Role of Physiotherapy in Recovery following Exhaustive Exercises

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ABSTRACT

Recovery from the exertion of exercise is one of the prime concerns of every professional group dealing with physical exercises. One of the reasons for the use of drugs in sports is to mask the fatigue while retaining alertness with increasing training loads. Absence of facility for accelerating recovery, using natural and safe means, might have potential to compel the athletes to look for the other means to combat the training loads and fall pra the menace of doping.

Natural recovery methods help to combat the rigorousness of training, without compromising the legal provisions. A number of recovery strategies ranging from psychological techniques, nutritional supplementation, and application of physical modalities and exercises are used for accelerating the recovery. The physical procedures for speeding recovery from exercise can be grouped under two broad categories - 'active recovery' and 'passive recovery'. The modification of passive recovery procedures includes massage, cold shower, specific body positioning, sauna bath, hydrotherapy etc. Of late, some electrotherapy modalities like electrical muscle stimulation, TENS and LASER have also been explored as tool of recovery.

In the light of these developments it is essential that the area of intervention of a physiotherapist, working in sports environment, should also expand to recovery and the other related areas. The purpose of this paper is to present an overview of various physical recovery methods that utilize the skills of physiotherapists.

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INTRODUCTION

Recovery from the exertion of exercise is one of the prime concerns of every professional group dealing with physical exercises. Athletes are often exposed to exhaustive activities during training and specific competitive bouts that stress the body to the maximum. Reaching the limit of physical ability is essential for increasing the physical capacity. Training induced adaptations take places during recovery. Therefore, recovery from the stress of training is of paramount importance in order to derive complete advantage of a strenuous training regimen.

Excessive volumes of intense training and competition, particularly with minimal recovery time, can place great physiological constraints on the musculoskeletal system and potentially cause symptoms of overreaching, overtraining, fatigue and results in the suppression of performance (Reilly & Ekblom, 2005). Recovery methods are employed to bring about an early reversal of altered homeostasis and a feel good factor on the psyche of the athlete.

The recovery period is not only the transition from high to low energy demands but also restoration of energy reserve, abolishment of the accumulated metabolic intermediates as well as normalization of water and ionic compositions of various tissue(Viru,1995). The objectives of recovery methods are diverse, including restoration of function, neuromuscular recovery, tissue repair, resolution of muscle soreness, psychological recovery, replenishment of nutritional energy reserve etc. (Brunker & Khan, 2010). The field of recovery is multidisciplinary and for speedy recuperation athletes use a number of recovery strategies that range from psychological techniques, nutritional supplementation, and application of physical agents and specific exercises.

While the psychological recovery and nutritional recovery are the specialization area of sports, psychologist and sports nutritionist working in the domain of physical recovery, would greatly benefit from the knowledge and skills of physiotherapists. The physical procedures for speeding recovery from exercise can be grouped under two broad categories - active recovery and passive recovery. The modification of passive recovery procedures includes massage, cold and hot shower and immersion, specific body positioning, sauna bath, hydrotherapy etc. (McArdle et al, 2001). Of late, the uses of electrotherapy modalities, as tool of recovery, in the form of electrical muscle stimulation, TENS (Babault et al, 2011) and LASER (Leal Junior et al, 2009a; 2009b) have also been explored. The purpose of this paper is to present an overview of recovery methods that utilize the skills of a physiotherapists.

Active Recovery

It is often recommended that on athlete should not terminate exercise abruptly, but engage in some form of tapering off or cool

down exercises before taking complete rest. This practice of performing low intensity aerobic exercise after a high intensity exhaustive exercise is known active recovery. The cool down exercises generally include the same activity, with reduced intensity, or some form of running at low intensity. In active recovery both the blood flow and the metabolic rate, within the active muscle, are increased. In addition, the type of exercise employed during active recovery preferentially recruits type I fibers which help reduce the accumulated lactate in blood and muscle. The three claimed main advantages of active recovery include faster removal of lactate accumulated during intense exerc improvement in subsequent performance and prevention of venous pooling due to sustained muscle pumping.

