STUDY REPORT

EFFECTS OF WHOLE-BODY CRYOTHERAPY ON DELAYED ONSET MUSCLE SORENESS

S2P Ltd., Laboratory for Motor Control and Motor Behaviour, Ljubljana, Slovenia

www.s2p.si

Authors:

Dr. Nejc Šarabon [nejc.sarabon@s2p.si]

Borut Fonda [borut.fonda@s2p.si]

Koper, 2012

INTRODUCTION

After plyometric or any other unaccustomed exercise, a sensation of discomfort within skeletal muscle, accompanied with decrease in muscle force, range of motion and physical performance, can be present in the elite or novice athletes (Akuthota, Ferreiro, Moore, & Fredericson, 2008; MacIntyre, Reid, & McKenzie, 1995; Proske & Morgan, 2001). This exercise-induced sensation is referred to as delayed onset muscle soreness (DOMS) and is one of the most common recurrent forms of sports injury. It is associated with exercise-induced muscle damage which in part explains the increased intensity of soreness. Muscle damage is also characterized by morphological changes such as disruption of contractile and non-contractile proteins and the plasma membrane, increases in muscle proteins in the blood (Clarkson & Sayers, 1999), prolonged loss of muscle function, swelling, and abnormality detected by imaging techniques. These are all markers of muscle damage (Tiidus, 2008).

The question of whether to use any recovery modality when a muscle has been left sore and damaged after strenuous exercise is one that has been extensively studied and addressed in the literature (Cheung, Hume, & Maxwell, 2003). A fast recovery is be important for athletes involved in a training program, or who have a competitive schedule that requires one or more high intensity efforts within a short period. It is therefore important that an appropriate balance between training, competition and recovery are implemented in order to maximize subsequent performances. Cryotherapy, the lowering of tissue temperature by the withdrawal of heat from the body, is one such intervention that my help maintain the balance between training, competition and recovery. Cryotherapy can be administered in a number of different ways and is purported to reduce inflammation, oedema and pain sensation which are all apparent following a damaging exercise.

The purpose of this study was to examine the effects of whole-body cryotherapy (WBC) on biochemical, sensational and performance factors after damaging exercise.

STUDY

Subjects (age 26.9 ± 3.8 years, height 184.5 ± 7.7 cm and weight 90.5 ± 3.8 kg) performed a damaging bout of exercise including drop jumps with emphasis on larger hip flexion and, explosive leg curl exercise and eccentric leg curl exercise. Subjects were randomly assigned into two groups. The experiment was performed in two separate occasions, where one group undertook the WBC in the first session, while the other group did not use any of the recovery modality. After ten weeks, in the next session, groups were changed and the second group performed the WBC, while the first group did not use any of the recovery modalities.

The WBC group performed the WBC one hour after the damaging exercise and then at the same time of the day for the next six days. WBC consisted of three minute exposure to temperatures ranging from -140 to -195 °C in a cryo-cabin (model: space cabin; Criomed, Ltd, Kherson, Ukraine). Feet were protected with warm shoes, while hands and head were not exposed.

Subjects were tested prior, and 1, 24, 48, 72, 96 and 120 hours after the damaging exercise. They had to assess their pain sensation in two conditions and perform three squat jumps, three counter movement jumps, three maximal voluntary contractions, three maximally explosive contractions, and two fast frequency leg stampings.

RESULTS

Perceived pain sensation evaluation was assessed using a 10 cm visual analogue scale from 0 to 10, with 0 indicating no pain and 10 indicating severe pain. Subjected indicated perceived pain sensation in two conditions: 1) during rest and, 2) during performing a squat. Significant difference was observed between the control group and the group that performed WBC every day (Figure 1 and Figure 2).

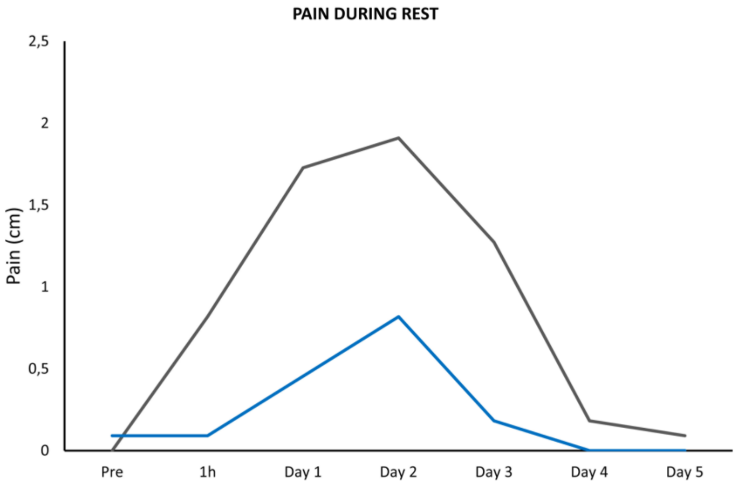

Figure 1: Pain sensation during rest. Blue line, WBC group; Gray line, Control group.

