Available online at www.sciencedirect.com
ScienceDirect
Journal of Science and Medicine in Sport 13 (2010) 189–193
Journal of Science and Medicine in Sport
www.elsevier.com/locate/jsams

Original paper

Acute alcohol consumption aggravates the decline in muscle performance following strenuous eccentric exercise

Matthew. J. Barnes *, Toby Mündel, Stephen. R. Stannard

Institute of Food, Nutrition, and Human Health, Massey University, Palmerston North, New Zealand

Received 23 July 2008; received in revised form 8 December 2008; accepted 13 December 2008

Abstract

This study investigated the effects of acute moderate alcohol intake on muscular performance during recovery from eccentric exercise-induced muscle damage. Eleven healthy males performed 300 maximal eccentric contractions of the quadriceps muscles of one leg on an isokinetic dynamometer. They then consumed a beverage containing 1 g/kg bodyweight ethanol (as vodka and orange juice) (ALC). On another occasion they performed an equivalent bout of eccentric exercise on the contralateral leg after which they consumed an isocaloric quantity of orange juice (OJ). Measurement of maximal isokinetic (concentric and eccentric) and isometric torque produced across the knee, plasma creatine kinase (CK) concentrations and muscle soreness were made before and at 36 and 60 h following each exercise bout. All measures of muscle performance were significantly reduced at 36 and 60 h post-exercise compared to pre-exercise measures (all $p < 0.05$). The greatest decreases in peak strength were observed at 36 h with losses of 12%, 28% and 19% occurring for OJ isometric, concentric, and eccentric contractions, respectively. However, peak strength loss was significantly greater in ALC with the same performance measures decreasing by 34%, 40% and 34%, respectively. Post-exercise plasma creatine kinase activity and ratings of muscle soreness were not different between conditions (both $p > 0.05$). These results indicate that consumption of even moderate amounts of alcohol following eccentric-based exercise magnifies the normally observed losses in dynamic and static strength. Therefore, to minimise exercise related losses in muscle function and expedite recovery, participants in sports involving eccentric muscle work should avoid alcohol-containing beverages in the post-event period.

Keywords: Ethanol; Creatine kinase; Muscle strength dynamometer; Athletic performance

1. Introduction

Strenuous eccentric contractions produce micro-structural damage to skeletal muscle resulting in impaired muscular performance, inflammation, and soreness.[1] Most running-based team sport events involve eccentric work and, particularly during competition, this results in varying levels of muscle damage.[2] Rapid post-event recovery is necessary to enable adequate training and optimal performance during the following event, and consequently much effort is afforded to practices which enhance recovery processes.

However many sportspeople, particularly those involved in team-based sports, regularly ingest moderate to large volumes of alcohol (ethanol) in the hours after training or competition as a means of celebrating, socialising or bowing to sponsorship commitments.[3–5] Yet, it is not known how this pattern of alcohol consumption affects recovery processes after eccentric exercise-induced muscle damage.

To date only one study has investigated the interaction of alcohol with recovery from eccentric exercise-induced muscle damage. Clarkson and Reichsman[6] had subjects drinking either a beverage containing 0.8 g of ethanol/kg body weight or a non-alcoholic control beverage 35 min prior to performing 50 maximal eccentric contractions of the elbow flexor muscles. Although the exercise brought about significant amounts of muscle damage, as demonstrated by significant changes in all criterion measurements, no difference between treatments was evident in measures of plasma creatine kinase (CK) activity, muscle soreness, isometric strength or range of motion leading the authors to conclude that ingestion of alcohol does not impair recovery after eccentric exercise-induced

* Corresponding author.
E-mail address: M.Barnes@massey.ac.nz (Matthew.J. Barnes).

1440-2440/$ – see front matter © 2009 Sports Medicine Australia. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.jsams.2008.12.627

muscle damage. As with much of the research into alcohol and physical performance[7], in the Clarkson and Reichsman study alcohol was ingested prior to exercise rather during the much more common post-exercise period. Thus despite recommendations to the contrary, the available evidence does not seem to warrant abstinence from alcohol in the post-event period for the purposes of optimal recovery.

The purpose of this study was to compare the effects of post-exercise alcohol ingestion with that of an isocaloric non-alcoholic beverage on changes in muscle performance following a bout of strenuous eccentric exercise. We hypothesise that moderate amounts of alcohol ingested following eccentric exercise will not delay normal recovery of muscular performance.

