Whole Body Cryotherapy as a Performance and Recovery Modality

What is the evidence?

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Introduction

Many athletes utilize Whole Body Cryotherapy (WBC) for workout recovery and injury recuperation. But is it worth the effort that it takes complete the process?
Whole Body Cryotherapy has become an emerging form of treatment used by many athletes to speed recovery from strenuous workouts. Some athletes experience prolonged muscle soreness and pain for up to 7 days after some workouts.(1) The soreness and pain can impair the athlete's performance during the extended recovery period. It has been well established that strenuous workouts cause structural muscle cell damage that that leads to delivery of proinflammatory cytokines and delayed onset muscle soreness and swelling in response to muscle injury. The release of these cytokines is often related to exercise intensity. (2) During the recovery period, athletes may not be able to function at optimal levels. Cold therapies have been thought to help with recovery by decreasing these inflammatory responses to muscle injury. Athletes have used modalities as simple as ice bags as well as more novel treatments such as whole-body cryotherapy to help recovery from workouts. These cutting-edge treatment modalities have gained headlines as high profile athletes like Lebron James tout their ability to accelerate muscle recovery. (3) But what does the evidence show about these novel treatments?

History of Cryotherapy

The word cryotherapy originates from the Greek language cryo = cold and Therapeia = cure. The Egyptians used cryotherapy as early as 2500 BC to treat inflammation and injury. Use of cold for treatment of swelling and pain has been described by Hippocrates and many ancient scholars. In 1961 liquid nitrogen became available for use clinically. WBC, as it is known in today's society, emerged after a Japanese physician Dr. Yamaguchi used freezing cold therapy to treat rheumatoid arthritis. He noted that after rapid cooling of the skin the body released endorphins and reduced pain. This paved the way for today's use in chambers that are designed to cool the body rapidly and improve recovery. (4)

WBC Process

The process of WBC treatment involves using a cryosauna unit. While in the unit, extremities are protected by undergarments, gloves, slippers and socks. It is important that the athletes skin is dry before entering the unit to prevent skin burning and necrosis. The sessions usually last between 1.5 and 3 minutes. WBC exposure temperatures range from -110 to -190 degrees C. (1) The air is cold but does not contain any moisture. The athlete feels cold, but it should not be uncomfortable. The skin temperature is expected to drop to 10 degrees C and should return to normal in a few minutes. This temperature change is enough to trigger the body's natural healing mechanisms. These mechanisms are thought to accelerate healing and recovery. The cost of the treatment is between 60 and 100 dollars. (5,6)

There are conditions that could potentially have adverse effects, which include the following:

- Pregnancy
- Blood or heart conditions
- Current treatment for cancer
- Seizure disorder
- Current kidney or Urinary tract infections
- Open wonders or ulcer
- Under the influence of drug or alcohol
- Sweaty or Wet skin (can lead to frost bite)
- Hypothyroidism
- Raynaud Disease
- Claustrophobia

WBC Physiology

WBC has been found to have effect on several blood parameters. Specifically, hemoglobin (Hb), Hematocrit (Ht), and Red Blood Cells (RBC). These changes were found to be transient and influenced by the type and intensity of the exercise that athletes perform. Several studies have evaluated each of these blood parameters. Studies conducted by Lombardi et al. and Szygula and colleagues both demonstrated a reduction in Hb, Ht, and RBC after consecutive treatments with WBC. Both of these studies took physically active subjects and subjected them to exercise and WBC sessions. The treatment sessions were either once or twice per day with the duration of the studies ranging from seven to thirty days. Decreases in Hemoglobin were found to be 15.06 + or - .84 to 14.70 + or - .62. These numbers returned to normal after 30 sessions of treatment. Hematocrit only changed a small amount 45.79 + or - 2.41 down to 45.20 + or -1.89. Red Blood Cells changes ranged from 5.11 + or - .33 down to 4.98 + or- .27. Reticulocyte counts did not change. This is relevant because WBC should not cause a false positive test for illicit bone marrow stimulation, as in blood doping. There have been other studies that did not show this decreased effect. This is thought to be due to the type of exercise and intensity of exercise that the subjects performed. Studies evaluating white blood cells showed no change or only a slight increase in cells after WBC treatments. In studies conducted by Lombardi et al and also Ziemann et al the white blood cell counts always remained in physiologic range. Platelet levels were not affected by WBC treatment. (7,8)

