EFFECTS OF ICE PACK ON MUSCLE INJURY INDUCED BY ECCENTRIC CONTRACTIONS

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Abstract

The purpose of this study was to examine whether local application of ice packs had positive effects on recovery from eccentric contraction-induced skeletal muscle injury and delayed onset muscle soreness (DOMS). Three male and 8 female healthy university students served as subjects. The subjects performed 20 eccentric contractions of elbow flexor muscles on 2 occasions, one with application of ice packs on the muscles immediately after eccentric actions (experimental trial) and the other without ice pack modality (control trial). Maximal isometric strength, relaxed upper arm circumference, flexed elbow angle and perceived muscle soreness were measured before, immediately after eccentric actions, after 30 min-long ice pack application, and 1 day after and 2 days after eccentric actions. Plasma creatine phosphokinase (CPK) activity was determined before, 1 day after and 2 days after eccentric actions. Repeated measure ANOVA showed significant cold treatment effect and treatment-time interaction were found for girth of upper arm. Girth of upper arm was significantly lower in the experimental trial than in the control trial. Moreover, ice pack treatment decreased the girth of upper arm to control values immediately after treatment. No treatment-time interaction existed for maximum isometric strength, perceived muscle soreness, relaxed elbow angle and CPK activity. It is concluded that cold treatment with ice pack modality has very little effects, if any, on the eccentric contraction-induced muscle injury and DOMS.

Introduction

Almost all of athletes and even non-athletes have so far experienced delayed onset muscle soreness (DOMS). DOMS often occurs when physical activity requiring eccentric muscle contractions is performed (Schwane et al. 1983). DOMS is characterized as a dull, aching pain which usually peaks a day or so after exercise. Recent investigations have revealed that DOMS is one of manifestations of body's sequential responses to exercise-induced initial injuries to the skeletal muscle (Armstrong et al. 1991, Evans & Canon 1991). According to Armstrong et al. (1991), eccentric

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contraction-induced muscle injury is hypothesized to follow the next sequences; mechanical damage to myofibril and membrane of the muscle fibers (initial event), disruption of calcium homeostasis, irreversible autogenetic, phagocytic and regenerative processes. Although exercise-induced skeletal muscle damage and DOMS are temporal, they causes reduction in muscle contractile force, range of motion and physical performance. Therefore, proper treatment methods to enhance recovery from the muscle injury and to alleviate DOMS are needed. The use of cold therapy has been widely accepted for the treatments of acute sports injuries and for the rehabilitations of injured athletes (Irrgang et al. 1995, Meeusen & Lievens 1986). However, the applicability of cold therapy to eccentric contraction-induced skeletal muscle injury has not been fully evaluated.

Purpose of this study was to examine whether application of cold with ice packs had positive effects on recovery from eccentric contraction-induced skeletal muscle injury.

Methods

Subjects. Three male and 8 female healthy university students served as subjects. They were fully informed of nature and risks of the experiments and signed written informed consent.

Eccentric actions. The subjects performed 20 eccentric contractions of forearm flexor muscles on 2 occasions, one with application of ice packs on the muscles immediately after eccentric actions (experimental trial) and the other without ice pack modality (control trial) . Eccentric actions were performed in such a way that forearms of the subjects were forcibly extended by a investigator from flexed position with elbow angle of 50 degrees to the angle of 170 degrees against subjects' maximal resistance. One eccentric contraction lasted 3 seconds and was repeated every 10 sec.

Ice pack. Arm flexor muscles were cooled with ice pack for 30 min. Ice pack containing crashed ice and cold water was placed on the flexor muscles which was kept horizontal on a table.

Measurements. Maximal isometric strength, relaxed elbow angle and girth of upper arm, and perceived muscle soreness were measured before, immediately after eccentric actions, after 30 min-long ice pack application, and 1 day and 2 days after eccentric actions. Maximum isometric strength was measured with a strain gauge tensiometer. The subjects were securely fastened on a chair of the versatile muscular and power measurement device (Takei Kiki Kogyo Co. Ltd., Japan) and the elbow held at a right angle. Relaxed elbow angle was measured with a goniometer while the subject stood. Girth of upper arm was obtained by using a tape measure. Perceived muscle soreness was assessed by a pain scale of 10 cm horizontal line. The left end of the line indicated no pain and the right end, unbearable pain. The distances between the left end and the point subjects marked were used for the data for perceived muscle soreness. For measuring plasma creatine phosphokinase (CPK) activity, 70 μl of blood sample was collected into heparinized tube from the hand fingertips before, 1 and 2 days following

the bout. Plasma was obtained with centrifugation at 10,000 rpm. CPK activity was determined with test kit (CPK-UV Wako) before, 1 day after and 2 days after eccentric actions.