Enhanced lactate removal during light aerobic exercise as compared to resting recovery following heavy exercise, was first reported by Jarvel in 1926 (Falk et al, 1995) and has since been supported by many others (Gladden, 2000). Till date, it is the best available method for facilitating lactate recovery. The intensity of recovery exercise that produces optimal rate of removal of blood lactate has been calculated to be between 30% and 40% of VO_{2max} for untrained subjects (Davis et al, 1970) and between 50% and 60% of VO_{2max} for trained subjects (Hermansen & Stensvold, 1972).

The facilitated lactate removal, in active recovery, is attributed to two main factors associated with the low intensity aerobic exercise, i.e., increased muscle blood flow and increased muscle metabolism. Improvement or prevention of deterioration of subsequent performance with active recovery has been attributed to the two beneficial effects associated with active recovery viz., enhanced lactate removal and Sechenov Phenomenon (Hildebrandt et al, 1992). The latter mechanism refers to some central reflexogenic recuperation of muscle exercise capacity (Asmussen & Mazin, 1978) which is not dependent on muscle blood flow. It is usually believed that lowering the blood and muscle blood lactate level, post exercise, would help prevent deterioration in the subsequent performance. But, a definite cause and effect relation ship between lactic acid and fatigues has not been determined as yet and elevated blood lactate level is not always associated with performance decrement (Glaaden, 2000). Therefore, the investigation into the beneficial effects of active recovery on repeated performance yielded contradictory results. Some studies support the notion that active recovery helps reduce performance decrement, following exhaustive exercise (Dorado et al,2004;Connolly et al, 2002) On the other hand, it is also reported that as compared to passive rest the active recovery does not produce better effect on repeated performance (Mcainch et al, 2004).

Many researchers (Hildebrandt et al, 1992; Choi et al, 1994; Falk et al, 1995) have

considered active recovery disadvantageous for the reasons that it negatively affects the re-synthesis of energy reserves and may overload the already stressed cardiovascular system, and raise core body temperature that would have obvious negative impact in tropical climate. Hildebrandt et al (1992) demonstrated a post exercise recovery impairment of orthostatic blood pressure and a consequent increase in heart rate along with an accentuated plasma fluid loss, during active recovery. They also argued that recovery exercise may lead to vasoconstriction in the resting muscles affecting muscle recovery as well as the lactate distribution. Falk et al (1995) observed a higher rectal temperature associated with accelerated lactate removal during active recovery, in hot environment, which in their opinion may offset the possible benefits of lactate reduction. It is further demonstrated that active recovery delays the repletion of glycogen stores and impedes the muscle glycogen re-synthesis (Choi et al, 1994). The methods of promoting psychological and nutritional recovery may not be administered properly during active recovery.

Passive Recovery

Passive recovery emphasizes complete rest during recovery period and discourages engagement in physical activity. During this

Table 1: Classification of Passive Recovery Methods

	Group	Sub group
1	Passive rest	alone
		in combination with respiratory exercises, psychological techniques(imagery, music, relaxation practice, yog nindra, physiological relaxation methods)
2	Manual methods	Massage
		Passive movement
3	Thermotherapy based methods	
	Hot/temperate	hot shower, sauna, steam, hot water immersion
	Cold-	cold shower, cold water immersion
	Contrast	alternate cold and hot exposure (immersion, shower
4	Combination of heat water and manual method	under water massage
5	Electrotherapy	Electrical muscle stimulation
		TENS
		Laser

period of inactivity, application of physical modalities that have the potential to bring about physiologic effect similar to active recovery such as increased blood flow and reduction in overall metabolic rate, are often postulated as effective strategies for combating post exercise exhaustion. Table 1 presents a classification of passive recovery methods.

Passive Rest

The passive rest during recovery period is advocated on the presumption that the total inactivity reduces the resting energy requirements and thus frees the oxygen for the recovery of homeostatic process. Passive rest has been shown to produce better glycogen store restoration in muscle as compared to active recovery (Choi et al, 1994). The use of breathing exercises, meditation and psychological relaxation techniques, during this period of passive rest, have been shown to alter the autonomic responses and bring about relaxation(Solberg et al, 1996). The use of savasna posture, following exhaustive work, is routinely used by several Indian teams. Of late yog nindra and other yoga techniques are being popularized for ensuring faster relaxation (Boyle et al, 2004; Donohue et al, 2006). Progressive muscle relaxation technique where contraction and relaxation of muscle group, in a specific order, may also be an effective technique for combating post exercise stress.

