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ORIGINAL ARTICLE

A single-bout of one-hour spinning exercise increases troponin T in healthy subjects

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Abstract

Objectives. While long-term endurance exercise is known to increase cardiac biomarkers, only a few studies on short-term exercise and these markers have been reported. The aim of this study was to investigate the acute effects of a one-hour bicycle spinning on cardiac biomarkers in healthy individuals. *Design*. Serum levels of high-sensitive troponin T (TnT), creatinine kinase MB fraction (CK-MB), N-terminal pro-brain natriuretic peptide (NT-proBNP), creatinine kinase (CK) and myoglobin were measured at baseline, 1 and 24 hour after one hour of spinning exercise in ten healthy and fit (age 31.0 ± 6.6 years) individuals. *Results*. TnT doubled one hour post-exercise (All values ≤ 5 – 9.7 ± 6.0 ng/L, $p < 0.001$). Two individuals had TnT levels above upper reference limit, URL (20.7 and 20.2 ng/L, URL = 12 ng/L). Myoglobin levels increased 72% one hour post-exercise (38 ± 20 – 66 ± 41 mg/L, $p < 0.02$). TnT and myoglobin levels returned to baseline 24 hour post-exercise. Serum levels of CK-MB, NT-proBNP and CK were not significantly changed. *Conclusions*. A single-bout of one-hour bicycle spinning transiently increases TnT and myoglobin in healthy subjects. Some subjects even have TnT release above URL. Thus, recently performed exercise also of short duration should be taken into consideration in the evaluation of acute chest pain with release of cardiac TnT.

Key words: *exercise, troponin T, Myoglobin, NT-proBNP, CKMB, spinning*

Introduction

Regular physical activity plays a central role in the prevention of cardiovascular disease. The positive effects are partly due to reduction of known cardiovascular risk factors and improved exercise capacity (1). Intense physical activity may be even more advantageous, but could potentially act as a double-edged sword, as some cardiac biomarkers are known to be increased by intense, prolonged endurance activity, such as marathon running, cross-country skiing and road cycling (2). It is unknown, whether this increase in cardiac biomarkers reflects physiological adaptation or actual cardiac damage, secondary to exercise. Echocardiographic evaluation of myocardial function in study subjects with exercise-induced troponin release, have shown varied results. While increased troponin levels after a marathon race, was shown to be associated with echocardiographic evidence of reduced right ventricular activity (3), no association between increased troponin levels and left ventricular function could be shown in participants of a 89 km foot-race (4).

Most non-elite individuals participate in physical activities of shorter duration and of varied intensity, such as jogging, swimming, ball-games or activities commonly performed in a gym, like treadmill running, exercise bicycling, aerobics and spinning. If these common types of physical activities were to result in increased cardiac biomarkers, the clinical impact on evaluation could be great.

Only a few studies have looked at the effect of sporting activities of shorter duration on cardiac biomarkers. Basketball and treadmill running have shown to induce troponin release (5,6), while the effect of these types of activity on other biomarkers such as brain natriuretic peptide (BNP) or creatinine kinase-mb fraction (CKMB) have not been studied. Other modalities of physical activity commonly performed in the general

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population, such as bicycle spinning and other activities of shorter duration needs to be further studied.

Spinning is a form of instructor-led exercise involving endurance, strength, intervals, high intensity and recovery, using a special stationary exercise bicycle, often performed in a exercise room setting.

The aim of the present study was to study the acute effect of a single-bout of one-hour spinning exercise on cardiac biomarkers.

Material and methods

Study subjects

We enrolled thirteen healthy, physically fit individuals of both sexes aged 31.0 ± 6.6 years with body mass index (BMI) 22.5 ± 2.0 kg/m^2 in the study. The study subjects were recruited among the medical staff or students at the Sahlgrenska University Hospital/ Ostra, Gothenburg, Sweden. The participants had no history of earlier cardiovascular events or risk factors. Exclusion criteria were signs of inflammation, infection and the ongoing use of other medications than contraceptives. The individuals were well trained and performed moderate to high intensity exercise (e.g. running, handball, aerobics, walking) 2–6 times per week of 20–90 min duration.

