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A Comparative Study of Electrocardiographic Changes and Blood Glucose Level in Athletes and Non-Athletes

Dutta Nandita[1], Dutta Choudhury Biju[2], Nath Neena[3], Saikia Anku Moni[4]

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ABSTRACT

Regular physical exercise prevents the occurrence of cardiovascular and metabolic diseases, halts their progress and also decreases their intensity. It is very much important to study the cardiac changes and glyacemic status of an athlete, who enjoys the extreme height of physical fitness, and non-athlete. This study was done to see the physiological adaptive electrical cardiac changes and blood glucose level of athletes and compare the changes with non-athlete individuals. A total of 100 male athletes of Sports Authority of India, Guwahati and 100-age match male control that were non-athletes were studied. 12-lead resting E.C.G. was recorded using a BPL-CARDIART 108-DIGI electrograph and post-absorptive blood glucose level is estimated by glucose oxidase/peroxidase (GOD/POD) colorimetric method of Tinder. The significance of the difference of the mean was calculated by Student t-test. In this study, bradycardia and early repolarization is found to be more in athletes (27% and 24%) in comparison to non-athletes (0% and 12%) respectively. Significant difference noted in heart rate (66.55±11.40/sec Vs.80.64±12.35/sec); PR-interval (0.1502±0.027/sec. Vs. 0.1356±0.019sec); and QRS amplitude (33.87±5.68mm) vs. (26.98±4.85mm). Athletes showed significantly (92.42±9.75mg/dl Vs. 96.53±16.46mg/dl) better glycaemic status than the non-athlete group. Regular physical training cause asymptomatic physiological adaptive cardiac changes and it also helps to maintain better glycaemic status.

Keywords*: Physical training, cardiac electrical activity, glycaemic status, sedentary person, adaptation change*

INTRODUCTION

In recent years physical exercise has gained prime importance in public life for enormous health benefits. Athletes do regular exercise to increase their endurance capacity and to delay fatigability. The stress of training they undergo affect their bodily mechanism to the ultimate limit which results in adaptive changes in cardiovascular function. A normal untrained person can increase cardiac output a little over four fold; while a well-trained athlete can increase output about six fold thereby increasing the cardiac reserve. Training causes cardiac muscle hypertrophy and increase in pumping effect of heart by 40-50% per beat in athlete than in untrained person, but there is corresponding decrease in heart rate at rest.[1]

E.C.G. is an acknowledged sensitive screening tool to gather information of heart rate and rhythm, abnormalities of conduction, muscular damage and hypertrophic changes of the heart. The cardiac adaptation induced in an athlete by physical training is reflected in athlete's

Address for correspondence and reprint:
[1]Assistant Professor
Dept. of Physiology, Gauhati Medical College, Assam
Email: ndnanditadutta@gmail.com
Mobile: 09864065763
[2]Professor, Dept. of Physiology, Gauhati Medical College Assam
[3]Associate Professor, Dept. of Medicine, Tezpur Medical College
[4]Associate Professor, Dept. of Community Medicine Gauhati Medical College

electrocardiographic finding. The physiological E.C.G. changes normally seen in athletes should be distinguished from pathological hypertrophic cardiomyopathies, which is a common cause of sudden cardiac death in young athlete,[2] before subjecting person to unnecessary further investigations. In addition to cardiac reserve, athlete also require energy during event and exercise. This energy is supplied mainly by carbohydrate diet. Increased levels of muscle glycogen and blood glucose level gives them more energy to perform well during event.[3]

Increased mobilization of glycogen to glucose does not alter the blood glucose level in athlete as regular exercise reduce insulin resistance, improves tissue sensitivity to insulin and glucose tolerance. Exercise also increase the number of insulin receptors and promotes activity of glucose transporters.[4] All these factors help to have a better control on blood glucose level. As there are very limited studies in the N-E region of India, the present study was undertaken with the objectives of studying the E.C.G. changes and blood glucose level in athletes and compares them with non-athletes.