Passive Manual Procedures

These procedures involve application of varying amount external mechanical force on the body of relaxing athlete with the aim of producing movement of soft tissue (massage# soft tissue manipulation, Myofascial release) or joints (relaxed passive movement) without active involvement of the athlete. In the field of sports, these procedures are recognized as an important preventive, restorative and therapeutic modality.

Massage

The association of massage with exercise is an ancient phenomenon recorded in all the civilizations. It is widely acknowledged among coaches and players that massage is an effective modality that can enhance the rate of recovery and reduce the soreness and discomfort following intense physical activity. Improvement of venous and arterial circulation, leading to improvement of the trophic condition of the part massaged, improved mobility of the soft tissue promoting relaxation and better functioning, reduction of pain and discomfort and improved perception of wellbeing are some of the widely known effects of massage (Sinha, 2010). Massage exerts strong psychological effects and can influence the state of arousal and contributes in a big way to enhance the perception of wellbeing. These effects make massage a powerful tool in the stress relieving strategies. Depending on the time frame and purpose of application, the various categories

of sports massage has been identified as pre event massage, preparatory massage, intermediate massage, post event massage, training massage and the medical massage which refers to the use of massage for treating the chronic injuries. All these categories employ the various techniques of manual massage in specific sequence and duration to elicit the desired effects, in relation to the training and competition.

The massage is commonly used to facilitate recovery following intense exercise, relieve discomfort of DOMS, lessen fatigue, help identify hidden soft tissue injury, identify abnormal area of biomechanical stress, identify and treat old soft tissue lesion (chronic overuse injury), enhance psychological recovery, and to modulate psychosomatic arousal during competitions.

Despite widespread use and anecdotal claims scientific evidences with regard to this modality are limited and conflicting (Hemmings, 2000). Massage is one of those health practices where a consensus on its various aspects does not exist. Several claims on its utility have not withstood the scrutiny of scientific investigations.

It is widely believed that massage, by virtue of increasing the blood flow and lymphatic drainage, may enhance the removal of H+ ions and lactate from muscle and facilitate the transport of lactate into systemic circulation (Lehn & Prentice, 1994). There is only one study (Bale & James, 1991) that supports the notion that massage facilitates lactate removal compared to passive rest. This study, conducted on nine male athletes, showed lower blood lactate level following 17 minutes of manual massage, compared with passive rest, though it was higher than that obtained following warm down procedures. However, this observation was not supported in subsequent studies (Gupta et al, 1996; Martin et al, 1998; Monedero & Donne, 2000; Robertson et al, 2004) that explored the effect of massage on blood lactate removal and reported that massage had no better effect than passive rest as far as the blood lactate removal is concerned.

Similarly, the experimental support to the notion that massage enhances repeated performance can at best be described as equivocal. Massage was found to enhance performance in some studies (Balke et al,1989; Zelikovsky et al,1993; Viitasalo et al, 1995; Rinder & Sutherland, 1995) but not in others (Cafarelli et al,1990; Drews et al,1990; Tiidus & Shoemaker ,1995; Hemmings et al,2000; Sinha & Sandhu, 2003). However, studies do support the notion that massage enhances the feeling of wellbeing and relaxation (Hemmings et al, 2000; Sinha & Sandhu, 2003).

With regards to the utility of massage in sports, one point of view considers massage as a panacea to almost all the physical problems encountered by the athletes whereas the other opinion holds that massage is mere placebo and its use should be discouraged (Tiidus, 1997). The exact

position of massage however may lies in the middle of these two extremes. A consensus on massage would be difficult to obtain from literature because of wide variation in the techniques, time, and area of body used in the experimental protocols and difficulty in exact quantification of its effects (Callaghan, 1993) which depends heavily on the skills on the operator. Therefore, if the massage is administered by a properly skilled person, for a genuine problem, its may produce beneficial effects. Conversely, unskilled therapist and imprudent application would no doubt create jeopardy.