Lipid Concentrations

Lubkowska et al. evaluated WBC and its effect on blood lipid profiles. They tested 69 male subjects and exposed them to varying numbers of WBC therapy sessions. They found that Low Density Lipoproteins (LDL), total cholesterol (TC), and triglycerides all decreased significantly with WBC treatments. High Density Lipoproteins (HDL) increased. [See table 1] These changes were found to be dose dependent, implying that an increase in the number of treatments resulted in a greater effect on the profile. WBC is thought to increase thermogenesis and lypolysis leading to improved levels. Studies have not shown any significant changes in Lean, or Fat body mass percentages. (9)

Table 1: Effects of WBC on Lipids

TC changes (mg/dl)	172 + or - 44.5 Decreased to 151.8 + or - 16.1 after 20WBC sessions
LDL changes (mg/dl)	97.7 + or – 48.3 Decreased to 72.8 + or - 52 after 20 WBC sessions
HDL changes (mg/dl)	53.2 + or - 16.5 Increased to 63.1 + or - 27.4 after 20 WBC sessions
Triglycerides (mg/dl)	108 + or – 50 Decreased to 69.4 + or – 27.2 after 20 WBC sessions

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Inflammatory Markers

Several studies evaluated the effect of WBC on inflammation. The results were mixed and not very consistent. The results also demonstrated more completed sessions led to a greater the effect on the body. Pournot et al. demonstrated that IL-IB 24 hours post treatment and C-reactive protein were both decreased after exercise and four treatments of WBC. They concluded that WBC treatment performed immediately after exercise impaired the inflammatory process and therefore improved muscular recovery. (6) Ziemann et al. demonstrated that 5 days of WBC twice per day reduced TNF alpha serum concentrations by 60%. Mila-Kierzenkowska et al. showed that in male volleyball players a pretreatment with WBC before submaximal exercise

decreased IL-1B and IL-6 levels. Ziemann et al. also demonstrated this effect. The authors found that a single session of WBC had the same effect as doing passive recovery, for example IL-6, IL-1B, and IL-10 all increased. The players then completed WBC twice a day for 5 days and IL-6 and IL-1B stayed at the same level as baseline. IL-10 remained elevated. (6) The differences displayed among these studies could be due to differences in exercise protocols and differences in body types. The effects of the WBC treatment also seemed to dissipate after the treatments are discontinued.

Recovery

Decreased perception of muscle pain and fatigue after WBC therapy was shown in a study by Hausswirth et al. They evaluated 9 endurance runners and compared WBC, Far infrared therapy and passive recovery. Each runner was evaluated for maximal isometric force generated during voluntary isometric contractions of the knee extensor muscles at 1, 24, and 48 hours after a run on a treadmill. The improved recovery effects were shown as early as 1 hour in the WBC group, the infrared group showed improvement only at 48 hours and the passive recovery group did not show any change at all (10).

Negative Implications for Muscle Growth?

A series of articles evaluating the effects of cold-water immersion on muscle adaptation after exercise have shown notable findings. These evaluations did not involve the use of WBC, however, there is emerging evidence that the results from cold water immersion hold true for WBC as well. One of the articles published by Roberts et al. utilized a randomized control trial. Twenty-four physically active men underwent a lower body strength training program with 12 randomly assigned to post workout cold water immersion and 12 with active recovery. Study participants completed the lower body training twice per week and had cold water immersion 5 minutes after the workout or active recovery on a stationary bike. The study duration lasted 12 weeks. Lower body strength was assessed before and after the training program. Muscle mass was measured by MRI and muscle biopsies were completed to evaluate for fiber type and for cross sectional area. The outcomes showed that muscle mass was significantly smaller in the cold-water immersion group compared to the active recovery group. Both groups improved but there was a 206 gram difference between the groups, 309 grams for active recovery and 103 for cold water immersion. With respect to strength, both groups improved significantly but the active recovery group displayed a 57 Kg Leg press, and 15.6 kg knee extension improvement over the cold water immersion group. Anabolic signaling inside the muscle was significantly higher in the active recovery group which led to greater strength gains and hypertrophy. This shows that cryotherapies intended to decrease inflammation and soreness may actually be counterproductive to muscle adaptation if completed after strength training (11).

