PHYSICAL AND NUTRITIONAL THERAPY FOR ATLETIC TRAINING RECOVERY

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ABSTRACT

Athletic training causes physical stress and depletion thus adequate recovery is needed to compensate it. Recovery strategies should be emphasized on resolving neurological, physical, nutritional and psychological fatigue due to exercise load. Among the techniques used for recovery are nutrition therapy and physical therapy which is usually in the form of hydrotherapy. Nutrition is needed to compensate caloric lost. It emphasizes on rehydration and carbohydrate and protein replenishment to stimulate anabolism and prevent structural catabolism. Hydrotherapy is intended to accelerate the recovery process especially on neural and muscle recovery through several processes includes changes in local hemodynamic and neural stimulation. The holistic approach for recovery training gives better responses rather than using isolated recovery techniques. The recovery techniques that can be employed and elaborated include active recovery, alternating hot-cold hydrotherapy, and nutritional plans. The combination of recovery techniques prevented overtraining syndrome and produce a higher rating of overall wellness which finally increase athletic performance.

Keywords : Recovery, Nutrition therapy, Physical Therapy

INTRODUCTION

Athletic training causes physical stress and depletion on physical, nutritional, neurological and psychological capacity (Kuipers, 1998:1137). Recovery is needed to adapt and compensate the stress and depletion. It involves improvements on muscle performance and other physiological functions. Hence, recovery is an important aspect of any physical conditioning program. Extremely hard training without giving body time to recover can lead to poor performances. Without a strategic recovery intervention, it is very difficult for an athlete to maintain a high level of performance continuously. Moreover in the long run, this will damage body tissues and create permanent injuries which is evident in overtraining syndrome (Budgett, 1998:107). Psychological, endocrinogical, physiological, and immunological factors all play a role in this syndrom. Careful monitoring of athletes and their response to training may help to prevent the overtraining syndrome. However, with a very careful exercise regimen and regeneration strategies, symptoms normally resolve in 6-12 weeks but may continue much longer or recur if athletes return to hard training too soon (Lehmann *et al.*, 1997:17).

Recently a lot of emphasis has been placed to accelerate the recovery process so athletes can proceed to successive bouts of training or competition without the associated fatigue or burn out effects. Numerous physical, psychological and nutritional methods have been used to accelerate this process. There has been an increase of the use of nutritional therapy and physical therapy (hydrotherapy) with little scientific evaluation of its use and effectiveness for exercise recovery (Budgett, 1998:107) . Among several hydrotherapy techniques are alternating hot–cold water immersion and cold bath. Reports from coaches, medical personnel and athletes suggest that this overall method has positive effects on subsequent performance (Cochrane, 2004:32). The aim of this review was to provide the scientific rationale and mechanisms of nutritional and physical therapy for post exercise recovery.

RECOVERY

Recovery is defined as the return of physiological condition to its pre-exercise state following exercise (Lehmann *et al.*, 1997:17). Shortly, after exercise, aerobic metabolism remains elevated. This physiological response defined as "**excess post-exercise oxygen consumption**" (EPOC) which consists of a fast and slow component (Kuipers, 1998:1137). According to Lehman (1997:18) the fast component aim to restores 70% of ATP and PCr energy stores within 30 second and reloads plasma hemoglobin and muscle myoglobin. Dependent on the exercise intensity it may take up to 24 hour for the slow component to return to its resting levels. Phosphagen stores take 3–5 minutes to fully recover compared to an hour or more for the resting return of lactate and pH. The rise in lactate production can disrupt the muscle contractile processes and the existing transport and metabolic pathways can become less efficient (Cochrane, 2004:32). The use of passive (no exercise, massage, contrast hydrotherapy) or active recovery (light exercise) and nutrition therapy for replenishing fuel stores and removal of metabolic wastes has implications for accelerating post exercise recovery rates (Cochrane, 2004:32).

Metabolic removal in active and passive recovery

Lactate production is evident when training or competing; however, the amount produced is dependent on the duration and intensity of the exercise and the length of the recovery interval. Hot–cold immersion may have some roles in aiding recovery if waste products are cleared faster (Cochrane, 2004:32). However, the mechanism by which active recovery promotes lactate removal is not clearly understood. This process is complex as it depends on a range of factors for example, local blood flow, chemical buffering, movement of lactate from muscle to blood, lactate conversion to pyruvate in liver, muscle and heart (Senttä *et al.*, 1998:1).