The study was approved by the Ethics Committee at the University of Gothenburg (Ö 652–03, date of approval Aug 19, 2004), and procedures were conducted in accordance to the same and the Helsinki Declaration of 1975, as revised in 1983. The subjects gave their informed consent, before participating in the study. Subjects characteristics are summarized in Table I.

Study design

The exercise protocol was performed as previously described (7). Study subjects performed a single complete one-hour bicyle spinning session lead by a professional instructor at a training centre. Heart rate during activity and the actual exercise time was measured using a heart rate monitor. The monitoring was started after the initial warm-up and stopped before the recovery/slow-down at the end of the session, to assess the maximum and mean heart rate during the actual main exercise period (effective spin time). Subjects were instructed to aim towards a heart rate level corresponding to 80% of their predicted maximum heart rate (HR_{max}) defined as 220-age. Strenuous exercise was to be avoided for three days prior to the initial blood sampling.

Biomarker analysis

Blood samples were drawn from an antecubital vein before, 1 hour and 24 hours after the spinning session. The samples were centrifuged and serum was stored in –80°C. Serum levels of high sensitive troponin T (TnT), creatinine kinase MB fraction (CKMB), N-terminal pro-brain natriuretic peptide (NT-proBNP) and myoglobin were analysed using Electrochemiluminiscence immunoassay (ECLIA) on automated analysers (Modular E and Cobas(NT-proBNP) from Roche Diagnostics GmbH, Mannheim, Germany. CK was analysed using photometry on Modular P800 (Roche/ Hitachi, Roche Diagnostics GmbH, Mannheim, Germany). The laboratory methods used were standard methods used by the Sahlgrenska University Hospital Clinical Chemistry Laboratory and well validated. The upper reference limit (URL) for TnT was defined as the 99th percentile of healthy participants, corresponding to 12 ng/L. The URL for CKMB was 5 μg/L, CK 1.6 μkat/L, myoglobin 90 μg/L and NT-proBNP 125 ng/L. The URL for CKMB, TnT and Myoglobin was based on the 99th percentile of a normal population sample. The URL for NT-proBNP was based on data suggesting high negative predictive value of levels below 125 ng/L (8). The URL for CK was 8.2 for men and 4,2 for women, based on levels in non-athletic subjects (9). The detection limit and the upper limit was 3 and 10 000 ng/L respectively for TnT, 0.10 and 500 μg/L for CKMB, 5 and 35 000 ng/L for NT-proBNP, 21 and 3000 μg/L for Myoglobin and 0.05–38.5 μkat/L for CK.

Statistical analysis

All values are presented as mean and range. Pre- and post-exercise levels of biomarkers were compared

Table I. Biochemical markers before and after the one-hour spinning session n = 10; mean (range), median. TnT = high-sensitive troponin T, CK-MB = creatinine kinase MB fraction, NT-proBNP = N-terminal pro brain natriuretic peptide, CK = creatinine kinase. $^*p < 0,05$ between baseline and 1 hour spinning.

Variable	Baseline	1 hour	24 hours
TnT (ng/L)	<5 (<5– <5), <5	9.7 (<5–20.7)*, 7.82	<5 (< 5–6.3), <5
CKMB (μg/L)	2.4 (2–5), 2	2.6 (1–4), 2.5	2.9 (2–5), 2.5
Myoglobin (μg/L)	38.5 (24–93), 35.5	66.1 (33–136)*, 42.5	49 (22–186), 27
CK (μkat/L)	1.8 (1–5.1), 1.4	2.1 (1.0–5.1), 1.4	2.6 (1.3–5.6), 2.2
NT-proBNP(ng/L)	52 (6–109), 57	55.6 (10–113), 44.5	57 (18–126), 48

