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Electrocardiographic and Blood Electrolytes Findings in Athletic Students of Sports Academy in Bangladesh

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Abstract

Regular intensive exercise and training may cause structural and functional changes in the heart and also in their electrolyte level. We conducted a case control study among 50 athletic students of 20-30 years old enrolled from a renowned sport academy of Bangladesh named Bangladesh Krira Shikkha Protisthan (BKSP). 50 age-matched healthy non-athlete men were selected as controls. Electrocardiograph was recorded by Bionet Cardiocare-2000 (EKG-2000). Serum sodium, potassium and chloride levels were measured by The Beckman Coulter AU auto-analyzer, and serum bicarbonate level was measured by Dimension. Data were collected during the colder part of the year. In this study, heart rate was significantly ($p<0.001$) decreased and QRS duration was significantly ($p<0.05$) prolonged in study group than that of control group. Also, Serum sodium and Serum chloride level were lower and Serum potassium level was higher in study group than that of control group, which were statistically non-significant. These findings support other researchers conducted in different countries worldwide. Therefore routine screening of athlete's will provide information regarding their physiologic adaptation to exercise and also helpful to measure water and electrolyte requirement before going for training session and match play.

Keywords: Electrocardiograph; Electrolytes; Football; Athletes; Sports; Bangladesh

Introduction

Athletes require regular intensive exercise and training, responsible for structural and functional changes in their hearts, which are reflected on electrocardiogram (ECG) findings [1]. The changes may include elevated QRS voltage, QRS axis shifts, ST-T wave changes that are consistent with early repolarization, bradyarrhythmias, first-degree and Mobitz type-1 atrioventricular block and inverted T-waves [2]. The most common finding in athlete's ECG is sinus bradycardia with resting heart rate as low as 40 beats per minute. Also trained athletes show following alterations of their 12-lead ECG. The alterations are increase in R or S wave voltages, ST-segment elevation, T-wave changes (either tall, flattened or frankly inverted), and deep Q waves [3].

There are some postulated mechanisms suggested by various researchers which imply the possible mechanism regarding these changes. Regular physical training and exercise cause physiological adaptation of the cardiac autonomic nervous system such as increased vagal tone and/or withdrawal of sympathetic activity. Increased vagal tone and decreased sympathetic activity result into bradycardia and prolongation of QRS duration. In athletes the SA node and AV node are suppressed by an increase in vagal tone, which causes their heart rate to decrease and give rise to bradycardia [3]. Again, increased vagal activity causes prolongation of QRS duration, which may give rise to left ventricular hypertrophy [4].

Furthermore the athlete's heart is considerably stronger than that of a normal person, which allows the athlete's heart to pump a larger stroke volume even during periods of rest. Excessive quantities of blood pumped into their arterial tree with each beat and initiate feedback circulatory reflexes or other effects to cause bradycardia [5]. Prolonged workout results into an increase in stroke volume both at rest and during exercise. Stroke volume raises as a result of increased end diastolic volume (EDV) and sympathetic reduction of end systolic volume (ESV). Increased stroke volume causes the heart rate to decrease even at rest [6].

However ECG changes in trained athletes can be divided into two groups, common and training-related; uncommon and training-unrelated. Common and training related ECG changes are sinus bradycardia, atrioventricular block and early repolarization. Uncommon and training unrelated changes includes ST-T repolarization changes, pathological Q waves, intraventricular conduction defects, ventricular pre-excitation, long and short QT interval [7].

Athletes had a higher prevalence of sinus bradycardia (80%) and sinus arrhythmia (52%) than non-athletes. The PR interval, QRS and QT duration were more prolonged in athletes than non-athletes [1]. However the prevalence of ECG changes among young Southeast Asian population was 7.0%. Most sports related ECG researches were done on endurance athletes such as long distance runners, basketball players, skiers etc. A few studies were conducted on football athletes measuring their ECG and electrolyte levels. Therefore changes in ECG and electrolyte levels in football athletes are mostly unknown [8]. Football is a team sports and football players undergo similar kind of exercise during their training session and match play. Nevertheless players show individual variability in their electrolyte levels though they are having similar training session or match play. Hence individual screening is necessary to determine water and electrolyte requirement of individual athlete [9,10]. Due to unavailability of sufficient published data the change among this parameter in Bangladeshi athletes is not precisely

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known. Furthermore, we need our standard baseline from which we can compare this parameter in our population. Therefore the present study was designed to observe the ECG and serum electrolyte levels in male football athletes of Bangladesh.

