Study on heart rate variability in adolescent male athletes by time domain (Short-Term) method

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Abstract

Background: Cardiac Autonomic Nervous Activities (CANA) deteriorates with age, obesity, sedentary life style and in various cardiac and noncardiac disease conditions. Regular physical exercise may improve CANA in health and diseases. Analysis of Heart Rate Variability (HRV) by time domain method is one of the most promising newer techniques to quantify CANA. Hypothesis: Regular physical exercise improves cardiac autonomic nervous activities. Objective: To observe the HRV parameters by time domain method, in male adolescent athletes in order to find out the influence of regular physical exercise on CANA. Method: The cross sectional study was carried out on 62 adolescent male athletes aged 12-18 years (group B), in the Department of Physiology, Bangabandhu Sheikh Mujib Medical University from 1st July 2007 to 30th June 2008. For comparison 30 age, sex and socioeconomic condition matched apparently healthy sedentary subjects (group A) were also studied. The study group was selected from the BKSP (Bangladesh Krira Shikka Prothistan, Savar, Dhaka) and the control from a residential Madrasha (sedentary life style) of Dhaka city. HRV parameters were assessed by Polygraph (Polyrite D, version 2.2). For statistical analysis Independent-Samples t-test was done as applicable. Results: Mean R-R interval and SDNN were significantly (P<0.001) higher in athletes than those of nonathletes. Resting mean heart rate was significantly (P<0.001) lower in the athletes. Conclusion: Regular physical exercise improves cardiac autonomic nervous activities and lower resting heart rate.

Key words

CANA, HRV, athletes

Introduction

The cardiac autonomic nervous activities deteriorate in health and various cardiac and non-cardiac disease conditions. Regular physical exercise may be a nonpharmacological, easy, safe and economic tool to improve the cardiac autonomic nervous activities in health and diseases. Analysis of heart rate variability (HRV) by time domain method is one of the most promising newer techniques to quantify cardiac autonomic nervous activities.

In healthy individual, HRV declines (CANA deteriorates) with age and sedentary life style. HRV also declines in several cardiac and non-cardiac disease conditions like Myocardial Infarction, Heart Failure, Hypertension, Cardiomyopathy, after heart transplant, Ventricular Arrhythmias, conditions lead to cardiac arrest or sudden death, obesity, diabetes, and chronically undernourished person.

Regular physical exercise improves CANA in healthy individuals. This improvement of
CANA was also observed in disease conditions like in Myocardial Infarction, Coronary artery disease, Heart failure, Obesity, type 2 Diabetes, Renal disease.

Though, it was evident that regular physical exercise improves CANA in health and diseases by large number of studies; yet, a few group of investigators, failed to prove that improvement in healthy individuals. Again, some other group of investigators showed that physical exercise does not improve, even in some cases deteriorates CANA in disease conditions. Thus, the influence of physical exercise on CANA remains still controversial.

Analysis of HRV by time domain method to quantify CANA has now become popular world-wide because it is independent, non-invasive, accurate, could be easily available and in some extent detailed informative. In time domain method standard deviation of the normal-to-normal (NN) intervals (that is intervals between adjacent QRS complexes resulting from the sinus node depolarizations) that is SDNN indicate the global variability that is the total change in the CANA. A higher value of SDNN indicates increased and a lower value indicates reduced HRV or CANA.

In Bangladesh, the number of patients with Diabetes, Cardiac diseases and Renal failure are increasing day by day. Again, a large number of people in our country may found to be affected from Autonomic Nerve Dysfunction due to under or over nutrition. In addition, due to rapid urbanization and mechanization of life, sedentary life style may affect CANA in all age groups. Therefore, people should be aware of the adverse effect of sedentary life and also about the usefulness of physical exercise as a preventive and prognostic measure.

Though, in our country, several studies were done to assess the CANA in Diabetes, aging and obesity by conventional method; but, no study was undertaken to document the changes of HRV as a result of physical exercise by microcomputer based time domain method.

Therefore, this study was carried out to evaluate the CANA, by analysis of HRV by time domain method, in healthy adolescent male athletes who perform regular physical exercise and also in healthy adolescent male with sedentary life style.

Methods
This cross-sectional study was carried out in the department of physiology of Bangabandhu Sheikh Mujib Medical University from July 2007 to June 2008. Departmental Ethical Committee approved the protocol.

