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Original article

Comparison of different cryotherapy recovery methods in elite junior cyclists

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Abstract

Background/objective: Cold water immersion (CWI) and active recovery treatment (ACT) are commonly used recovery treatments for athletes between exercise bouts, but they are sometimes limited by space and availability of equipment in training and competition venues. Therefore, the purpose of this study was to determine whether cold compression therapy (CCT) would provide the same effect as CWI and ACT as an alternative option in a hot environment.

Methods: Eight elite male junior cyclists (age, 15.5 ± 1.2 years; height, 167.7 ± 3.3 cm; body mass, 57.3 ± 3.5 kg; peak oxygen uptake, 64.7 ± 4.3 mL/kg/min) completed a maximal cycling test to determine their peak power output (PPO) and oxygen uptake. Then they completed three tests using randomised recovery protocol of CWI, CCT and ACT for 15 minutes. Each test consisted of two 35-minute exercise bouts, with 5 minutes of warm-up, 15 minutes of cycling at 75% PPO and 15 minutes maximal trial. The two exercise bouts were separated by 60 minutes (5 minutes cool-down, 10 minutes preparation for recovery treatment, 15 minutes recovery treatment, and 30 minutes passive recovery).

Results: There was no significant difference between average power output, blood lactate, rating of perceived exertion, and heart rate for two time-trial bouts for all recovery treatments. A significant decrease in core temperature was noted prior to the start of the second exercise bout for CWI.

Conclusion: CCT, CWI and ACT are all useful recovery treatments between exercise bouts.

Keywords: cryotherapy; immersion; intermittent pneumatic compression device

Introduction

Various postexercise strategies were developed in an effort to boost recovery effect during training and competition in the past decade. Among these strategies, cryotherapy—originally used to prevent swelling of acute musculoskeletal injuries[1–3]—is a common recovery method used after elite sporting events, especially for those who have a training and competition schedule that requires several bouts of exercises within 1 day or under environments of extreme heat and humidity. During training or competition in a hot environment, an increased ambient temperature may reduce the contractibility of muscle and central motor drive, and thus decrease overall muscle performance and may lead to heat injury.[4–6]

It is crucial to adopt suitable recovery modalities during the postexercise period as it would affect the training effect afterwards. Specifically, the majority of research has indicated that cold water immersion (CWI) is a common method to induce vasoconstriction, stimulating venous return, aiding metabolite removal after exercise, and reducing swelling and muscle soreness for better recovery during multiple exercise bouts.[7–9] However, factors such as water temperature and duration of immersion can be manipulated to influence the thermal outcome. For example, Peiffer et al[10] compared three different cold-water (14°C) immersion durations (5 minutes, 10 minutes, and 20 minutes) on both rectal and muscle

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temperature following a time-to-exhaustion cycling trial in a hot environment. Their result showed that 5 minutes of CWI did not decrease the muscle temperature after cooling, whereas there was no significant difference between 10 minutes and 20 minutes of treatment. Moreover, Vaile et al[8] compared the mean body temperature after 15 minutes of CWI protocols at different temperatures (10°C, 15°C and 20°C), and suggested that athletes performed better after CWI at 15°C was applied for recovery in an endurance event.

Although CWI is becoming increasingly popular to enhance recovery from training and competition, uniform and equipment constraints may hinder its usage, especially during races.[11] For road cycling events with short resting duration, CWI may not be preferred for cyclists as the resting locations are not always the same, and it is not practical to set up a movable immersion pool. In addition, the true effect on anaerobic performance is still under debate. Crowe et al[12] examined the effect of 15-minute CWI in between two bouts of 30-second all-out cycling tests. Although the blood lactate level after CWI was significantly reduced when compared to that of the passive rest group, peak power and total work were significantly lower than the latter, which suggested that CWI is not a preferable recovery method to passive recovery in terms of anaerobic performance.