Research has shown that lactate removal is increased when active recovery periods are implemented compared to passive rest for continuous or repeated bouts of exercise found that a recovery period of moderate continuous intensity facilitated lactate removal faster than passive recovery. Additionally, a combination of high intensity (65% VO2 max) and low intensity (35% VO2 max) was no more beneficial than a recovery of low intensity (35% VO2 max) for 40 minutes. From isotope tracer studies, it is suggested that lactate produced in fast twitch muscle fires can be transported to other fast twitch or slow muscle fibers for pyruvate conversion, which undergoes chemical reactions for aerobic energy metabolism (Martin *et al.*, 1998:30). This shuttling allows for both production and removal of lactate. During recovery from low intensity activity, lactate clearance may be enhanced by active muscles causing a pumping action and adjacent muscles providing oxidative metabolism to removing metabolites (Cochrane, 2004:32).

NUTRITIONAL THERAPY

The main objectives of nutritional therapy in recovery process are to rehydrate and to replenish carbohydrate and protein lost during high intensity activity. Rehydration is the first objective in nutritional therapy for athletic recovery as although water has no nutrient value, it is essential since water is needed as a medium for much biochemical process (Burke *et al.*, 2004:30).

The second objective of nutritional therapy is carbohydrate replenishment as carbohydrate loss is the most obvious nutritional issue caused by endurance exercise. Carbohydrate in the form of muscle and liver glycogen is the primary fuel the body for the first 60-90 minutes (Burke *et al.*, 2004:30). As muscle glycogen becomes depleted, the body increase fat metabolism to reserves carbohydrates and protein consumption during prolong exercise.

However, fat metabolism requires more complex mechanism, thus several studies have shown that the pre-exercise muscle glycogen level is a very important energy determinant for exercise performance (Kuipers, 1998:1137). This lead to developing technique called carbohydrate loading which is the strategy to enhance glycogen capacity before competition or training. Furthermore, glycogen capacity can be substantially increase through the process of replenishing during recovery process.

According to Burke (2004:30) The mechanism of increasing glycogen storage involves insulin modification. Along with insulin, which regulates blood sugar levels of ingested carbohydrates, an enzyme known as glycogen synthase converts carbohydrates from food into glycogen and stores it in muscle cells. This also drives the muscle repair and rebuilding process . However, to maximize the recovery process, it is needed to take advantage of glycogen synthase when it's most active.

Carbohydrate replenishment as soon as possible after exercise, when the body is most receptive to carbohydrate uptake, maximizes both glycogen synthesis and storage. Glycogen synthesis from carbohydrate intake takes place most rapidly the first hour after exercise. A less-fit athlete, or one who has not been refueling properly after exercise, has very limited muscle glycogen available, perhaps as little as 10-15 minutes worth (Burke *et al.*, 2004:30). A fit athlete who has been consistently refueling his or her body with carbohydrates immediately after exercise can build up a glycogen supply that will last for up to 90 minutes of intense exercise. Additionally, consumption of carbohydrates will also tip the scales in the direction of protein synthesis instead of protein catabolism (breakdown). In other words, a sufficient amout carbohydrate is essential in rebuilding muscle cells as well as restoring muscle glycogen (Burke *et al.*, 2004:30).

Studies suggest that the carbohydrate inflow gives the muscle cells the necessary fuel to begin the rebuilding process. Using the energy derived from carbohydrates, the muscles absorb amino acids from the bloodstream, helping initiate protein synthesis. Carbohydrates also boost the production and release of insulin from the pancreas. Insulin is an anabolic (tissue-building) hormone that has a profound positive impact on protein synthesis in muscles, and it also tends to suppress protein breakdown (Burke *et al.*, 2004:30). As the conclusion, for replenishing glycogen stores and aiding in the rebuilding of muscle tissue, quick replenishment of carbohydrates is a must. Ideally it should be done within the first 30 minutes, consume 30-60 grams of high quality complex carbohydrates (Burke *et al.*, 2004:30).

Carbohydrate intake promotes many aspects of post-exercise recovery, but it should be supported by protein. Protein will be the raw materials to rebuild stressed muscles. Whey protein is the premier protein source of the three branched chain amino acids (BCAAs, leucine, isoleucine, valine) used for muscle tissue repair. Furthermore, protein will enhance glycogen storage. It is shown that the consumption of carbohydrates plus protein, versus carbohydrates alone, is a superior way to maximize post-exercise muscle glycogen synthesis. Protein is also thought to increase immune system maintenance (Burke *et al.*, 2004:30).

