Effects of Intermittent Exercise on Cardiac Troponin I and Creatine Kinase-MB

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ABSTRACT

Objectives: The aim of this study was to examine the influence of high-intensity intermittent exercise and carbohydrate supplementation on cardiac troponin I (cTnI) and creatine kinase-MB (CK-MB) in soccer players.

Methods: Twelve elite soccer players were selected and divided equally into three groups of carbohydrate (CHO), placebo (P) and control (C). Blood samples were taken in six phases and were analyzed with the chemiluminescence method.

Results: Results showed that three bouts of 90-min exercise along with carbohydrate supplementation did not have any significant effect on the level of cTnI indices. However, there was a significant difference in CK-MB values after the second and third sessions compared with the first day ($P < 0.05$).

Conclusion: In summary, exercises with less duration and intensity like soccer do not seem to be effective on cTnI and CK-MB. When the overall intensity of exercise was moderate, it appeared that carbohydrate supplementation had less effect on the alteration of biochemical markers of the myocardial muscle.

Keywords: Carbohydrate supplementation; Intermittent exercise; Cardiomyocyte injury.

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INTRODUCTION

Strenuous physical activity is destructive for cardiac function causing an increased risk of myocardial infarction during and one hour after the exercise bout.[1] Cardiac fatigue is exercise-induced cardiac dysfunction in the absence of underlying cardiovascular diseases with a large number of symptoms and an unclear etiology.[2] Cardiac troponin T (cTnT) and troponin I (cTnI) are regulatory proteins which are located on the contractile apparatus of the myocyte, are highly sensitive and are certain indicators of cardiomyocyte damage.[3] As a result, these markers provide the tools necessary for evaluating competitive athletes from clinical point of view.[3]

Numerous studies have suggested that prolonged exercise may induce a transient appearance of cardiac-specific troponins (such as cTnI), normally indicative of myocyte necrosis.[4-6] However, most of the available literature has concerned young, well-trained athletes competing in ultra-endurance events such as an Ironman Triathlon or exercise of even longer duration. Limited data are available for shorter durations (90 min) and intermittent exercises such as multi-sprint sports like soccer. George et al studied cTnT before and after intermittent exercise. They showed lack of troponin in the blood that was opposite to other findings on endurance exercise.[7]

Today, soccer players are professional athletes and changes within the game itself are creating a drive for a higher level of fitness, which requires greater versatility from players, longer playing season and greater frequency of games. Because of accumulated fatigue from three or two games a week and an imbalance between training and recovery, players are at risk of becoming overtrained, subsequently increasing the possibility of cardiac damage.

Therefore, the aim of this study was to monitor the physiological stress placed upon players during a typical week of a season. The objective was to study the effects of three intermittent exercises a week and carbohydrate (CHO) supplementation and responses of new biomarkers of cardiomyocyte injury (cTnI and CK-MB). The second purpose was to create a strategy for monitoring these responses, by determining

whether CHO supplementation can prevent possible increase in these variables.

We examined the influence of three bouts of 90 minute high intensity intermittent exercise (specific for soccer) along with CHO supplementation on cardiac troponin I (cTnI) and creatine kinase-MB (CK-MB) in soccer players.

METHODS

Participants

Twelve elite soccer players were selected and divided equally into three groups of CHO (age, 22 ± 2.6 years; body mass, 71.7 ± 5.4 kg; height, 173.2 ± 7.04 cm), placebo (P) (age, 24.2 ± 2.6 years; body mass, 76.5 ± 11.3 kg; height, 177 ± 12.2 cm), and control (C) (age, 25.2 ± 0.5 years; body mass, 75.5 ± 3.4 kg; height, 176 ± 0.8 cm). All participants provided written informed consent before the study. They reported no symptoms of infection or cardiovascular diseases and did not take any medications three weeks before the study.

Experimental procedures

The participants were divided into three groups; namely, CHO supplementation, placebo and control groups. Then, they performed three 90-min intermittent exercise bouts specific to soccer in one week.[7] The experimental groups received CHO supplementation or placebo before, during and after exercise. The basic data (resting state) were collected on the first day, the ninth day (after three sessions) and the twelfth day (three days after the final session). In addition, blood samples were taken after each exercise session (day two, five and eight) for assessing acute responses.

Immediately before, during and after the exercise session, fluid intake was recorded. In the carbohydrate group, participants consumed 400 ml of a lemon flavored glucose solution (6%) 10 min before the start of each 45 min of exercise and 5 min after the exercise; a further 150 ml of this solution was consumed 14 and 29.5 min into each period of exercise. In the placebo group, the participants consumed equal volumes of a lemon-flavored placebo drink (containing aspartame as the sweetener) at similar times as in the CHO group. The participants reported on the laboratory at 08:00 o'clock on each occasion, after an overnight fast. Blood samples (10 ml) were taken from an antecubital vein after each exercise protocol and in resting states (day 1, 9 and 12).