MATERIAL AND METHOD

This cross sectional study was carried out among the athletes of the Sports Authority of India (SAI), Guwahati and an equal number of age matched non-athletes were taken as control. The study duration was from 1st January to 31st December 2010. The study subjects were briefed about the procedure and informed consent was obtained from each participant. 100 male athletes between the age group of 15-25 years were taken among the boarders of S.A.I. hostel who were actively involved in sports activity for last 3-5 years and also perform regular exercise two times a day and six days a week. For control male non-athletes matched for age, height and weight were taken.

Exclusion Criteria: Cases with history or symptoms of any cardio-vascular disorder, known diabetic and obese person were excluded from the study.

Both the groups were subjected to ECG and random blood glucose estimation. The ECG was done at resting condition in the morning hours, which were 24-48 hours after last physical exercise in athlete group and 3-4 hours after any meal. For control also ECG was done at resting condition in the morning hours and 3-4 hours after any meal. E.C.G. recording was done using a BPL CARDIART 108-DIGI electrograph with BPL ECG paper. The ECG room was comfortably warm and the subject was made to lie supine on a non-metallic examination table. The procedure was explained in advance to allay any apprehension to make him relax. Any external metallic object, electrical circuits and other electronic equipment were kept away from the subject so as to avoid interference to prevent artifacts. The parameters of ECG that were studied: Heart rate (from RR interval), P wave amplitude and duration, PR interval, QRS complex-amplitude and duration, ST segment, T wave changes, QT interval and mean axis of the standard leads.

After recording ECG, 2 ml of venous blood was collected under all aseptic and antiseptic precaution in a sodium fluoride vial from both the groups for random blood sugar (RBS) estimation. It was carried out in the dept. of Physiology, Gauhati Medical College. After keeping the samples undisturbed for 30-40 minutes the supernatant plasma was separated and centrifuged for 3 min at 3000 rpm. Glucose was then estimated in each serum sample by glucose oxidase/peroxidase (GOD/POD) colorimetric method of Tinder using the glucose kit, CREST BIOSYSTEMS, a division of Coral Clinical System, Goa. Using Mean, standard deviation and student t-test did statistical analysis.

RESULT

Figure 1 Represents the different types of sports the athletes are involved with.

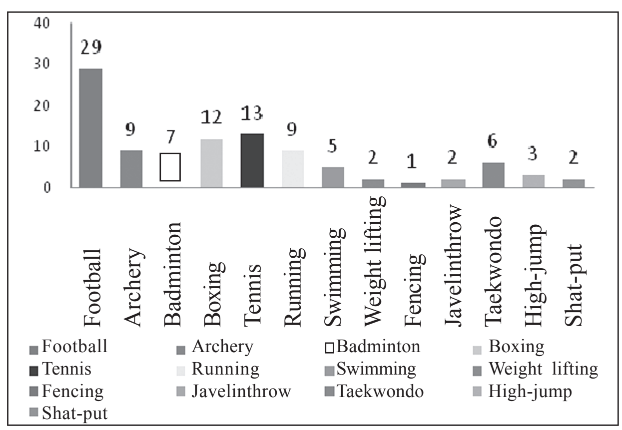

Figure 1 Distribution of Athletes Group according to types of Sports

In **Table 1**, physiological parameters like pulse rate, biochemical test of random blood glucose level and systolic and diastolic blood pressure in athletes and non-athletes were depicted and comparison was made in the two groups. The results showed that athletes had a significant lower mean value of RBS than the non-athletes group [99.42vs 96.53 with p value –0.0328]. Pulse rate was significantly lower in athlete group [66.43vs79.76 with p value <0.0001] but no significant differences were found in systolic and diastolic blood pressure of both the group.