2. Methods

Eleven healthy males (23.9 ± 4.7 years; 87.6 ± 9.5 kg), who regularly participated in resistance training on a recreational basis and who were not naive to alcohol, volunteered to participate in this study. The protocol was approved by the Massey University Human Ethics Committee and written consent was obtained from each participant.

The study employed a one-legged model during each of two experimental trials (treatment and control) to enable a single cross-over on the contralateral leg. Leg and treatment were allocated randomly. The advantage of this design is that the participants are their own control, yet any residual effects in the muscle from the previous trial are negated. The latter is particularly important because of the well-described 'repeated-bout' adaptation which takes place following eccentric exercise-induced muscle damage.[8]

At least 1-week before the first experimental trial participants were familiarised with the Biodex® isokinetic dynamometer (Biodex Medical Systems, New York, USA) and the movements involved in the protocol. Participants were seated with the lateral femoral epicondyle aligned with the dynamometer axis of rotation and the ankle strap positioned approximately 5 cm proximal to the medial malleolus. Each participant's seat position was recorded for subsequent trials.

At least two days later, participants attended the laboratory for the first experimental trial. Four hours prior to the start of each trial participants consumed a standard meal (4440 kJ). Immediately before testing participants warmed-up on a cycle ergometer (Monark, Varberg, Sweden) for 5 min at 100 W. Then once seated on the Biodex straps were fixed across the chest, hips and active leg to isolate movement to the quadriceps. Knee joint range of motion was set and recorded for use in follow-up tests. Five maximal isometric, concentric and eccentric contractions of the quadriceps muscles were then completed as tests of muscle performance. Isometric tension was measured at a knee angle of 75° (1.31 rad). Concentric and eccentric torque was measured at an angular velocity of $30^\circ\ s^{-1}$ ($0.52\ rad\ s^{-1}$)[9]. Absolute peak torque and average peak torque over five contractions was recorded. Each set was separated by 2 min of passive recovery.

Once performance tests were complete, participants remained on the Biodex and performed 300 maximal eccentric contractions using the quadriceps muscles of one leg. Participants were verbally encouraged to resist the downward action of the dynamometer arm as hard as possible and had access to visual feedback of their torque throughout the protocol to ensure continuous maximal effort. This eccentric exercise bout was divided into three sets of 100 repetitions separated by 5 min of passive recovery, during which time subjects remained seated. For the second trial the contralateral leg was damaged using the same protocol.

A 60° (1.05 rad) range of motion was set from maximal knee flexion (0°) using the dynamometers inbuilt goniometer. Repetitions were performed at an angular velocity of $30^\circ\ s^{-1}$. Adapted from the work of MacIntyre and colleagues[9], this protocol has previously been shown to bring about significant levels of muscle damage and soreness.

At the completion of the eccentric exercise bout participants consumed a standardised meal (1620 kJ). Then, 30 min after exercise, they began drinking a beverage containing either 1 g of alcohol per kg of body weight as vodka (Smirnoff, Australia) in orange juice (Frucor Beverages, New Zealand) (ALC) or a control beverage of orange juice alone (OJ). The treatment beverage was mixed in a 3.2:1 ratio of orange juice to vodka. Equivalent to 8.8 (±1) standard drinks, the mean volume of vodka consumed per participant was 235.9 ml (±25.5). The two beverages were balanced for fluid and energy value however participants consumed larger amounts of both vitamin C and carbohydrate in the OJ trial. Equal volumes of beverage were consumed every 15 min over a total time of 90 min. Once the required amount of beverage was consumed participants were driven home and instructed to go directly to bed. Participants returned to the laboratory for testing the following three mornings, having fasted overnight (≥12 h).

Ratings of muscle soreness were taken immediately post-drinking, and 12, 36, and 60 h later. Blood samples were collected prior to exercise, immediately post-drinking and 12 and 36 h later. Muscle performance tests, as described above, were repeated at 36 and 60 h post-drinking. Participants were instructed to abstain from any form of exercise and alcohol from 48 h before until 60 h after each damaging exercise bout and there were at least 10 days in between experimental trials.

Participants completed a questionnaire rating their current level of perceived muscle soreness on a subjective scale from 0 to 10 (0 = no soreness, 10 = very, very sore) as outlined by Sorichter et al.[10] Soreness was rated while stepping up (concentric muscular contraction) onto a 40 cm box and lowering into a squatting position (eccentric contraction).

Each venous blood sample was obtained from the antecubital vein and collected into a 4 ml EDTA-containing vacutainer, placed on ice for 10 min, and centrifuged at 4 °C for 10 min at $805 \times g$. Plasma was aspirated into 300 μl aliquots and frozen at −80 °C for later analysis. CK