In contrast, cold compression therapy (CCT) can be achieved by applying cold compression wrap on local injury or worked-out sites. It shares the same principle of reducing muscle tissue temperature with CWI without the associated inconveniences of CWI. CCT may be as effective as CWI and has been used as an alternative recovery technique for multiple exercise bouts within the same day.[11,13] However, little scientific evidence exists to substantiate its effectiveness on postexercise recovery.

To the authors' knowledge, there was only one study that reported ice application with adjunctive compression leading to a greater magnitude and rate of cooling when compared with the ice application without compression. Janwantanakul[14] examined the effect of different levels of compression in ice treatment and found that with a higher level of compression, a shorter time was required to lower the temperature. This justified the use of compression wrap during rehabilitation and after exercise for higher recovery rate. Meanwhile, compression has been proven to be effective in preventing performance degradation as well as muscle soreness.[15] An increase in hydrostatic pressure on the body may have contributed to the beneficial effect of lower rectal temperature during CWI. De Pauw et al[16] examined the effects of cooling with compression for recovery between two same-day bouts of 30-minute cycling time trials and found no significant differences in performance when compared with passive recovery. This may attributable to the small surface area covered by the cooling apparatus and the fairly low pressure applied (20 mmHg). Moreover, there was no comparison between CCT and CWI strategy in any form of indicators in exercise performance in the study.[16]

Active recovery treatment (ACT), which refers to gentle exercise during the recovery period, has been widely adopted by athletes between two exercise bouts. ACT was proven to enhance lactate removal and improve sports performance.[16] Therefore, ACT serves as an ideal control for investigating the effect of different recovery treatments. However, ACT may not be allowed in some training and competition venues because of limited space and equipment.

Developing experimental models to examine the value of recovery modalities as integral components of training specific to the needs of athletes should consider exercise mode, training volume, and intensity.[17] Most studies of CWI treatment in cycling that lasted for 5–30 minutes did not provide clear and specific guidelines for cryotherapy.[13,18,19] Post-treatment recovery time ranged from 30 minutes to 48 hours.[8,9,15] For sports with multiple bouts and short rest intervals in between, for example, track cycling, a plausible and realistic recovery modality should be well defined. As aforementioned, CCT could be a substitute for CWI as they have a similar recovery effect, and CCT also has a more convenient setup. Therefore, the purpose of the present study was to determine whether CCT intervention would provide the same effect as CWI and ACT treatment on recovery in a hot environment. It was hypothesised that CWI, ACT, and CCT should have no significant differences in recovery effect by comparing cycling performance after a rest interval in between sessions.

Materials and methods

Eight elite male junior cyclists (mean ± standard deviation; age, 15.5 ± 1.2 years; height, 167.7 ± 3.3 cm; body mass, 57.3 ± 3.5 kg; peak oxygen uptake, 64.7 ± 4.3 mL/kg/min) were recruited to participate in this study. All participants provided written informed consent and were free from any known illness and cardiovascular concerns at the start of the study. The experimental procedures and risk factors were explained to all participants before the study began. Hong Kong Sports Institute Research Ethics Committee approved the experimental protocol, and the rights of the participants were protected. All tests were conducted in a temperature-controlled and humidity-controlled chamber (Welltech, Hong Kong, China) with ambient temperature at 31.4°C, relative humidity at 74%, and wind speed 0 m/s. Considering that cyclists always train in daytime during summer, this setting (data from the Hong Kong Observatory for the summers of 1981–2010) was able to simulate their training environment. Participants were also instructed to abstain from intense exercise in the 24-hour period prior to each session.

A randomised crossover design was adopted in this study, and the participants were required to perform three trials, each separated by 2–5 days. Prior to participation, all participants completed a maximal cycling test on an electromagnetically braked lower extremity cycle ergometer (Lode, Excalibur, Groningen, The Netherlands) to determine peak power output (PPO) and maximal oxygen uptake (VO_2max). The maximal cycling test was carried out at a fixed cadence of 90 rpm. Expired gas was analysed by a metabolic gas analysis system (MedGraphics CPX Ultima System; MGC Diagnostics