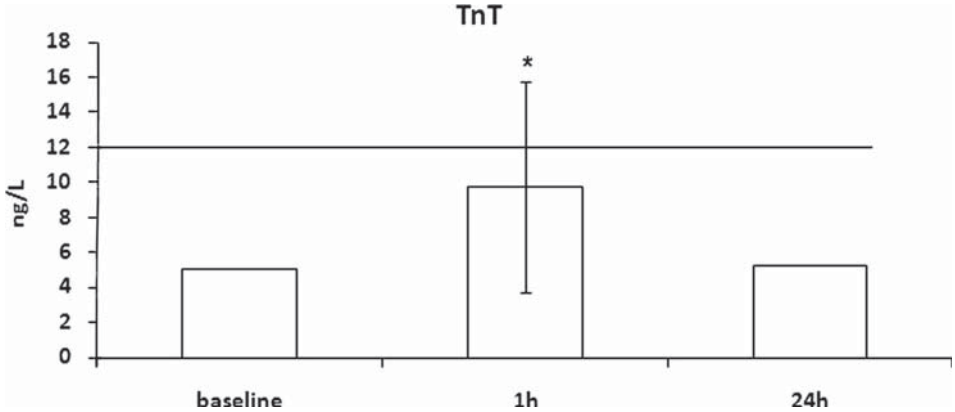

Figure 1. The effect of one-hour spinning exercise on TnT. TnT was significantly increased one hour after the completed exercise session, $p < 0.001$. The horizontal line illustrates the URL.

using Wilcoxon rank sum test. A value of $p < 0.05$ was considered significant.

Results

Three individuals were excluded from the study; one because of non-compliance with the study protocol and two because of technical errors. All participants successfully completed the spinning session with an average effective spin time of 43 (41–47) min. Predicted HR_{max} (defined as 220-age) was 190 (173—196) beats/min (bpm) and the average heart rate (AHR) actually measured during the spinning session was 162 (150–172) bpm. The mean exercise intensity was therefore 85 (78–95)%, % AHR of predicted HR_{max}. In all, nine of ten individuals reached at least 80% of predicted HR_{max}.

Effects of spinning exercise on cardiac biomarkers

Serum levels of TnT almost doubled one hour post-exercise (all values below 5 vs 9.7 (<5–20.7) ng/L, $p < 0.001$, Figure 1. Two individuals had TnT levels above URL one hour post-exercise (Figure 2 and Table I). These effects of a single bout of strenuous exercise on TnT levels declined with time to return back to baseline levels at 24 hours post-exercise 5.2 (< 5–6.3) ng/L, Figure 1.

The levels of CKMB and NT-proBNP stayed unchanged over the study time. Both CKMB and NT-proBNP stayed below URL both at baseline and post-exercise.

Effects of spinning exercise on skeletal muscle biomarkers

Serum myoglobin was increased by 72% one hour post-exercise, 38.5 (24–93) μg/L at baseline vs 66.1 (33–136) μg/L, $p < 0.02$, which returned back to baseline 48.6 (22–186) μg/L at 24 hours.

Levels of CK were not significantly changed 1.75 (1.0–5.1) μkat/L at baseline vs 2.08 (1.2–5.8) μkat/L post-exercise, p = NS. Three participants had serum levels above the URL for myoglobin one hour post-exercise (112, 124 and 136 μg/L, respectively). The individual with the highest level of myoglobin post-exercise had myoglobin levels slightly above URL prior to the spinning session (93 μg/L). Three individuals had CK levels above URL prior to exercise, only two individuals increased in CK touching a level slightly above URL. None of the participants had complaints of any muscle pain after the exercise session.

Discussion

The main findings of this study were that (1) A single bout of one-hour spinning exercise in young, healthy humans significantly increases the serum levels of TnT, in some cases, even above upper reference limits (2) Spinning associated changes in CKMB and NT-proBNP could not be seen (3) Spinning exercise also increases serum levels of myoglobin, in some cases above the URL, while the levels of CK are not significantly affected.

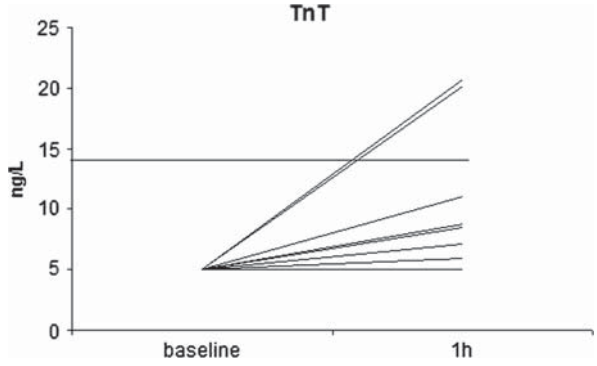

Figure 2. The individual TnT values, n = 10. The horizontal line illustrates the URL. In three subjects no TnT change was seen between baseline and one hour post-spinning.