Statistics. Repeated-measures ANOVA was used to analyze the data. For multiple comparison, the Student-Newman-Keuls test was employed. Significance was established at $P < 0.05$.

Results

Repeated measure ANOVA showed a significant main effect across time for maximum isometric strength, perceived muscle soreness, and relaxed elbow angle. Thus, maximal isometric strength was decreased significantly immediately after eccentric contractions, which was followed by recovery process (Fig. 1-1). Perceived muscle soreness ratings significantly increased with advancing time in both trials (Fig. 1-2). Relaxed elbow angle was decreased significantly after eccentric actions in both trials (Fig 1-3). There was no main effect of time for CPK activity, though the gradual increase in mean of CPK activity with time existed (Fig. 1-4). There was no significant treatment-time interaction

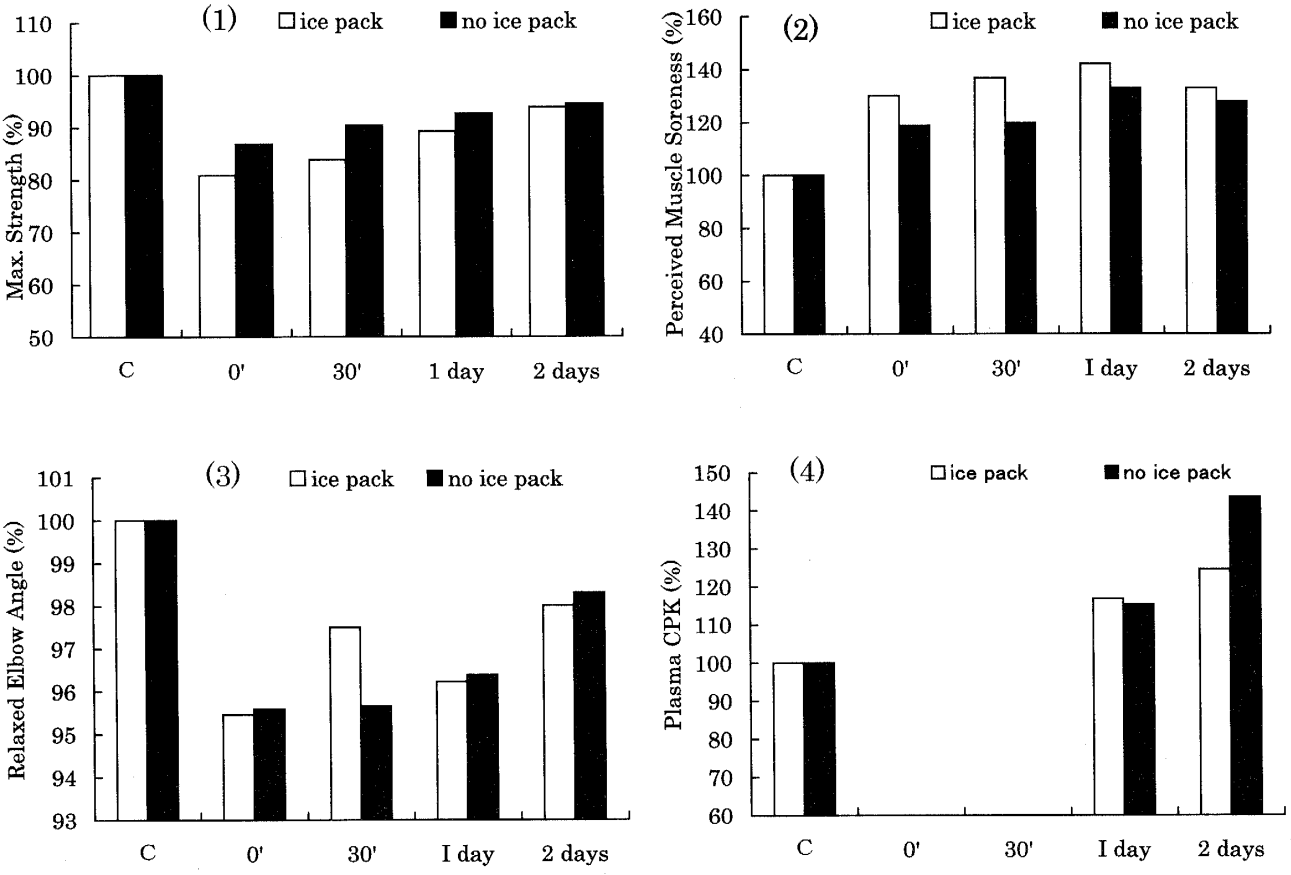

Fig.1 Effect of ice pack treatment on maximal isometric strength (1), perceived muscle soreness (2), relaxed elbow angle (3) and plasma CPK activity (4). Measurements were performed before (C), immediately after (0'), 30 min (30') after eccentric contractions with or without ice pack application, and 1 day and 2 days after eccentric actions. The same abbreviations are employed in Fig. 2.

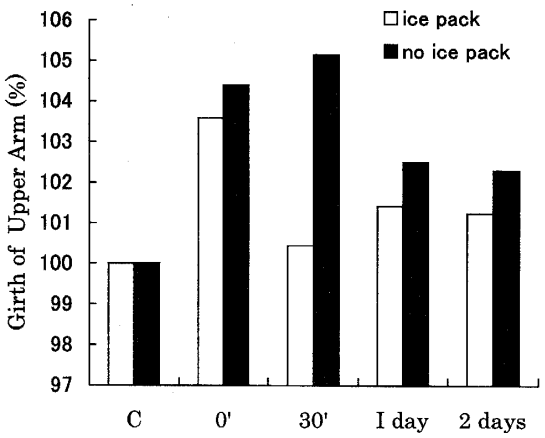

Fig. 2 Effect of ice pack treatment on girth of upper arm.

for the parameters described above. Significant cold treatment effect and treatment-time interaction were found for girth of upper arm (Fig. 2). Girth of upper arm was significantly lower in the experimental trial than in the control trial. Moreover, ice pack treatment decreased the girth of upper arm to control values immediately after treatment.

Discussion

It remains unknown whether ice pack application is effective for improving recovery from fatigue or injury in ball games, especially handball. In the present investigation, we attempted to determine the applicability of ice pack modality for improving recovery from eccentric contraction-induced muscle injury and DOMS, since movements in almost all sports including handball contain eccentric actions.

