

Microstretching – a new recovery and regeneration technique

By Nikos Apostolopoulos

The focus of elite sports is on intense training and elevated competition, resulting in record-breaking performances, all of which expose the athlete's body to strains and stresses exceeding its inherent adaptive capacity. If training, skill acquisition and competition exceed the adaptive capabilities of the body, the result is trauma, a condition defined by the author as Exercise Induced Injury Response Syndrome (EIIRS). If the magnitude of the syndrome becomes chronic it may develop into a pathological disorder. Microstretching is a recovery-regeneration technique directed towards the restoration of normal structure and function of the musculoskeletal system. It works in synthesis with the body diminishing and eliminating the effects of EIIRS, providing the coach, athlete and sports medicine professional with a new technique aiding the recovery-regeneration process. The obvious advantage is decreased trauma enabling the athlete to recover and regenerate the musculoskeletal system and maximise performance and longevity.

ABSTRACT

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maximise performance depends on a balance between "physical exertion" and "recovery". If an athlete's daily training produces an imbalance between the two parameters, he/she is likely to produce symptoms of over-training, but more importantly, it will cause micro-trauma to the musculoskeletal system. The increased demands on the human body to perform at higher levels, can be defined as a form of musculoskeletal stress; the pathogenesis being an increased intensity and functional load and a decrease in recovery pre-, intra-, inter-, and post-exercise.

The inability to recover quickly inevitably produces acute muscular symptoms such as

Introduction

Muscular adaptation to physical stress is significant for normal function and development. The need for proper recovery during and after training is paramount for a successful increase in the level of fitness. The ability to increase and/or

sprains and strains and both are a direct assault on the musculoskeletal tissue. Micro-traumatic responses will stimulate an inflammatory response. This response has been defined as Exercise Induced Injury Response Syndrome (EIIRS), referring to localised damage to muscle fibre membranes and contractile elements. The inflammatory response may be a result of a single forceful mechanical event such as lifting, catching or jerking during a maximal lift or an accumulated strain associated with less forceful but repetitive loading of the musculoskeletal structure.

During exercise, two types of pain sensations are generated: Temporary Pain (TP) and Delayed Onset Muscle Soreness (DOMS). Temporary pain is an accumulation of a metabolic by-product (i.e. lactic acid) and fully dissipates with the proper implementation of a work / rest ratio during sets and post training. After training, a low impact aerobic activity such as walking or cycling will continue blood circulation and flush out the accumulated lactic acid.

A false assumption is that lactic acid is responsible for muscle soreness two or three days post intense workout. Blood and muscle lactate levels typically return to normal values after 30 to 60 minutes of recovery. The micro-trauma to the connective tissues caused by EIIRS is responsible for this soreness as a result of microscopic tears of the muscle tissue. EIIRS is a determinant of DOMS. The symptoms usually appear a couple of hours to a day post strenuous training, peak between one and three days and disappear within five to seven days. It has been suggested that strenuous muscular work can trigger the initiation of an inflammatory cascade, characterised by a series of cellular and humoral changes qualitatively similar to, but quantitatively different from trauma and sepsis (Shepherd and Shek, 1998). Muscle damage is indicated by ultra-structural and morphological changes, as denoted by an increase and presence of intramuscular neutrophils and cytokines. The neutrophil infiltration persists for up to five days (Fielding et al. 1993). Its influx serves to clear damaged tissue in preparation for repair and

cell growth, the proliferation and remodeling phases of an inflammatory response.

Recovery of the muscle tissue depends on the intensity and duration of the athlete's exercise programme and the type of exercise. Eccentric exercises, a forced contraction during lengthening, causes the greatest damage to the connective tissue with extreme soreness post exercise and training. A possible explanation may be that fewer fibres are recruited to handle a given load, resulting in excessive mechanical strain on the fibres (Clarkson et al. 1992). Other studies have reported an increase in cytokines from high intensity long duration exercises exceeding 75% of an athlete's aerobic capacity for a duration of two hours (Bury et al. 1995).

The regulatory activity of EIIRS is important to correct departures from the normal course of the health of the connective tissue. Unlike severe trauma and sepsis, which can be life threatening, EIIRS is sub-clinical, resulting in the removal of damaged cells and the subsequent re-growth of connective tissue by increasing collagen production. The disturbances affecting the function of the musculoskeletal system can be classified as either acute or chronic. EIIRS–acute is a response defined as an equilibrium between physical exertion and recovery. The individual recovers fully and the connective tissue adapts to a new training level resulting in an increase in performance. The collagen that is deposited produces weak fibrils with random orientation. With maturity the collagen during the remodeling phase becomes oriented in line with local stresses (Doillon et al. 1985). However, EIIRS–chronic is interpreted as an imbalance where the process of physical exertion overrides the recovery process. The musculoskeletal system is in constant flux and is not given the opportunity to adapt to the new physical demands. It is only with proper rest and recovery that the individual will resolve this imbalance.

The athlete's response to a physical demand on their body is to adapt both quantitatively

and qualitatively. The vital response is an inherent protective adaptive mechanism whose outcome is to establish a new or maintain an old level of function. Many therapeutic techniques as well as the manipulation of the training parameters (intensity, frequency and duration) have been designed to work synergistically with this adaptive mechanism. The recovery processes work to restore damaged tissue as a direct adaptation to a normal function.

Microstretching

Introduction

Microstretching is a recovery - regeneration technique directed towards the restoration of normal structure and function. It aims to restore the integrity of the connective tissue thereby increasing its load handling ability. It is important for a recovery technique to conform to the healing process of the body meshing with the appropriate activities of the regeneration period. If the technique is aggressive and the musculoskeletal tissue is inflamed, athletes will find themselves in a perpetual recovery– inflammatory phase not fully progressing and improving performance.

