Original Article

Electrophysiologic Study of Exhaustive Exercise

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Background: Exhaustive exercise is well known to pose a variety of health hazards, such as sudden cardiac death reported in ultra-marathon runners. Depressed parasympathetic tone is associated with increased risk of sudden cardiac death, thus parasympathetic withdrawal in post-exercise phase may be a high risk period for sudden death. To date, the effect on cardiac electrophysiology after exhaustive strenuous exercise has not been described. The aim of this study was to evaluate the impact of severe exhaustive exercise on cardiac electrophysiology.

Methods: The subjects in ranger training were invited to participate in this prospective study. The parameters measured consisted of PR interval, QRS duration, and macro T wave alternans as well as corrected QT QTc dispersion, T_{peak} –T_{end} interval and T_{peak} –T_{end} dispersion.

Results: The study group consisted of 40 consecutive male rangers who completed training and the control group (22 healthy age and height matched male subjects). In regard to electrocardiographic criteria, no differences were found between rangers before and after training program. In respect of the repolarization markers, there were no significant differences between the rangers before and after training program.

Conclusion: There was no significant change in cardiac repolarization markers after severe exhaustive exercise. Additionally, there was no relationship between sudden cardiac death and electrophysiologic changes after exercise.

Keywords: Electrophysiology, Exercise, Sudden Death

Introduction

Electrophysiologic response of human heart to exercise has been studied extensively,[1-4] but little information is available on the effects of extreme strenuous exercise on cardiac electrophysiology. Exhaustive exercise is well known to pose a variety of health hazards such as sudden cardiac death reported in ultra-marathon runners.[5-7] Depressed parasympathetic tone is associated with increased risk of sudden cardiac death, thus parasympathetic withdrawal in post-exercise phase may be a high risk period for sudden death.[8] To date, the effect on cardiac electrophysiology after exhaustive strenuous exercise has not been described. The aim of this study was to evaluate the impact of severe exhaustive exercise on cardiac electrophysiology.

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Patients and Methods

Individuals in ranger training were invited to participate in this prospective study for which they provided informed written consent. The study protocol was approved by the local ethics committee. Clinical data included age, height, weight, heart rate, and blood pressure. All patients underwent 12-lead surface electrocardiography (ECG) before and after training schedule. The program was a highly forceful physical training and did not include smokers. The daily training consisted of physical exercise, 8-km running no slower than 8 minutes/km and 16-km walking. To become an infantry ranger, candidates had to complete 8 weeks of training. The 12-lead surface ECG measured the PR interval, QRS duration, and macro T wave alternans and was recorded at a paper speed of 25 mm/s with an amplification of 10 mm/mv with the following repolarization features.

1) Corrected QT (QTc) calculated by Bazett's formula (QT/√RR interval) in lead V2
2) QTc dispersion indicating the difference be-

tween maximum and minimum QTc interval
3) $T_{peak} - T_{end}$ interval denoting interval from peak of a positive T wave or nadir of a negative T wave to the end of T wave in lead V2
4) $T_{peak} - T_{end}$ dispersion designating difference between maximum and minimum $T_{peak} - T_{end}$ interval

Statistical Analysis

All values are presented as mean±SD. Comparisons between groups were made using Student's t-test. For all analyses, P-value less than 0.05 was considered significant.

Results

The study group comprised 40 consecutive rangers who completed training and the control group consisted of 22 healthy, age and height matched males. The mean age were 30 ± 4.6 29.47 ± 4.68 years in the study and control groups respectively. There were no differences observed in height, resting heart rate, or blood pressure between controls and rangers before training program. The standard electrocardiographic data are listed in Table-1. No differences were found in electrocardiographic parameters between rangers before and after training program. Regarding repolarization markers, no significant differences were found between the rangers before and after training program (Table-1).

Discussion

Non-cardiac side effects of exhaustive exercise

It is well known that severe exercise poses a variety of health hazards and ultra-endurance racing is not without risk.[9,10] Competitive running or high-impact aerobics pose a high risk for a number of injuries in bones and muscles. It has been suggested that intense activity increases the production of oxygen free radicals. Renal failure and heat stroke have also been reported in ultra-marathon runners.[11,12]

Sudden cardiac death following exhaustive exercise

Vigorous exercise is associated with sudden cardiac death (SCD). Coronary artery disease is the major cause of exercise-induced SCD while in adolescents the cause is hypertrophic cardiomyopathy and congenital abnormalities of coronary arteries [(13)]. Few studies reported aortic dissection as a cause of SCD following severe exercise.[14]

The present study explored the effect of intense and exhaustive exercise on cardiac electrophysiology with particular attention to specific repolarization markers in which no significant changes were found after exhaustive exercise. Therefore, SCD was unrelated to electrophysiologic changes after training program.

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Table 1. Electrocardiographic repolarization markers before and after training

	Before Training	After Training	P value
PR Interval	132.2 ± 13.9	138.7 ± 11.5	NS
QRS Duration	78.7 ± 21.1	75.8 ± 18.8	NS
QTc in Lead V2	411.3 ± 22.9	423.5 ± 28.5	NS
QTc Dispersion	21.6 ± 11.8	22.1 ± 8.7	NS
$T_{peak} - T_{end}$ Interval in Lead V2	65.3 ± 10.7	62.5 ± 8.1	NS
$T_{peak} - T_{end}$ Dispersion	10.5 ± 7.6	11.3 ± 7.3	NS

NS: non-significant

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