Table 1 Mean distribution of different parameters among the athletes and non-athletes and their 't' value

PARAMETERS	MEAN±SD		t- value (p-value)	Significance at 0.05 level
	ATHLETES (n=100)	NON-ATHLETES (n=100)		
Pulse Rate (Beats/min)	66.43±11.28	79.76±11.83	8.18 (0.0001)	Significant (p<0.05)
Blood Glucose (mg/dl)	92.42±9.75	96.53±16.46	2.15 (0.0328)	Significant (p<0.05)
B.P. (mmHg)	118.86±8.55	21.16±10.99	1.65	Not Significant (p>0.05)
-Systolic - Diastolic	75.42±7.01	176.16±6.12	0.79	Not Significant (p>0.05)

Table 2 Comparison of mean values of ECG parameters among the athletes and non-athletes

ECG Parameters	Athlete (n=100) (Mean±SD)	Non-athlete (n=100) (Mean±SD)	t-value	Significant at 0.05 level	P-value
Heart Rate (Beats/min)	66.55±11.40	80.64±12.35	8.38	Significant (p<0.05)	< 0.0001
PR interval (sec)	0.1502±0.027	0.1356±0.019	4.42	Significant (p<0.05)	< 0.0001
RR interval(msec)	91.44±17.24	75.90±11.05	7.59	Significant (p<0.05)	< 0.0001
P-wave ● Duration(sec) ● Amplitude (mV)	 0.08±0.005 0.14±0.04	 0.08±0.006 0.14±0.04	 --- ---	 NS NS	
QRS Complex ● Duration(sec) ● Amplitude (mm)	 0.09±0.009 33.87±5.68	 0.09±0.009 26.98±4.85	 --- 9.22	 NS Significant (p<0.05)	 < 0.0001
QT interval (sec)	0.39±0.02	0.36±0.02	---	NS	

In the **Table 2**, electrocardiographic parameter showed significant lower heart rate (p<0.0001) in the athlete group, whereas PR interval, RR interval and amplitude of QRS complex are significantly (p< 0.0001) higher in athlete group in comparation to non-athlete group. No significant difference was noted (p> 0.05) in P-wave, QRS duration and QT interval among the two groups.

Table 3 Distribution of respondents according to bradycardia, early repolarization, A-V block and axis deviation

Group	Bradycardia	Early repolarization	1^0 A-V block	RBBB with right axis deviation
Athletes	27%	24%	2%	2%
Non-athletes	0%	12%	0	0

Table 3 depicts that 27% from athlete group showed bradycardia and 2% showed 1^0 atrio-ventricular blocks respectively. Incomplete RBBB with right axis deviation was also found among 2% of athlete; whereas neither of them was present among non-athletes group. Incidence of early repolarization is more in athlete group than in the non-athlete group.

Again in the present study, it was noted that 27% of the athletes' ECG showed isolated QRS voltage criteria for LVH and 4% of the non-athlete also has LVH according to voltage criteria which may be found in young person.

DISCUSSION

Trained athletes commonly show electrocardiographic changes such as sinus bradycardia, 1^0 atrioventricular block and early repolarization, which result from physiological adaptation of cardiac autonomic nervous system to athletic conditioning. Trained athletes often exhibit pure voltage criteria for left ventricular hypertrophy that reflect the physiological ventricular remodeling with increase ventricular wall thickness and chamber size,[5] termed as "athletic heart". Resting sinus bradycardia is common in athlete depending on the type of sports and the level of training. It is easily overcome with exercise, suggesting high vagal tone which causes slowing of the sino-atrial node. However, it is noteworthy that chemically denervated hearts in athletes have significantly lower intrinsic heart rates than those of sedentary control, which suggests that sinus pacemaker cells are influenced by athletic conditioning independent of neural input.[6] Various studies done previously on athlete's cardiac activity on E.C.G. showed similar findings as the present study. A. Lawan and Coworkern[7] noted bradycardia, 1p A-V block and ventricular hypertrophy in 150 athlete[10] in their study. R.J. Northcole et al[8] in another study got profound bradycardia and heart block pattern. Similarly, N. Hanne

Paparo et al[9-11] found that the most common E.C.G. finding in trained athletes were sinus bradycardia, A-V conduction disturbances, left and right ventricular hypertrophy and various disturbances of the repolarization phase.