The results of this study showed that application of cold with ice pack significantly alleviate swelling in the injured muscles immediately after 30 min-long application of ice pack. However, the results also showed no positive effects on muscle strength, muscle soreness perception, relaxed elbow angle and plasma CPK activity. Thus, overall results demonstrate that cold therapy with ice pack modality has very little effects, if any, on the eccentric contraction-induced muscle injury and DOMS, which are in accordance with the previous studies (Yaczan et al. 1984) where it was observed that cold application with ice massage for 15 min did not relieve soreness and a range of motion. Cold treatment prior to or during eccentric exercise was not also shown to have significant effects on the damage response to 70 maximal eccentric contractions of the forearm flexor muscles (Braun & Clarkson 1989). Effectiveness of diverse treatments for managing eccentric contraction-induced muscle injury and DOMS has been evaluated. Thus, Hasson et al. (1993) reported that, although one of nonsteroidal anti-inflammatory drugs (NSAIDs) ibuprofen did not prevented CK release from the muscle, it decreased muscle soreness perception when prophylactically administered. On the other hand, Grossman et al. (1995) reported that ibuprofen was not effective in treating

DOMS. Concerning physical therapy, Hasson et al. (1989) have shown that pulsed ultrasound is effective in decreasing DOMS and restoring normal muscle function. Chleboun et al. (1995) have shown that intermittent pneumatic compression significantly decreases swelling and stiffness of the injured elbow flexor muscles while the loss of isometric strength is not affected. Saxton & Donnelly (1995) observed that light concentric exercise performed 4 days after 70 maximal eccentric actions significantly suppress serum CK response whereas the treatment did not affect relaxed elbow joint ankle and soreness perception. Taken altogether, the data reported so far reveals that treatments with pharmacological agents or physical therapy are minimally effective in their current treatment mode. Further studies are definitely necessary for optimize the treatment.

Hough (1902) reported that DOMS did not occur when a trained muscle was exercised eccentrically. It was recently shown that performance of one bout of eccentric exercise produced protective effects for several weeks on a subsequent bout of eccentric actions as judged from at least some parameters (Nosaka et al. 1991). These findings suggest that careful conditioning performed prior to eccentric actions is important for effectively managing eccentric contraction-induced muscle injury and DOMS.

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