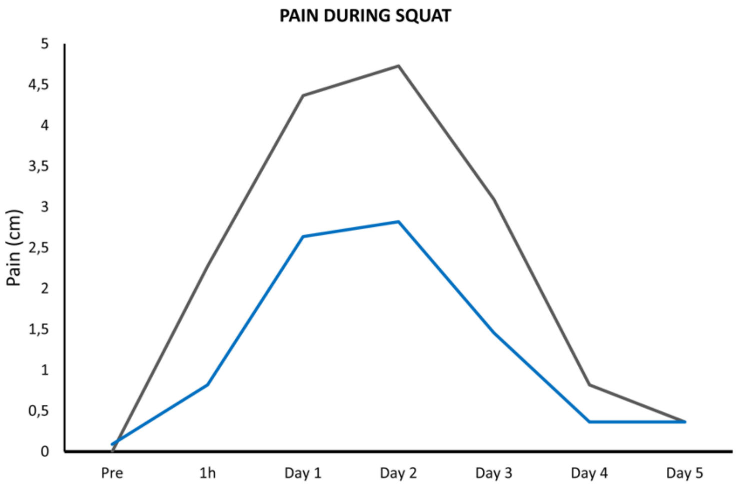

Figure 2: Pain sensation during squat. Blue line, WBC group; Gray line, Control group.

Blood samples were tested for creatine kinase (CK), aspartate aminotransferase (AST) and lactate dehydrogenase (LDH), as the most commonly used biochemical markers to confirm the onset of muscle damage. Higher the response, more damaged the muscles are. The most significant difference was observed in CK where the rise was huge in the control group, while the WBC group did not exhibit any significant rise in CK (Figure 3). AST and LDH showed differences between the groups as well.

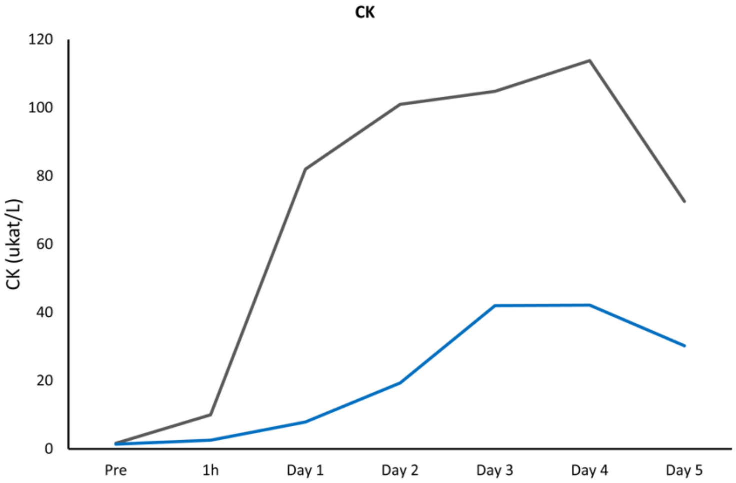

Figure 3: CK response. Blue line, WBC group; Gray line, Control group.

Squat jump (SJ) is a vertical jump and among the most often used tests for maximal anaerobic power output of the lower extremities. It is a concentric muscle action which involves coordinated upward movement by extension of the trunk, hips, knees and ankles. The following parameters were used for analysis: height and relative maximal power (i.e. maximal power divided by body weight). Both groups exhibited the drop in performance after the damaging exercise, however the group that performed WBC showed earlier regeneration and return to the values measured prior the damaging exercise (Figure 4, Figure 5).

