiomyopathy.

All these elements, well known and classic for adults, presented, instead, certain limits for teenagers, because there are few studies, about this subject, performed, especially, on Caucasian teenagers, most of them, males [6].

The influence of practiced sportive discipline over these changes is less studied.

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Author contribution

All authors have contributed equally to this article.