Relaxed Passive Movement

Relaxed passive movements are a group of specialized techniques used by physiotherapists to maintain the range of motion of the paralyzed extremities and also to induce relaxation prior to active workout. The slow and rhythmic executions of these movements relieve the tension of muscle, stretch the soft tissue and promote relaxation. The role of stretching, following exercise, is well established and often athletes are advised to engage in stretch the major muscles during active recovery. These techniques may be used during passive rest or in conjunction with manual massage.

Heat based passive recovery procedures

The effects of variation of temperature on physiological system are the known effects commonly utilized by physiotherapists in clinical practice as thermotherapy. Sauna bath, steam bath, hot and cold water immersion and shower etc are used routinely by the athletes for rejuvenation and relief of stress. These techniques permit application of thermal energy to whole body.

Sauna bath

Sauna bathing is a special form of heat exposure characterized by a short-term exposure to exceptionally high environmental temperatures. It is an ancient habit in both cold and warm countries. Sauna bathing is still popular in many northern circumpolar countries and, during the past decades, it has also become a widely practiced wellness form in many central European countries. The sauna is a wood-paneled room where the bathers relax on benches well above the floor level in the heat from the heater constructed of, or filled with, rocks. The hot room air temperature falls within the range of 70 to 100°C, optimally between 80 and 90°C at the face level of the bathers. The relative air humidity, modified by sprinkling water on the heated rocks, ranges from 15 to 30%.

The sauna bath consists of repeated cycles of exposure to heat and cold. The duration of stay in the hot room, usually between five and 20 minutes, depends on each bather's own sensations of comfort. This is followed by a cool-off (shower, swim, or a period at room temperature), the length of which also depends on personal sensations. A recovery period of about 30 minutes

following a few hot/cold cycles is required for normalizing the body temperature and cessation of sweating (Kauppinen, 1989).

Sauna bath exerts several physiological effects. The cardiovascular system combats the thermal stress by cutaneous vasodilatation, and increased skin blood flow, heart rate and sweating. The sympathetic nervous system and the hypothalamus-pituitary-adrenal hormonal axis are activated to maintain thermal balance (Kauppinen & Vuori, 1986; kukkonen-Harjula & Kauppinen, 2006). The thermal challenge of the bath cycle induces several hormonal changes involved in water retention and a fight-or-flight response leading to reduced perception of pain, elated mood and alertness. The sauna bath elicit secretions of ACTH (Kukkonen-Harjula et al, 1989; Jezovà et al,1994; Kauppinen et al ,1989) noradrenaline and cortisol Plasma growth hormone, prolactin and endorphin (Jezovà et al,1994). During the bath, the reduced plasma volume and loss of sodium in the sweat activate the renin-angiotensin-aldosterone axis, leading to rise of plasma arginine vasopressin levels and the plasma atrial natriuretic peptide concentrations during a bath(Kauppinen et al ,1989).

There are several uses of sauna; including pain relief in degenerative musculoskeletal disorders, and prevention exercise-induced musculoskeletal pain, heart failure, respiratory disease, depression, functional menstrual irregularities, dysmenorrheal and menopausal symptoms etc. The research evidence of the recovery effect of sauna, post exercises, is not widely available.

Water Immersion

Hot and cold shower, whole body immersion in water and other forms of hydrotherapy are popular tools to enhance recovery, following training and competition in elite athletes. Water immersion interventions, including, cold, warm and contrast, are popular procedures used in many sports. The effects of hydrostatic pressure associated with water immersion may result in both muscular and vascular compression and therefore assist the reduction of early onset swelling and inflammation (Goodall & Howatson, 2008). The effect of buoyancy in reducing the weight not only brings about pleasant feeling but also helps in maintaining fitness in lower limb injuries requiring progression from non-weight bearing to partial weight bearing.