First degree and Morbitz type I second degree atrio-ventricular block are also frequently encountered in trained athlete being present in 35% and 10% respectively.[12] As with sinus bradycardia, atrio-ventricular slowing and block are mediated by increase parasympathetic tone and/or decrease sympathetic tone.

Intensive athletic conditioning is associated with morphological cardiac changes, including increase cavity dimensions, wall thickness and ventricular mass, which are reflected on the 12-lead electrocardiogram.[13] Physiological LVH usually manifests as an isolated increase of QRS amplitude with normal QRS axis, atrial and ventricular activation patterns, normal ST segment and T wave repolarization.[14, 15]

In the present study, using Sokolov and Lyon criteria we got the incidence of LVH 27% and 4% in athlete and non-athlete respectively. Several studies have reported a high incidence of athlete's ECG that fulfill electrocardiographic left ventricular hypertrophy if the criteria of Sokolow and Lyon are used, i.e., S in V1 + R in V5/ V6> 35 mm, or R>27 mm in V5/V6.[16] Non voltage ECG criteria for LVH like atrial enlargement, left axis deviation and a 'strain' pattern of repolarization, which are incorporated into Romhilt-Estes point score system, are usually not seen in athletes.[15] These ECG abnormalities raise suspicion for underlying cardiac pathology.

The present study found 2% RBBB among athletes. Incomplete RBBB is more often noted in athletes engaged in endurance sports and it has been suggested that the right ventricular conduction delay is not within the specialized conduction system, but is caused by the enlarged right ventricular cavity size and/or increased cardiac muscle mass and the resultant increase conduction time.[17] The present finding of 24% early repolarization among athletes could be considered as physiological. This reflects the development of a training related hypervagotonia in athletes. Early repolarization is a benign ECG pattern in the general population of young people and more specifically among highly trained athletes in resting ECG.[18]

These adaptational electrocardiographical abnormalities are reversible phenomenon which reduces or disappears with deconditioning[19] and should be clearly separated from uncommon and training unrelated ECG patterns, like ST-T repolarization abnormalities, pathological Q wave, left axis deviation, intraventricular conduction defects, ventricular pre-excitation, long and short QT interval and Brugada like repolarization changes which may be the expression of underlying cardiovascular disorders, notably inherited hypertrophic cardiomyopathies or ion-channel diseases which may predispose to sudden cardiac death. In this study, the mean blood sugar level was found to be 92.42±9.75 mg/dl in athletes; while it was 96.53±16.46 mg/dl among the non-athletes. Though not much difference was observed, the random blood glucose level in our study showed that it was slightly lower in the athlete group than in the non-athlete group ($p<0.05$). Sedentary persons are more prone for obesity and central fat deposition, which are strong predictors of insulin resistance.[20] Several training studies have demonstrated that regular aerobic exercise leads to enhance insulin sensitivity in previously sedentary person. The cumulative effects of exercise training to enhance insulin sensitivity are markedly different from the effect of single bout of exercise to enhance insulin sensitivity as long term exercise program is associated with improved insulin action at whole body and tissue level.[21] S.Nayak etal[22] observed better glucose tolerance in athlete than in non-athlete control group. R.E. Frisch et al[23] studying the prevalence rate of diabetes among athlete and non-athlete reported it was 0.5% in athlete and 1.3% in non-athlete.

The extent of cardiac morphological and electrical changes in trained athletes varies with the athlete's gender, race, level of fitness and type of sports[24] in which field further study is necessary. Regarding glycaemic control effect of regular exercise, a longitudinal study over longer period might have been more specific. But cross sectional random blood glucose level is acceptable as shown in the study done by Gill, Hardy et al[25] as done in present study.

CONCLUSION

This present study led to the conclusion that in trained athletes ECG findings are consistent with remodeling of cardiovascular system. But findings of pathological heart disease should be investigated by further specialized tests. By doing regular exercise, which improves insulin sensitivity and lower insulin resistance, the development of type II diabetes can be checked and a healthy life can be assured.

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Ethical clearance: Taken.

Conflict of Interest: None.

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