Methods

The research used cross-sectional study design, conducted by Department of Physiology, Dhaka Medical College on November 2013. Ethical permission was obtained from the ethical committee of DMC. Fifty (50) male football athletes (age limit 20 to 30 years) with experience of playing matches for more than 3years were considered as study group, and fifty (50) apparently healthy age matched men were enrolled as control group for comparison. After selection of the subjects, the purpose and procedure of the study were explained to each subject and informed written consent was taken. They were allowed to withdraw their participation in choice. Detailed family and medical history, and physical examinations were done before recruitment.

Data collection

They were allowed to rest for 1 hour before electrocardiography was done. And with all aseptic precaution, 5 ml of venous blood was collected from ante-cubital vein by a disposable plastic syringe from each subject for estimation of serum electrolytes. The blood was centrifuged at a rate of 3000 rpm for 15 minutes. After that supernatant serum was collected in labeled eppendorf tube and preserved in a refrigerator at -20°C until analytical measurement of serum electrolyte levels were done.

Anthropometric measurements of the subjects were recorded in a pre-designed data collection form.

Height (meter): Standing height was measured using with soft non elastic measuring tape. The subject was positioned fully erect and measurement started from back of the head, thoracic spine along the trunk, buttocks and touched the heels by keeping the heels together. Height was recorded in meter.

Weight (kg): A standard weight measuring device was placed on a hard flat surface and checked for zero balance before measurement. The subjects were in the center of the platform wearing light cloths without shoes. Weight was recorded in kilogram.

Body mass index (BMI) kg/m^2: BMI of each subject was calculated from the measured weight and height, using standard formula of BMI.

BMI=Weight (kg)/Height (m^2)

Measurement of blood pressure

Blood pressure was recorded from right upper arm in sitting position, placing the calf at the level of the heart, using the standard sphygmomanometer by auscultator method. After 10 minutes of rest, a second reading was taken. Blood pressure was measured in mm Hg.

Study parameters

1. Electrocardiogram

- Heart rate
- P wave
- QRS duration
- PR interval

2. Serum electrolytes

- Sodium
- Potassium
- Chloride
- Bicarbonate

Laboratory investigations

- ECG recording was done by Bionet Cardiocare-2000(EKG-2000), from Seoul, Korea.

- Serum sodium, potassium and chloride were measured by Ion Selective Electrode (ISE) method in the Beckman Coulter AU auto-analyzer and serum bicarbonate was measured by Dimension ®.

Statistical analysis

All the parameters were expressed as Mean ± SD (standard deviation). Comparison between the groups was done by unpaired Student's 't' test. Pearson's correlation-coefficient (r) test was performed to compare relationship between study parameters. P value of < 0.05 was accepted as level of significance. Statistical analysis was performed by using a computer based statistical program IBM SPSS Version 21.

Results

The mean (±SD) age of the study and control group were 22.76 ± 1.91 and 21.64 ± 1.29 years respectively. The mean (±SD) height of the study and control group were 1.69 ± 0.05 and 1.68 ± 0.06 meter respectively. The mean (±SD) resting SBP was 112.5 ± 7.43 mm of Hg in group A and 110.85 ± 9.56 mm of Hg in group B. And the mean (±SD) resting DBP was 71.4 ± 6.67 mm of Hg in group A and 71.3 ± 7.61 mm of Hg in group B. In this study, there was no significant difference in the mean SBP and DBP in two groups (Table 1).

The mean (±SD) BMI was 23.31 ± 32 kg/m^2 and 25.76 ± 3.29 kg/m^2 in group A and B respectively.

The mean (±SD) P wave duration was 0.15 ± 0.02sec and 0.11 ± 0.01sec in-group A and B respectively. The mean (±SD) PR interval was 0.19 ± 0.15 and 0.15 ± 0.02 sec in-group A and B respectively. The mean (±SD) serum sodium was 139.40 ± 2.47 and 138.60 ± 5.04 mmol/L in-group A and B respectively. The mean (±SD) serum bicarbonate was 30.48 ± 1.68 and 26.98 ± 4.57 mmol/L in-group A and B respectively.