Each exercise protocol comprised two periods of intermittent exercise (45-min each) that simulated the activity patterns of a soccer match, using the activity profile described by Bangsbo et al.[8] The two periods were separated by a 15 min half-time interval. Each 45-min period was divided into three bouts of exercise. Each bout was separated by 1.5 min of rest, during which 150 ml of the prescribed drink was consumed. The bouts comprised seven circuits of 2 min each: 50 m dribbling the ball through cones placed 5 m apart, 50 m backwards running, 25 m cruising, 25 m sprinting and 50 m walking.[9] Any remaining time at the end of each 2 min circuits was a rest period. A total distance of approximately 9.7 km was covered during the 90-min exercise protocol. This distance is similar to that reported to be covered during English first division matches by midfield players.[10]

Blood analysis

Blood samples were collected into two separate vacutainer tubes, one containing tripotassium ethylene diamine tetraacetic acid (K3EDTA) and the other containing lithium heparin. The quantitative determination of cTnI and CK-MB in the serum was performed on the LIAISON analyzer. This procedure is based on two-site immunoluminometric assay (sandwich principle). A monoclonal antibody was used for the coating of the solid phase (magnetic particles) and a polyclonal antibody (goat) was used for the tracer.

The LIAISON analyzer automatically calculates the troponin I concentration in each sample by means of a calibration curve generated by a two-point calibration master curve procedure. The results are expressed in ng ml-¹.

Statistical analysis

The results were presented as mean values and standard deviation. Dependent t-tests were used for comparing any significant difference of each group on the first day. Analyses of variance with repeated measures were used for determination of any significant difference in any variables in the six days of sampling. One-way analysis variance was used for detection of any significant difference between groups in each phase. The post hoc LSD test was used to assess significant differences between groups.

Table 1. Mean ± SD level of cTnI (ng/ml) in studied grops

	Day 1	Day 2	Day 5	Day 8	Day 9	Day 12
CHO	0.007 ± 0.024	0.006 ± 0.002	0.067 ± 0.035	0.12 ± 0.14	0.052 ± 0.005	0.12 ± 0.13
P	0.097 ± 0.095	0.02 ± 0.002	0.092 ± 0.063	0.005 ± 0.00	0.14 ± 0.01	0.13 ± 0.077
C	0.001 ± 0.063	0.005 ± 0.00	0.082 ± 0.037	0.02 ± 0.034	0.012 ± 0.013	0.055 ± 0.001

CHO: Carbohydrate group; P: Placebo group; C: Control group

RESULTS

The results are presented in tables 1 and 2. Results of this study showed that three bouts of 90-min exercise along with carbohydrate do not have any significant effect on the level of cTnI. However, there was a significant difference in CK-MB values after the second and third session compared to the first day ($P < 0.05$). Comparison of the three groups in different days showed significant differences between CHO and P groups after the first and second session ($P < 0.05$).

DISCUSSION

The aim of this study was to examine the influence of high-intensity intermittent exercise and CHO supplementation on cTnI and CK-MB in soccer players. The results of this study showed no significant difference between pre-exercise values of cTnI in three groups after three exercise sessions or in resting states. Other findings of this study showed that CHO supplementation has significant influences on serum CK-MB. In addition, CK-MB values increased after all exercise sessions. Although not entirely unanimous, numerous studies have suggested that prolonged exercise may induce a transient promotion in the appearance of cardiac-specific troponins, such as cTnI, normally indicative of myocyte necrosis.[2,4,5,6,11,12] To date, most of the available literature is on well-trained athletes competing in a range of ultra endurance activities. There are no data for individuals taking part in moderate duration exercise with intermittent periods of high intensity exercise like soccer and other team sports. Owing to the extended duration of activities reported in previous studies, this type of exercise tends to be relatively submaximal and steady state in nature. Such events contain very limited periods of intense cardiovascular acceleration or deceleration that may increase myocardial oxygen demand.

To our knowledge, there is only one study on young healthy subjects taking part in high-intensity intermittent exercise of 90 min.[7] George et al found a lack of troponin in the blood samples of the subjects.[7] Present findings suggest that this type of exercise does not result in myocyte necrosis or alteration in membrane permeability. Therefore, further research is required to understand the effects of such type of exercise on cardiac markers. However, results of previous studies about continuous ultra-endurance activities were inconclusive. Some studies on events such as race across the Alps[5] and ultra-endurance mountain marathon[11] reported an increase in these biomarkers. On the other hand, some studies on exercises like marathon[6,12] and triathlon[13] showed no increase in these markers.

Therefore, with respect to uncertainty regarding increase of the troponins after ultra endurance activities, it is critical to be sure that exercises such as soccer with lower duration and intensity, even with three exercises a week, lead to increase in these biomarkers. However, bearing in mind the appearance of sudden death in soccer during the recent years, it is important to study chronic effects of intermittent exercises such as soccer on understanding exercise-induced cardiac injuries.

Table 2. Mean ± SD level of CK-MB (ng/ml) in studied patients

	Day 1	Day 2	Day 5	Day 8	Day 9	Day 12
CHO	3.47 ± 0.66	3.36 ± 0.30	4.77 ± 1.36	4.14 ± 6.85	3.88 ± 0.05	3.28 ± 0.41
P	3.26 ± 0.79	5.15 ± 1.26	7.88 ± 2.79	3.84 ± 12.31	5.53 ± 1.61	4.45 ± 1.41
C	2.36 ± 0.54	3.03 ± 0.21	3.18 ± 0.81	-0.13 ± 9.1	3.25 ± 0.97	3.06 ± 0.95

CHO: Carbohydrate group; P: Placebo group; C: Control group

CONCLUSION

In conclusion, in spite of the mild increase in CK-MB that may result from the intermittent and explosive nature of the exercise protocol and muscle injuries, our findings suggest that performing three 90-min intermittent exercises a week may lead to significant variations in the cardiac markers. However, it is important to consider higher intensities of a real soccer match and repeating this pattern over longer term periods of time.

Conflict of interest statement: All authors declare that they have no conflict of interest.

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