The effects of variation of temperature on physiological system are the known effects commonly utilized by physiotherapists in clinical practice. The cold application is associated with reduction in blood flow and reduction of conduction velocity of nerves and is used commonly following acute musculoskeletal injuries. Cold water immersion brings about reduction in blood flow, resolution of inflammation and is associated with lower metabolic rates of the body. It is proposed that cold water immersion

would reduce the elevated metabolic rate, induce freshness and would prevent progression of micro injuries sustained during training or competition. Cold water immersion (CWI) has been proposed as a tool to enhance both physiological and perceptual recovery (Eston & Peters, 1999; Gill et al, 2006; Bailey et al, 2007).

In comparison with cold water immersion the use of warm shower and warm water immersion is a more popular tool of recovery among athlete in India. Application of warmth is associated with vasodilatation which may accelerate the disposal of accumulated metabolites along with increased extensibility of collagen, reduction in stiffness of soft tissue. In sub acute and chronic injuries application of warmth is shown to accelerate healing. Within therapeutic range both hot and cold water brings about sedation of nerve and reduced the unpleasant sensation associated with fatigue.

The contrast bath or the technique of alternating hot-cold water is proposed to create a "vaso-pumping" action through alternating vasodilatation and vasoconstriction of the blood vessels due to temperature changes (Cochrane, 2004; Hing et al, 2008). Most experimental evidence suggests that hot-cold water immersion helps to reduce injury in the acute stages of injury. There are very few studies that have focused on the effectiveness of hot-cold water immersion for post exercise treatment (Cochrane, 2004).

Like other recovery interventions limited and conflicting scientific evidences are available for water immersion methods. In one such study Pournot et al (2010) concluded that the practice of cold water immersion and contrast water therapy are effective immersion modalities to promote a faster acute recovery. They examined the effects of cold water immersion, hot water immersion and contrast water immersion on the recovery following 20 min of exhaustive, intermittent exercise bouts. Each recovery group was immersed underwater in a sitting position to the level of the iliac crest for 15 min in a dedicated bath. The water temperature for cold and hot immersion were 10 °C and 36 °C, respectively whereas for contrast water immersion the alternated immersion at 10 °C and 42 °C with 5 cycles of 1 min 30 sec in each bath was used. They reported a significant improvement in maximal anaerobic performances associated with a comparative blunting of the rise in total number of leucocytes at one hour post and of plasma concentration of Ceatine Kinase - the venous blood markers of muscle damage at 24 hour post recovery, in the cold water and contrast water immersion groups. On the other hand Ingram et al (2009) could not observe any differences in the rate of CK release 24 hour post exercise with either cold or contrast water immersion. Rowsell et al (2009) observed no improvement in vertical jump and 20 m sprint performance with immersion in temperate water at 34°C and cold water at 10°C.

Under water massage

This technique utilizes the relaxing effects of warm water combined with mechanical massage rendered through high pressure jet of water. The equipment consists of a large tub attached with a pressure pump, heating device, hose and nozzles of different diameter for altering the pressure of the water stream. Person sits or lies in the tub of water and receives the stream of water from hose at the various body parts. The pressure, angle, speed and direction of movement of stream of water can be altered by the therapist. Effects of all the techniques of massage (effleurage, kneading, friction, tapotment) can be produced during underwater massage (Sinha, 2010). For the purpose of enhancing the lymphatic and venous drainage the stream should be moved from distal to proximal area while constantly striking the skin at 50-70degree. A high pressure stream striking the skin at 90 degree moving to and fro in small range can have the effect of transverse friction. The advantages of this technique include preservation of energy of therapists, enjoyable atmosphere and facilitation of relaxation. Underwater massage is commonly used as an aid to recovery following intense physical activity (Viitasalo et al, 1995). Zikozi, an advanced equipment constructed on the principle of underwater massage, is becoming very popular in spas. The equipment permits self administration of underwater massage.

Electrical Stimulation

The use of electrical stimulation of muscle (electro-myo-stimulation) and sensory nerves (Transcutaneous Electric Nerve Stimulation TENS), in the recovery of athletes, is relatively a new concept. Electrical stimulation (ES) of innervated muscles is routinely used in clinical practice for facilitation of muscle contraction, improvement of venous and lymphatic drainage and in all other conditions where active contraction is desired but cannot be performed by the patient. There has been resurgent increase in the use of electrical stimulation for increasing strength in innervated muscles (Nelson & Currier 1987). Role of electrical stimulation in performance enhancement has also been reported (Malatesta, 2003).However, electrical stimulation had not been investigated for its effects on the recovery, following exhaustive exercise, till 2000.