PHYSICAL THERAPY

One of the physical modalities widely used for post exercise recovery is hydrotherapy (Cochrane, 2004:32). Warm spas with cold plunge pools or contrast hot–cold baths and showers are common practices used by athletes after training or exercise. Contrast hot–cold water technique is thought to accelerate recovery by increasing the peripheral circulation by removing metabolic wastes and stimulating the central nervous system. It is also suggested that contrast hot–cold increases lactate clearance, reduces post exercise oedema and enhances blood flow to the fatigued muscle (Cochrane, 2004:32). Additionally, it is thought to slow down the metabolic rate and revitalize and energize the psychological state (Kenttä *et al.*, 1998:1).

Physiology of Cooling and Heating in Hydrotherapy Related to Recovery

There is a general consensus that the application of cold ice or water immersion decreases skin, subcutaneous and muscle temperature. The decrease in tissue temperature is thought to stimulate the cutaneous receptors causing the sympathetic fibres to vasoconstrict which decreases the swelling and inflammation by slowing the metabolism and production of metabolites thereby limiting the degree of the injury. Superficial tissues can remain cool up to four hours from ice packs or cold water immersion (Wilcock *et al.*, 2006:747).

It is found that cold pack treatment up to 20 minutes significantly decreased superficial tissue temperature by dulling and reducing the sensation of pain. They concluded that cold pack treatment limits the amount of swelling in acute injuries by slowing the metabolic rate by shunting less blood to the cold superficial area (Cochrane, 2004:32). Earlier research has shown that metabolites are cleared by the blood exchange from superficial to deep tissue. Incoming warm blood is diverted to the deeper tissues thereby slowing down the cooling effect of the deep tissues. A cooling effect also decreases nerve conduction velocity in superficial tissues by slowing the rate of firing of muscle spindle afferents and reflex responses thus decreasing muscle spasm and pain (Wilcock *et al.*, 2006:747).

Thermotherapy has shown to increase tissue temperature, increase local blood flow, increase muscle elasticity, cause local vasodilation, increase metabolite production and reduce muscle spasm. Additionally, superficial heating decreases sympathetic nerve drive which causes vasodilation of local blood vessels and increases circulation. The increased blood flow allows an increased supply of oxygen, antibodies and the ability to clear metabolites. It is proposed that if contrast therapy is reported to produce physiologic effects (vasodilation and constriction of local blood vessels, changes in blood flow, reduction in swelling, inflammation and muscle spasm) significant fluctuations of muscle temperature must be produced by the alternating hot–cold contrast treatments (Cochrane, 2004:32).

Active recovery often requires additional energy that further depletes precious energy stores therefore, if passive recovery is proven to increase glycogen resynthesis contrast hydrotherapy may be justified as a post training tool (Burke *et al.*, 2004:30). However, most athletes have the tendency to spend more time in the warm water immersion thus if setting the purported benefits as dehydration and neural fatigue are accentuated. Additionally, if competition is conducted at night recovery could be compromised if other engagements such as team debriefing, after match functions or press conferences take priority. A comparison of lactate clearances following passive rest, light exercising (active recovery) and the contrast immersion protocol was undertaken (Lehmann *et al.*, 1997:17). Results indicated that lactate levels were recovered equally fast by using either the contrast water immersion or the active recovery protocol. However, the lactate recovery following passive rest was significantly slower (
Канttä *et al.*, 1998:1).

In sports medicine contrast baths have been used to treat sub-acute soft tissue and joint injuries by alternating hot–cold, thus promoting vasodilatation/vasoconstriction causing a ‘pumping’ action to reduce swelling of the injured site (Cochrane, 2004:32). This ‘pumping’ action may explain reports of reduced post exercise stiffness and the accelerated return to basal and metabolic resting levels. However, the removal of metabolites and reduced swelling from the mechanical force of alternating hot–cold immersion is unproven and contentious. It is suggested that the significant skin temperature fluctuations from the hot–cold contrast packs caused vasoconstriction and vasodilatation thereby initiating subcutaneous response and mechanical shunting (Wilcock *et al.*, 2006:747). Conversely, they argue that the increase in local blood flow would not reduce oedema, as swelling reduction requires the removal of debris and fluid performed by the lymphatic system. Since the lymphatic system requires muscle contraction or gravity to move fluid contents, it is unlikely this mechanism can be substantiated, as lymph flow is independent of circulatory changes (Cochrane, 2004:32).

The investigation found that the hydromassage intervention was able to return haematocrit, plasma potassium and lactic acid levels to resting levels faster than those who received no hydromassage. However, the acquired effects of hypergravity and proprioception from the underwater jets to assist the clearance of waste products were not discussed. Further research is needed to establish whether mechanical shunting from the hot–cold immersion elicits a possible mechanism for metabolite removal to accelerate post exercise recovery. Application of alternating hot and cold water to the whole body can help recovery by increasing blood flow, stimulating the central nervous system, decreasing swelling, decreasing stiffness, increasing range of motion, decreasing muscle soreness and increasing the removal of metabolites (Martin *et al.*, 1998:30).