Among the total 50 study subjects, BMI ranging between 25-30 kg/m^2 was found in 44 (88.0%) subjects and BMI > 30 kg/m^2 was found in 6 (12.0%) subjects, heart rate <60 beats/min was found in 24 (48.0%) subjects and heart rate > 60 beats/min was found in 26 (52.0%) subjects (Table 2).

P wave <0.10 sec was found in 1 (2.0%) subjects and P wave >0.10 sec was found in 49 (98.0%) subjects. PR interval <0.12 sec was found in 37 (74.0%) subjects and PR interval >0.12sec was found in 13 (26.0%) subjects. among the total 50 study subjects, serum chloride level was found <98 mmol/L in 22 (44.0%) subjects and 98-108 mmol/L was found in 28 (56.0%) subjects.

Pearson's correlation coefficient (r) test was performed to compare relationship between BMI and different parameters. The test of significance was calculated and p value <0.05 was accepted as level of significance. Heart rate showed positive correlation (r=+0.113) with BMI, which did not show statistically significant association and QRS duration showed positive correlation (r=+0.167) with BMI, which did not show statistically significant association. Serum sodium level showed positive correlation (r=+0.048) with P wave duration. The

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Parameters	Healthy male subjects Group A (n=50)	Male football athletes Group B (n=50)
Age (years)	21.64 ± 1.29 (24.0-24.0)	22.76 ± 1.91 (20.0-27.0)
Height (m)	1.68 ± 0.06 (1.57-1.87)	1.69 ± 0.05 (1.57-1.82)
Weight (kg)	54.80 ± 7.44 (35.0-72.0)	61.14 ± 8.81 (45.0-85.0)
SBP (mm of Hg)	112.50 ± 7.43 (90-120)	110.85 ± 9.56 (90-130)
DBP (mm of Hg)	71.40 ± 6.67 (60-80)	71.30 ± 7.61(60-90)
BMI (kg/m²) ECG	23.31 ± 32(18.0-29.5)	25.76 ± 3.29 (21.22-34.69)
Heart rate (beats/min)	75.56 ± 10.43(58.0-105.0)	62.38 ± 10.81(44.0-88.0)
P wave (sec)	0.15 ± 0.02 (0.10-0.20)	0.11 ± 0.01(0.08-0.13)
QRS duration (sec)	0.09 ± 0.01(0.06-0.13)	0.11 ± 0.01(0.08-0.11)
PR interval (sec)	0.19 ± 0.15(0.10-0.98)	0.15 ± 0.02(0.13-0.17)
Serum Electrolytes		
Sodium	139.40 ± 2.47(137.0-154.0)	138.60 ± 5.04(121.0-146.0)
Potassium	4.26 ± 0.39(3.60-5.30)	4.19 ± 0.77(2.40-5.80)
Chloride	102.92 ± 5.64(84.0-115.0)	101.54 ± 2.34(98.0-115.0)
Bicarbonate	30.48 ± 1.68(27.0-34.0)	26.98 ± 4.57 (14.0-35.0)

Table 1: General characteristics and parameters of respondents from both groups.

Parameters		Group B (n=50)	
		Frequency	Percentage (%)
BMI	25-30kg/m²	44	88.0
ECG	>30kg/m²	6	12.0
Heart rate	<60 beats/min	24	48.0
	>60 beats/min	26	52.0
P wave	<0.10 sec	1	2.0
	>0.10 sec	49	98.0
QRS duration	<0.10 sec	45	90.0
	>0.10 sec	5	10.0
PR interval	>0.12 sec	13	26.0
	<0.12 sec	37	74.0
Serum Electrolytes			
Sodium	<138mmol/L	37	74.0
	138-14mmol/L	13	26.0
Potassium	<3.5 mmol/L	22	44.0
	3.5-4.2 mmol/L	28	56.0
Chloride	<98 mmol/L	22	44.0
	98-108 mmol/L	28	56.0
Bicarbonate	<23 mmol/L	30	60.0
	23-28 mmol/L	20	40.0

Table 2: Distribution of parameters in study groups.

relationship was statistically non-significant (Table 3).