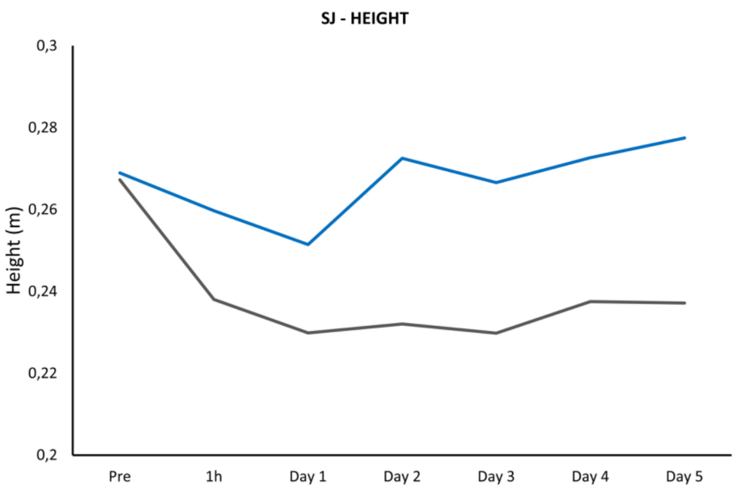

Figure 4: Height of the squat jump. Blue line, WBC group; Gray line, Control group.

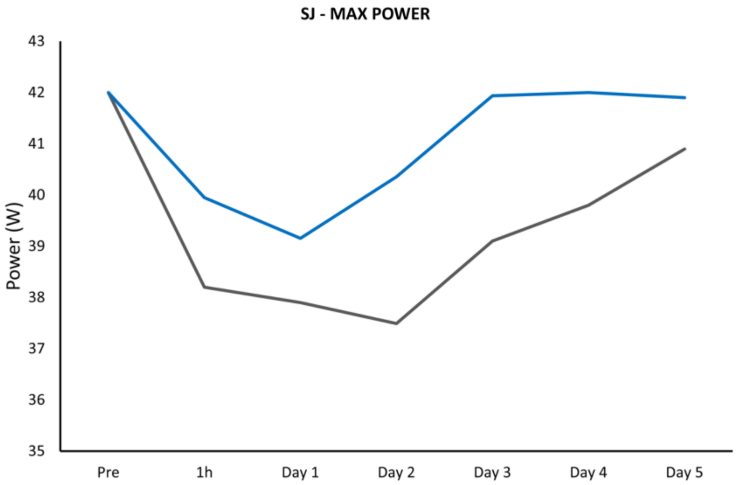

Figure 5: Maximal power during squat jump. Blue line, WBC group; Gray line, Control group.

Counter movement jump (CMJ) is a vertical jump performed with an eccentric-concentric muscle action which involves a push off action with prior counter (downward) movement. For CMJ, parameters used were: height of the jump, relative maximal power (i.e. maximal power divided by body weight), and duration of deceleration during counter movement (i.e. time from the start of deceleration to the lowest position. Height and power were decreased in both groups after the exercise, while deceleration duration increased. All parameters returned to baseline values faster in the WBC group than in control group (Figure 6, Figure 7, Figure 8).

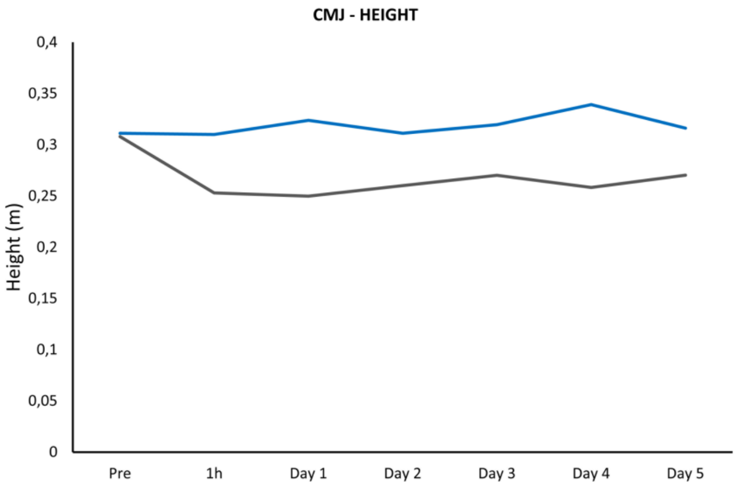

Figure 6: Height of the counter movement jump. Blue line, WBC group; Gray line, Control group.