During 2003-05, this author conducted probably the first study (sinha,2005) on the effect of clinical electrical muscle stimulation on recovery, following exhaustive bout of running, and reported that electrical stimulation promote facilitate lactate recovery and improved perception of recovery (Sinha & Sandhu, 2005). With 10 minute of stimulation of each leg with 50 Hz Faradic current of duty cycle 28.17% using the technique of faradism under pressure a consistent blood lactate reduction in three different circumstances was observed. The

perception of recovery was significantly higher in electrical stimulation group as compared to simple rest, though these were not translated into performance enhancement. Subjects, in electrical stimulation group, felt as if their leg was receiving a nice and intense massage. Recently, some western studies have also reported the similar findings (Tessitore et al, 2009; Neric et al, 2009; Warren et al, 2011).

Tessitore et al (2009) reported that the electrostimulation produced better perception of recovery as compared to exercise recovery and seated rest. In the study of Neric et al, (2009) electrical muscle stimulation led to a lower mean blood lactate after 20 minute recovery compared with passive rest, after an exhaustive swimming bout. Warren et al, (2011) reported significant reduction of blood lactate levels during EMS assisted recovery in Baseball pitching as compared to passive recovery or active recovery. Perceived recovery was also found to be best in the EMS and passive rest conditions.

However, when electrical current was used only at sensory level the reduction in the lactate level was not observed. So et al (2007) reported that application of transcutaneous electrical acupoint stimulation, after strenuous knee extension/flexion exercise, resulted in enhanced rate of muscle force recovery but had no effect on lactate removal.

Barring few differences, the physiological responses of electrical stimulation and voluntary muscle contraction are similar (Low & Reed, 1999; Nelson & Currier, 1987). Both induce a temporary increase in local metabolism with associated effects like increased O2 uptake, CO2 and lactic acid production as well as rise in temperature and greater blood flow (Low & Reed, 1999). Even the long term adaptations of skeletal muscle to chronic electrical stimulation such as increased oxidative capacity, increased capillary density and transformation of fast twitch fibers into the slow twitch fibers are very similar to low intensity aerobic training (McArdle et al, 2001).

Astrand et al (2003) stated that even though the activity imposed on the muscle by electrical stimulation is very simple compared with the activity imposed during physical training, muscle adapts to these two strategies in strikingly similar ways. This strongly suggests that basic pathways involved in both the conditions of muscle contraction are same (Salmons, 1994). Therefore, it is reasonable to assume that facilitated blood lactate removal by electrical stimulation, as observed in these studies, involved similar mechanisms of active recovery i.e. increased muscle blood flow and elevated metabolic rate.

The ES induced motor stimulation is always associated with prior stimulation of sensory nerves, which is known to interfere with the propagation of noxious stimuli. In addition, transcutaneous ES is known to facilitate the release of endogenous opiates (Low & Reed, 1999) which are implicated

for the feeling of wellbeing and warmth. These mechanisms may be attributed to the better perception of recovery observed following electrical stimulation.

Use of electrical muscle stimulation, in recovery, offers a viable method of combining the benefit of active and passive recovery. With electrical stimulation, benefits of active recovery may be obtained without volitional effort. Moreover, the methods of enhancing other aspects of recovery such as psychological recovery, nutritional recovery etc. may also be employed with greater ease during electrical stimulation assisted recovery. However, the full-fledged use of ES, as a recovery modality, demands more exploration.

Laser

In the recent years, research reports from brazil appeared in the literature that hint at the possibility of using low intensity IASER (Light Amplification by Stimulated Emission of Radiation) as a recovery tool after exhaustive exercise bout. It is postulated that exposure to low intensity laser may bring about a delay in the development of skeletal muscle fatigue by decreasing post-exercise blood lactate levels and inhibiting the release biochemical markers of fatigue such as Creatine Kinase and C-Reative Protein.