Comparisons

Cold Water Immersion

Many athletes use cold tubs to help recovery from injury and soreness. Vieira et al. evaluated 42 college aged men after an exercise protocol. They were randomly placed in one of three groups: cold water emersion at 5 degrees C, 15 degrees C, or control group (no cold treatment). They measured isometric knee extension torque, muscle soreness, countermovement jumps, and creatine kinase levels at specific times. Participants were tested immediately after, 24, 48, 72, 96, and 168 hours post exercise protocol. Results displayed that countermovement jumps recovered faster than the controls. They recovered to baseline at 72 hours for 15 degree group and 96 hours at 5 degree group. The controls did not recover to baseline during the testing visit. CK improved to baseline in 15 degree group at 72 hours, the 5 degree group and control did not return to baseline during the testing period. Muscle soreness improved at 24 hours post testing in the 15 degree group as compared to the other groups (12).

Wilson et al. evaluated WBC, vs cold water immersion, or placebo after resistance training. They tested 24 well trained males. The exercise protocol required a completion lower body weightlifting. After the session the subjects were placed into groups. Cold water immersion for 10 min at 10 degrees C, WBC for 3 to 4 min, and the control

group had no treatment. The evaluation measures consisted of perceived muscle soreness, inflammatory proteins levels, and muscle function test like peak torque isometric contractions, Reactive Strength Index, and counter movement jumps up to 72 hours post exercise. Subjects could not workout, receive other treatments like massage or take anti- inflammatory drugs during the 72 hour period. The results showed that WBC worked best for perceived muscle soreness. The WBC soreness returned to baseline at 72 hours but did not reach baseline in the other two groups. Isometric squats were improved with WBC at 48 hours as compared to cold water immersion and placebo. Values for squats were unclear or trivial at 24 and 72 hours. Counter movement jump data showed that all groups had decreased performance. WBC showed a greater decrement at 24 and 72 hours post treatment. Cold water immersion showed greater decrements at 48 and 72 hours.

The results also showed that there was very minimal change in blood inflammatory markers in response to WBC and cold water immersion as compared to placebo (13).

Peake et al. also showed very little influence on inflammatory markers after intense resistance exercise with the use of cold water immersion for active recovery. They tested 9 physically active men using single leg exercises and then 10 minutes of cold water emersion at 5 degrees C. Participants completed muscle biopsies before and at 2, 24, and 48 hours after exercise. They found that inflammatory cells cytokines, neurotrophins and heat shock proteins did not differ significantly between the recovery treatments (14).

Conclusions and Recommendations

Cryotherapy is used frequently by athletes and non-athletes alike. The results from the use of these treatment modalities are mixed. As a result of these inconsistencies, making definitive recommendations about treatment recovery protocols is difficult. Certainly, WBC seems to be effective in relieving perceived soreness, fatigue and muscle pain, but it has not been definitively shown to improve blood markers of inflammation consistently. The use of WBC also has been shown to be more effective from an inflammation standpoint with increased use. It also has positive effects on lipid profiles, but negative effects on strength and muscle hypertrophy if used immediately after strength training sessions.

Athletes are mostly concerned with how they feel and how they will perform and less concerned about the markers of inflammation or how these markers change by recovery treatments. Health and performance professionals should be aware of the above literature and make recommendations for treatments that take into consideration budgetary constraints, the type of athletic training session and athlete's performance goals. With that in mind, use WBC for recovery and improvement in soreness and refrain from using these treatments immediately after strength training sessions.

We will need further controlled studies to conclusively determine when and how often this treatment modality should be implemented.

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