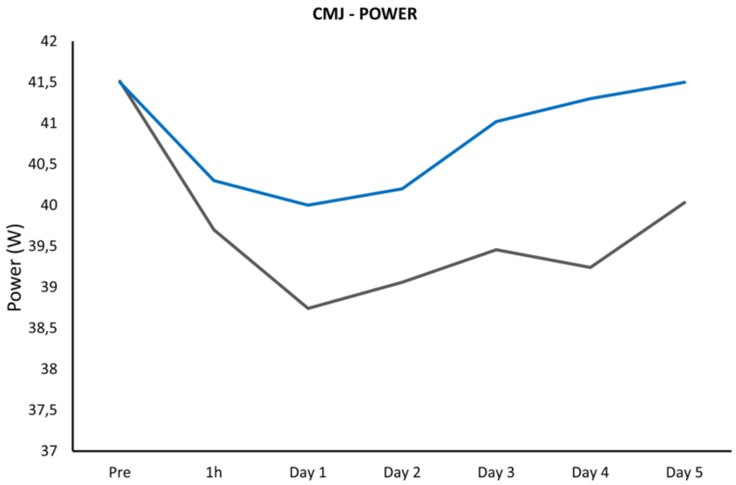

Figure 7: Maximal power during counter movement jump. Blue line, WBC group; Gray line, Control group.

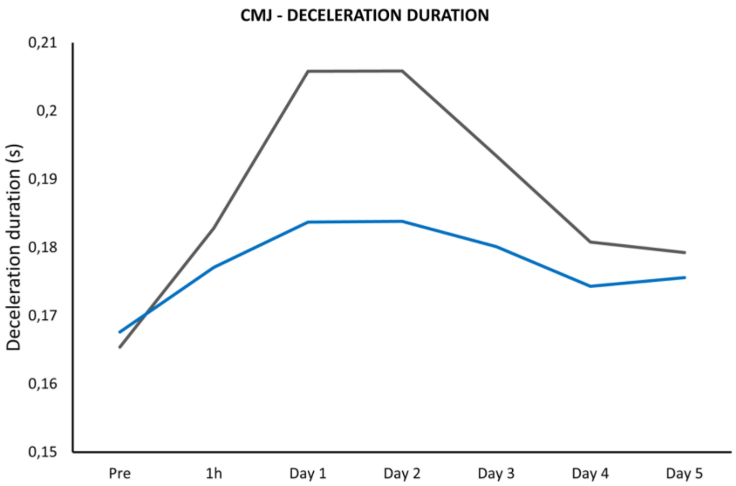

Figure 8: Duration of deceleration during counter movement jump. Blue line, WBC group; Gray line, Control group.

Fast alternating leg movements (e.g. stamping) are essential to the locomotion in agile sports such as fast acceleration, quick stops, turns or direction changes. Subjects performed 20-seconds maximal frequency stamping where we analyzed the mean frequency of stamping. Mean frequency was decreased after damaging exercise with faster return to the values measured prior exercise in the WBC group compared to the control group (Figure 9).

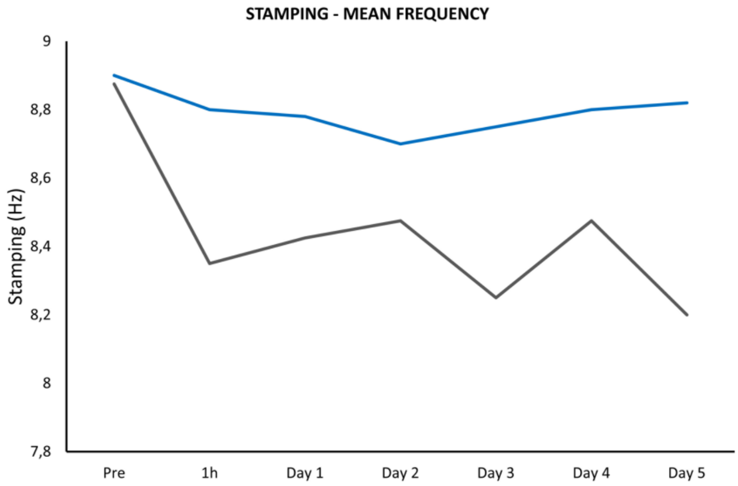

Figure 9: Stamping mean frequency. Blue line, WBC group; Gray line, Control group.

Isometric strength was measured with a dynamometer where subjects had to perform maximal voluntary contraction for knee flexion. Maximal torque was taken into further analysis. Interestingly the drop in maximal torque was observed only in the control group but not in the WBC group (Figure 10).