In one such study, Leal Junior et al (2009a) investigated the immediate effects of bilateral, 830 nm, low-level laser therapy (LLLT) on high-intensity exercise and biochemical markers of skeletal muscle recovery on twenty male athletes of Brazil and observed that LLLT irradiation, before the Wingate test, seemed to inhibit an expected post-exercise increase in CK level and to accelerate post-exercise lactate removal without affecting test performance. They reported significant reduction of the level of blood lactate and creatine kinase in the group subjected to active LLLT than in the group subjected to placebo LLLT, though there was no significant difference in the work performed during the Wingate test.

The same group of researchers in the same year (Leal Junior et al, 2009b) have examined the effects of active cluster LEDT (69 LEDs with wavelengths 660/850 nm, 10/30 mW, 30 seconds total irradiation time, 41.7 J of total energy irradiated) on exercise performance, in 10 Football players, in a randomized cross over trial where low-level laser therapy was delivered to the middle of biceps humeri muscle immediately before exercise . All subjects performed voluntary biceps humeri contractions with a workload of 75% of their maximal voluntary contraction force (MVC) until exhaustion. They reported 12.9% increase in the number of biceps humeri contractions along with significant reduction in the post-exercise levels of blood lactate, Creatine Kinase and C - reactive protein.

Evidence on the efficacy of recovery methods

Most of the recovery methods are used on the basis of anecdotal evidences. The research reports have yielded conflicting reports on the efficacy of almost every recovery method. In a review Barnett (2006) opined that there was no substantial scientific evidence to support the use of the recovery modalities to enhance the between-training session recovery of elite athletes. However, he also listed important limitation in the research designs and research questions. This observation may be attributed to the fact that despite a century of research little is known about the nature of fatigue; and there is no objective measure that correlates well with the subjective experience of fatigue and recovery.

The effects of various recovery strategies have been evaluated using the outcome measure of post-recovery performance (Mean peak power and mean average power, lactate level in blood and muscle, muscle glycogen level, VO2 peak, pH of blood biochemical markers of fatigue and muscle damage such creatine kinase, C reactive proteins etc. However, a definite cause and effect relation ship between various outcome measures and fatigues has not been determined and none of the measures completely correlates with the symptoms of fatigue and exhaustion leading to contradictory observations. Further, fatigue has a strong psychological component that is difficult to quality. Therefore, it is not easy to validate the claimed efficacy of the recovery methods commonly employed. Some of the practical difficulties of research in this area include difficulty in exact simulation of exhaustive exercise bout, absence of single markers of fatigue, diversity of recovery methods, and lack of standardization of methods of administration of recovery method.

Importance of recovery methods

Limited time available for full physiological recovery, between training sessions and/or games, is the issue that confronts most highly trained athletes. Elite team sports are often required to perform high intensity exhaustive activities on consecutive days and the use of recovery interventions between sessions may benefit the recovery process and ensure consistent performance. Since, the final outcome in competitive sports is by and large determined by the athlete's ability to give consistently best performance, the recovery attains as important a role as skill acquisition, strength, speed and endurance training. It becomes even more important in the multi-event competition scheduled on a single day. Sportsperson cannot undertake very high load of training unless proper mean are provided to accelerate the process of recovery.

One of the reasons for the use of drugs in sports is to mask the fatigue while retaining alertness. Beotra et al (2002) reported that during national games 2002 steroid and CNS

stimulants were the two most common substances detected in positive samples. Antalgics, cardio-respiratory analeptics, central nervous system stimulants are some of the drugs used by the athlete in order to postpone fatigue and cope up with the heavy training load. If the organized facility for accelerating recovery using natural and safe means is not easily available to athlete it would be natural for them to look for the other means to combat the training loads and fall pray to the menace of doping.

This draws attention to the need of incorporating natural recovery method in the overall training schedule. Natural recovery methods provide athlete the opportunity to combat the rigorousness of training without compromising the legal provisions. Since, many recovery methods require the skills and expertise of physiotherapy the active involvement of Physiotherapists, in facilitating recovery, would help athlete to achieve their target of harder training and improve physical prowess.

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