Our study is the first looking at the effect of cardiac and skeletal muscle biomarkers on a single bout of one-hour bicycle spinning exercise. Spinning in this study were performed at a mean intensity of 85% of estimated heart rate max (range 78–95), corresponding to strenuous exercise. The results of this study, showing an increment in TNT and myoglobin after spinning exercise, has an important clinical significance, since spinning is widely utilized by the general population as recreational activity, in contrast to the more elite oriented endurance events that previously have been studied regarding cardiac biomarker release (2,10). After prolonged endurance exercise such as marathon running or long-distance bike rides, almost half of the participants get increased TnT levels (11) and almost 75% show an increase in TnI. A few studies have shown that shorter exercise episodes such as basketball (5) and 30 min of treadmill running (12) also may have an effect on troponins. Furthermore, the release of TnT seems to be dependent on running distance as well as age and training status, as untrained and older individuals seem to get higher levels of TnT relase (13,14). In spite of that our study population was well-trained and the mean age was low, we still found TnT release secondary to spinning exercise. In an older and more untrained population, the effect might have been more pronounced. As opposed to patients with myocardial infarction, the increased troponin levels usually normalize within 24 hours (15–18), but individuals seeking medical care for chest pain or dyspnea symptoms in that time-frame, may show false-positive increments secondary to exercise, making the differential diagnosis difficult.

The exact significance of exercise associated increments in cardiac biomarkers is not known. Prolonged endurance exercise such as half-ironman activities, have shown to induce impaired systolic and diastolic function as assessed by echocardiography immediately following the race, however, after a 48 hours control all these parameters were normalized (19).

The underlying mechanisms behind the exercise induced increase in cardiac troponins are also not known but may be several. In patients with myocardial infarction, it is the cytoplasmatic unbound cardiac troponin that is released first, followed by the structurally bound troponin of the troponin complex, which is when increased levels are detected in the serum (20). Thus, one possible explanation for the exercise induced troponin increase could be an increased membrane permeability with the release of the unbound cytosolic troponin fraction (11,17,20,21).

Similarly, increased levels of CKMB have previously been seen with exercise, however, most of these studies have been done in longer endurance type exercises, such as ultra-endurance marathons and longer road cycle trips (19,22,23). In those studies, cardiac troponin was normal while CK was elevated, which suggests a non-cardiac origin of the CKMB. In our study examining a single-bout of spinning exercise for one hour, we did not find significantly elevated level of CKMB.

The release of cardiac biomarkers may be associated with the intensity and duration of physical activity performed. Other studies have shown that NT-proBNP increases with exercise, but this seems to depend on the exercise duration (17,24). The effective exercise time in our study was short, that is why it is not surprising that the NT-proBNP levels were unchanged in spite of the intensity. While NT-ProBNP seems to be affected mainly by exercise duration, Troponins (TnI) have been shown to be affected both by exercise duration and intensity (24).

The local response to strenuous exercise in the working skeletal muscle is expected to be different from the healthy heart. While most forms of strenuous exercise within 'normal' limits is not expected to cause ischemia in the healthy heart, there are data suggesting that prolonged exercise and short term strenuous exercise might cause local hypoxia in the leg muscle. The transcription factor, hypoxia-inducible factor-1 (HIF-1), that is induced by hypoxia, has been shown to increase in skeletal muscle in response to exercise (25). In our study we found that myoglobin almost doubled with spinning exercise, with three individuals showing myoglobin levels above URL (one of these individuals had slightly raised myoglobin prior to exercise which increased post-exercise).

In summary, a single-bout of exercise in the form of one hour bicycle spinning, increases troponin T in healthy well-trained subjects, while levels of NT-ProBNP and CKMB stay unchanged. These results may be of great clinical significance since spinning is a type of exercise which is becoming increasingly popular in the general population. This increase in TnT might present a problem in the clinical evaluation of chest pain. Thus, when evaluating these biomarkers in an emergency setting, careful information regarding any recent exercise activities should be obtained, especially in the first 24 hours post-exercise.

Limitation

In some biomarkers, we found a big baseline individual variation. As an example, NT-proBNP ranged from 6 to 110. Although expected, this variation in baseline values is a limitation in this study, in particular, since the number of subjects is low.

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