Total 92 apparently healthy male adolescents age ranged from 12-18 years were selected, of whom 30 were non-athletes sedentary taken as control (Group A) and 62 were athletes selected as experimental (Group B). Control (Group A) was selected from a Madrasha (a residential Islamic school) in Dhaka city and the study (Group B) was from Bangladesh Krira Shikkha Prothistan ( BKSP - the top most residential sports academy in Bangladesh). All the control subjects were used to maintain a sedentary life style while the experimental subjects were exposed to regular physical exercise for at least one year. The subjects were excluded for any systemic diseases, drug user specially drug affecting nervous system and smoker. All ethical considerations for the subjects were taken into account before inclusion in to the study. The aims and benefits of the study were explained to each subject and were encouraged to participate voluntarily. A written informed consent was taken from each subjects and their authority. A detail physical activity, medical, personal, socio-economic history was taken and thorough clinical examination of the subjects was done. All these information were recorded in a prepared questionnaire. The subjects were advised to have his meal by 9:00 p.m., to remain free from any physical and mental stress, not to take any drugs affecting nervous system and to have a good sleep at night before
the examination day. The subject was also asked to avoid tea or coffee at breakfast and to attend at the autonomic nerve function laboratory between 9:00 am to 11:00 am on the day of examination. On the day of examination, after detailed history and all physical examinations, the subject was kept under complete bed rest in supine position for 20 minutes in a cool and calm environment at "Autonomic Nerve Function Test Laboratory" of the department of physiology. During this period he was restricted to talk, eat, drink, any physical or mental activity and even sleep. Then all preparations for recording of the heart rate variability parameters was made by connecting the channels i.e. the channels for ECG of Polyrite-D (RMS INDIA Version-2.2). Then five minutes recording was taken in resting supine position. After recording, all the non-sinus beats were filtered out from the ECG and the time domain parameters of the HRV (R-R interval, heart rate and SDNN) were obtained from the time series. Then, with all aseptic precaution, 5ml of venous blood was drawn from the subject in order to measure serum glucose and creatinine levels to exclude diabetes and kidney diseases.

All datas were recorded systematically in preformed data collection form and expressed as mean±SD. Statistical analysis was performed by using SPSS for windows version 12.0. Independent-Samples t-test was performed to compare the data between the control and study group. 95% confidence limit (p<0.05) was taken as level of significance.

### Results
The anthropometrics parameters of the subjects are presented in Table 1. The mean height and weight were significantly (p<0.001) higher in group B than that of group A. No statistical significant difference was observed between the groups in relation to age and BMI.

### Discussion
The present study was undertaken to observe the time domain HRV parameters like R-R interval, heart rate and SDNN in order to assess the influence of regular physical exercise on CANA in adolescent male athletes. For this purpose, 62 adolescent male athletes, aged 12 to 18 years, exposed to physical training for at least one year were selected. HRV of the

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group A(n=30)</th>
<th>Group B(n=62)</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age(years)</td>
<td>15.1±2.54</td>
<td>14.99±2.23</td>
<td>0.843 ns</td>
</tr>
<tr>
<td>BMI(kg/m2)</td>
<td>18.09±1.72</td>
<td>18.19±1.61</td>
<td>0.79ns</td>
</tr>
</tbody>
</table>

BMI = Body Mass Index.
Group A: Apparently healthy adolescent male non-athletes.
Group B: Apparently healthy adolescent male athletes.

*** = P < 0.001. ns = not significant. n = number of subjects.

The Mean R-R interval and SDNN were significantly (p<0.001) higher in group B than that of group A. Again, The Mean heart rate was significantly (P<0.001) lower in group B than that of group A (Table - 2).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Group A(n=30)</th>
<th>Group B(n=62)</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean R-R interval.</td>
<td>0.79±0.05</td>
<td>1.05±0.09</td>
<td>0.000***</td>
</tr>
<tr>
<td>SDNN (ms)</td>
<td>53.17±2.6</td>
<td>73.16±5.92</td>
<td>0.000***</td>
</tr>
</tbody>
</table>

SDNN = Standard Deviation of NN (normal R wave to normal R wave) intervals, Sec. =Second, ms = millisecond, R-R = Interval between successive R waves (sec).
Group A: Apparently healthy adolescent male non-athletes.
Group B: Apparently healthy adolescent male athletes.

*** = P < 0.001. n = number of subjects.
subjects were analyzed by microcomputer based polygraphic recorder (Polyrite D, RMS India version 2.2). All these time domain HRV parameters were also studied in age and sex matched healthy sedentary subjects for control and also to find out their baseline data in this group of population.

In this study, all the time domain HRV parameters in the healthy control subjects were within normal ranges and are comparable with the findings of the Task Force Guidelines. Serum Glucose and Creatinine levels in all the subjects were within normal range and were studied for exclusion of Diabetes Mellitus and kidney diseases.

In the present study, Mean R-R interval was significantly (P<0.001) higher in athletes than that of non-athletes. This finding is almost similar with the findings of most of the studies concerned with physical exercise and CANA. On the other hand, Leitch et al. (1997), Davy et al. (1997), and Bonaduce et al. (1998) failed to find any effects of regular physical exercise on the mean R-R interval.

The mean heart rate was significantly (P<0.001) lower in the athletes than that of non-athletes. Most of the groups of investigators also made similar observations. SDNN was significantly (P<0.001) higher in the athletes than that of non-athletes. This finding of the present study is in consistent with the findings of most of the different groups of investigators of different countries. A few group of investigators failed to reveal any effect of regular physical exercise on SDNN.

The Bradycardia (as well as increased R-R interval) shown in athletes of the present series is most likely due to simultaneous changes in CANA (increased parasympathetic activities and normalization of sympathetic activities) as a result of exercise-induced adaptation. However, it is not possible to comment on the contribution of the intrinsic structural changes in the heart tissue to cause bradycardia, because the left ventricular mass and dimensions were not measured in this study.

Conclusion
From this study, it has been observed that physical exercise causes improvement of CANA. Again, it is also evident that the resting bradycardia in athletes is associated with exercise-induced improvement of CANA. Therefore, from this study, it may be concluded...
that regular physical exercise is helpful to maintain normal/better CANA and thereby is beneficial in preventing the occurrence of different cardiac diseases due to Cardiac Autonomic Neuropathy.

References
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