Research suggests that an equal ratio of time in hot and cold water immersion in a bath/spa or shower is ideal. It can be conducted by 2 minutes in cold, 2 minutes in hot water, repeated 3 times (Cochrane, 2004:32). Cold treatment is the most commonly used strategy for the treatment of soft tissue injuries. Cold water immersion or an ice bath may be an effective treatment to decrease skin, muscle and core temperatures, decrease metabolism, reduce inflammation, enhance blood flow, decrease pain and reduce muscle spasm (Cochrane, 2004:32).

Neural recovery

It is well established that during exercise there is a decrease in parasympathetic and increase in sympathetic activity. The sympathetic excitation causes a release of nor adrenaline and adrenaline that increases myocardial contractility and accelerates heart rate. Additionally, vasodilation occurs in skeletal and heart muscle, blood flow increases from vasoconstriction of other organs and the airways become dilated (Kenttä *et al.*, 1998:1). Post exercise sympathetic activity remains high but with adequate recovery it returns to resting levels. However, if a high training load, volume or intensity is repeatedly performed without the necessary rest, sympathetic activity will become unceasingly high. This often leads to overtraining/overreaching when the signs and symptoms are not detected. Neurological recovery of the peripheral nervous system may be augmented by contrast hydrotherapy, massage and floatation by reducing the load of the sympathetic activity (Lehmann *et al.*, 1997:17).

Athletes who perform hot–cold hydrotherapy after training or competition have reported lighter and less tight muscles with a feeling of mental freshness (Cochrane, 2004:32). This may be associated to central nervous system relief. However, little is known on the effects that hot–cold water immersion has on the nervous system. There are significant changes of simple reaction time of simplex reflex. As there are improvement on the speed of the central spread of electrical activation in the nerve, neuromuscular synapses and the muscle thereby producing a positive post exercise (Cochrane, 2004:32).

Muscle recovery

It has been confirmed that eccentric, intensive and unfamiliar exercises are causes of muscle damage. Delayed onset of muscle soreness (DOMS) usually transpires 24–48 hours post exercise with symptoms consisting of tender, stiff and sore muscles (Furlan *et al.*, 1993:482). Several theories have been presented to explain the physiological mechanism of DOMS but with little agreement (Cochrane, 2004:32). They include muscle fiber damage, breakdown of muscle proteins resulting in inflammation and cellular degradation has argued for a combined neural, connective and cellular mechanism.

Whatever the proposed mechanism causing DOMS the recovery process is important for regeneration. The symptoms of DOMS normally develop within 24 hour and peak between 24–72 hours (Lehmann *et al.*, 1997:17). The symptom of exercise-induced muscle damage (pain, spasm and inflammation) is similar to that of injured muscle therefore cryotherapy has been the primary treatment modality. Recent studies found that perceived soreness and resting elbow flexion returned to baseline levels when cold whirlpool and contrast therapy were administered, propagating that these treatments were more effective than warm whirlpool and passive resting (Cochrane, 2004:32). It is concluded that following exhaustive eccentric exercise the cold-water immersion appeared to reduce muscle damage and stiffness but had no effect on the perception of muscle tenderness and strength loss. It can be concluded that the research is contradictory to alleviating the symptoms of DOMS due to variations in the type, frequency and duration of treatments (Cochrane, 2004:32).

CONCLUSION

Training and competition creates an overload to stress the body, which in turn produces fatigue followed by decreased performance. Depending on the nature of the training or activities; nutritional, physiological, neurological and psychological components are stressed in different ways that result in fatigue. The site of fatigue for the neurological component is the peripheral nervous system; physiological (muscle cell); nutritional (fluid and fuel stores); and psychological (central nervous system). From the ranking system the athlete and coach can then identify the appropriate recovery techniques needed to accelerate the recovery. The recovery techniques includes rehydration and carbohydrate intake for fluid and fuel stores; hydrotherapy, ‘warm down’ and massage for increasing blood flow to fatigued muscles; visualization, progressive muscular relaxation, meditation, flotation and massage for psychological fatigue; passive rest, massage, hydrotherapy, and ‘warm down’ for neurological fatigue. The holistic approach for recovery training may give better responses rather than using isolated recovery techniques. The recovery techniques that can be employed includes physical therapy (hydrotherapy) and nutritional plans. The consequences of the combined recovery techniques prevented physical drop off and produced a higher rating of overall wellness.

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