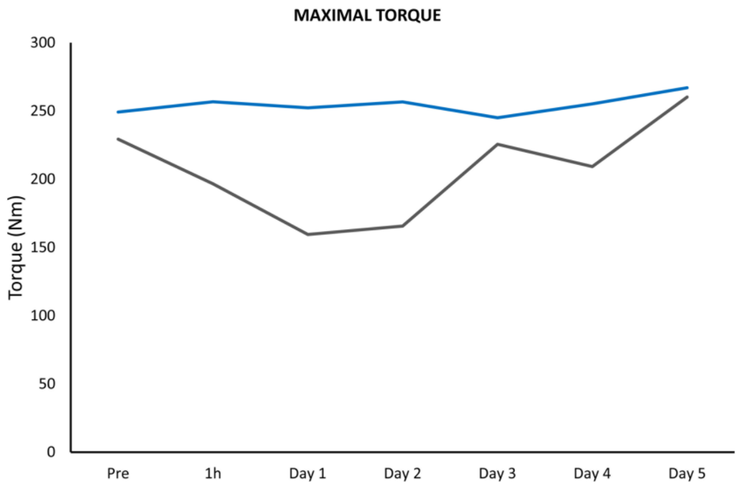

Figure 10: Maximal torque production. Blue line, WBC group; Gray line, Control group.

Maximally explosive contractions of knee flexion were performed to evaluate the maximal rate of torque development in the first 250 ms. The rate of torque development was decreased in both groups after exercise but returned to baseline values faster in the WBC group compared to control group (Figure 11).

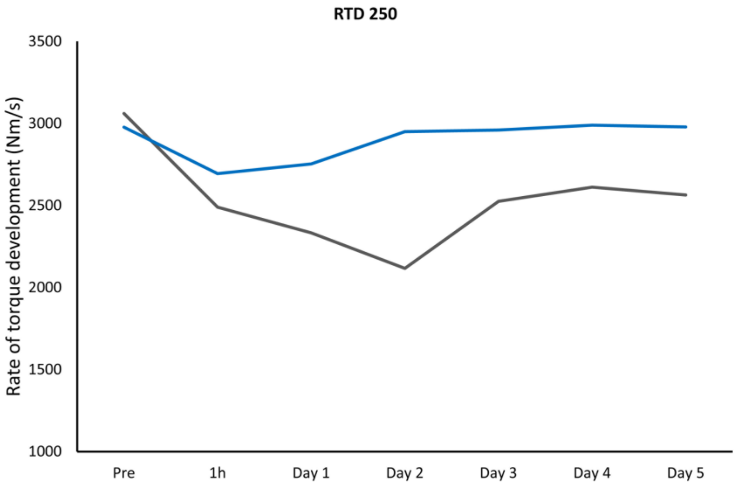

Figure 11: Rate of torque development in the first 250 ms. Blue line, WBC group; Gray line, Control group.

CONCLUSIONS

This investigation examined the efficiency of repeated WBC in enhancing recovery from exercise-induced muscle damage. This is the first study that examined the effect of WBC on the recovery from sport specific bout of heavy plyometric exercise. In previous studies (Pournot et al., 2011) was showed that WBC is effective in reducing the inflammatory process following severe exercise but no data was reported on muscle performance and motor control.

The results clearly demonstrate that repeated WBC significantly enhanced recovery process from damaging exercise to a greater extent compared to control group.

REFERENCES

Akuthota, V., Ferreiro, A., Moore, T., & Fredericson, M. (2008). Core stability exercise principles. *Current Sports Medicine Reports*, *7*(1), 39–44.

Cheung, K., Hume, P., & Maxwell, L. (2003). Delayed onset muscle soreness : treatment strategies and performance factors. *Sports Medicine (Auckland, N.Z.)*, *33*(2), 145–164.

Clarkson, P. M., & Sayers, S. P. (1999). Etiology of exercise-induced muscle damage. *Canadian Journal of Applied Physiology = Revue Canadienne De Physiologie Appliquée*, *24*(3), 234–248.

MacIntyre, D. L., Reid, W. D., & McKenzie, D. C. (1995). Delayed muscle soreness. The inflammatory response to muscle injury and its clinical implications. *Sports Medicine (Auckland, N.Z.)*, *20*(1), 24–40.

Pournot, H., Bieuzen, F., Louis, J., Fillard, J.-R., Barbiche, E., & Hausswirth, C. (2011). Time-Course of Changes in Inflammatory Response after Whole-Body Cryotherapy Multi Exposures following Severe Exercise. *PLoS ONE*, *6*(7), e22748.

Proske, U., & Morgan, D. L. (2001). Muscle damage from eccentric exercise: mechanism, mechanical signs, adaptation and clinical applications. *The Journal of Physiology*, *537*(Pt 2), 333–345.

Tiidus, P. M. (2008). *Skeletal muscle damage and repair*. Human Kinetics.