Serum potassium level showed negative correlation (r=-0.105) with P wave duration. The relationship was statistically non-significant. Serum chloride level showed positive correlation (r=+0.066) with P wave duration. The relationship was statistically non-significant. Serum bicarbonate level showed positive correlation (r=+0.050) with P wave duration. The relationship was statistically non-significant. Serum sodium level showed negative correlation (r=-0.123) with QRS duration. The relationship was statistically non-significant. Serum potassium level showed positive correlation (r=+0.119) with QRS duration. The relationship was statistically non-significant. Serum chloride level showed negative correlation (r=-0.199) with QRS

BMI	Group B (n=50)	
	r	p
Heart rate	+0.113	0.435
QRS duration	+0.167	0.247
P wave		
Sodium	+0.048	0.740
Potassium	-0.105	0.468
Chloride	+0.066	0.648
Bicarbonate	+0.050	0.731
QRS duration		
Sodium	-0.123	0.396
Potassium	+0.119	0.410
Chloride	-0.199	0.166
Bicarbonate	+0.045	0.755
PR interval		
Sodium	+0.040	0.780
Potassium	-0.240	0.093
Chloride	-0.053	0.714
Bicarbonate	+0.242	0.090

Table 3: Correlation Analysis

duration. The relationship was statistically non-significant. Serum bicarbonate level showed positive correlation (r=+0.045) with QRS duration. The relationship was statistically non-significant. Serum sodium level showed positive correlation (r=+0.040) with PR interval. The relationship was statistically non-significant. Serum potassium level showed negative correlation (r=-0.240) with PR interval. The relationship was statistically non-significant. Serum chloride level showed negative correlation (r=-0.053) with PR interval. The relationship was statistically non-significant. Serum bicarbonate level showed positive correlation (r=+0.242) with PR interval. The relationship was statistically non-significant.

Discussion

The present study was conducted to observe the electrocardiogram and serum electrolyte levels changes among male football athletes in Bangladesh. In this study, all the parameters of healthy male were within reference value and almost similar to the findings observed by the various investigators from different countries [1,5,11-24]. The mean BMI was higher among cases than that of controls, and the result was statistically significant (p<0.001). This finding supports other study results from different countries [5,16].The mean heart rate was found lower among athletes which was statistically significant (p<0.001). This finding was in agreement with many researchers of different countries [1,5,10,17,18].

The mean P wave duration was significantly (p<0.001) lower in male football athletes than that of healthy male subjects. Similar type of observations was found by some researchers [3,15].But no research has found any significant changes in P wave duration in athletes [2,14]. The mean QRS duration was significantly (p<0.001) higher among athletes. This finding was supported by other studies from different countries [3,14-17]. The mean PR interval was found shorter which was statistically non-significant. Similar type of observations was found by some researchers [15]. However some researchers found prolonged PR interval in athletes [1,16-18]. In this study, mean serum sodium, potassium, and chloride level were found statistically non-significant.

Similar types of observations were found by some researchers [19,22-24]. However the mean serum bicarbonate level was lower, which was statistically significant (p<0.001). Similar type of observations was found by some researchers [19,23,24]. Serum sodium and chloride level decreased in athletes, as they loss sodium and chloride by excessive sweating. Sodium chloride loss associated with net dehydration may lead to observed hyponatraemia [23]. Loss of sodium leads to volume depletion, which causes release of antidiuretic hormone (ADH). ADH stimulates water reabsorption by kidney, so blood sodium becomes diluted and further hyponatraemia occurs. Potassium is the primary electrolyte in body, stored in muscle fibers along with glycogen. Athletes undergo intense exercise and training. Glycogen breaks down to supply energy during their exercise and muscle cells are depleted of potassium. As a result there is greater concentration of potassium in their blood. Serum potassium level increases during exercise thought to be due to shift of potassium from the intracellular to the extracellular space.

In view of our results, and in agreement with earlier publications, we should consider screening athletes for preventing sudden death during heavy training. Our results demonstrate the ECG and serum electrolytes are useful, accessible weapon in basic pre-participation sports screening. Electrocardiographic analysis only enables the detection of other potentially lethal conditions. Since physical exercise is considered as a healthy life style, we should ensure the safety practices by promoting prior screening requirements.

Conflict of Interest and Funding

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