It has been suggested that for the proper function of the musculoskeletal system there needs to be a constant ratio between the force of muscular contraction and resistance of the tendon. The musculo-tendinous unit can be considered the interface of adaptation to different locomotor needs. This site is very important in cushioning abrupt and violent motor stimuli. Conditions such as muscle fatigue and weakness diminish the contractile ability of the muscle predisposing the musculo-tendon unit to a strain injury (Ippolito et al. 1986).

The tensile strengths of the relative connective tissues provide clues as to the intensity level of the stretching exercises, preventing the potential onset of an inflammatory response. Muscle has a tensile strength of 77lbs/in² (5.41 kg/cm²) while tendons have a tensile strength of 8,700 to 18,000lbs/in²

(604.64 to 1264.53 kg/cm² (Hollinshead et al. 1981). At the muscle laboratory of Duke University, researchers found that cyclic stretching equivalent to 50% of the maximal force needed to produce failure resulted in a significant increase in the length of muscle stretched at failure (László et al. 1997). Even though the study was conducted on animals, it indicated the importance of light intensity stretching and its ability to increase length and decrease the likelihood of injury to muscle.

The dynamic forces (tension, compression, shearing, rotation, and bending) and how the structure functions under these forces, provides the stages and steps of physical causation of the reaction of the connective tissue. These forces are present during training, directing and controlling the response of the musculoskeletal system. The response of the body to the effect of these dynamic forces can and will produce changes that are lessened by microstretching, imparting a quality of resiliency to the whole structure. Microstretching benefits the athlete beyond simply aiding in the recovery of the contractile system. This restoration helps to raise the threshold to EIIRS by increasing the response of the self-regulating mechanisms associated with restoring the motor system. Structuro-functional unity helps the athlete to increase their physical loads and sustain longer and harder training sessions with minimal damage to the connective tissue.

The athlete's primary concern is the execution of movement – a dynamic equilibrium between structure and function. Microstretching provides simple guidelines effective for increasing performance and decreasing the potential of trauma to the body. During the recovery phase from workouts, the athlete needs to incorporate a proper recovery-regeneration programme, one that becomes habitual, correcting any slight morpho-functional shifts.

The key to proper stretch-recovery pre- and post-training lies in the tensile strength of

the tissues as indicated above. The discrepancy of the tensile strength between the muscle and the tendon suggests that during an extreme stretch, a micro tear will occur primarily in the muscle section of the musculotendon junction. If the connective tissue has already been traumatised due to EIIRS it is counterproductive to continue the trauma by introducing a recovery technique that elicits pain causing potential muscle fatigue and weakness.

The design of a proper recovery programme using microstretching takes into consideration the intensity, frequency, and duration of the stretch and the principle of Stability, Balance and Control (SBC®). When training is done properly and the integrity of the connective tissue is maintained, the recovery process is enhanced with the development of a “flexibility reserve”. This refers to the development and storage of an increased range of motion in the musculoskeletal system, enhancing performance, allowing movement to be executed without excessive tension, decreasing the resistance of the extended muscles and serves as a prophylaxis to injury and diminishes the onset of EIIRS. Microstretching may exceed other forms of flexibility (ballistic, active assisted and proprioceptive neuromuscular facilitation) with regards to recovery by diminishing the onset of EIIRS.

Microstretching decreases muscle tension thereby increasing circulation and neural conductivity. Dr. Robert Salter, who developed Continuous Passive Motion (CPM), has shown the importance of passive motion as a therapeutic modality following trauma to the connective tissue. Salter hypothesized that a gentle passive motion technique would accelerate the healing of articular cartilage and peri-articular structures, such as the joint capsule, ligaments and tendons (Salter 1989) Even though his emphasis was post-operative patient care, the effects of trauma and inflammation can become inhibitors to rehabilitation. Early passive non-painful recovery can assist connective tissue to heal in an acceptable manner, resulting in the typical

parallel arrangement of collagen and elastin fibres (Ibid).

The emphasis in this section has been to establish the positive influence of gentle forces on the recovery of the musculoskeletal tissue after intense training and repetitive loading. The implementation of this knowledge and its influence on the training parameters (intensity, frequency and duration) provides the athlete and coach with the tools to develop a proper recovery programme aimed at preventing injury, increasing performance and years of participation at a high level.

Intensity

Microstretching is always executed at a low intensity level (approximately 30 – 40 percent of a maximal perceived exertion). This value is less than that indicated earlier with regards to the Duke University Muscle lab. This level increases the pliancy of the connective tissue, specifically the tendons and the ligaments. Similar to micro-injuries the influence of microstretching is manifested at the cellular level. Unlike a strain, it results in a minimal activation of the specialised receptor tissues of the muscle and tendon (the muscle spindle fibres and the Golgi tendon organ). The muscle spindle senses muscle lengthening while the Golgi tendon organ senses tension.

Microstretching helps damaged tissue to recover and regenerate, and aids in the realignment and the potential breakdown of scar tissue. As scar tissue is laid down and ages, there is a tendency for compression to occur. Developed compression predisposes the injured area to a greater level of strain. If an athlete performs an aggressive stretch they will activate the specialised receptor tissues. However, microstretching may bypass these receptor tissues, further enhancing the process of recovery and regeneration.

It is critical while stretching, to avoid strain and pain. Pain will activate the sympathetic nervous system, increasing muscle tone prim-

ing the body for activity. This insult on the tissue will cause EIIRS developing and perpetuating a recovery – inflammation loop, reinforcing and maintaining an injured state.

Using low intensity stretching or microstretching, an athlete will recover from this loop, decreasing the muscle tone affected by the connective tissue (i.e. fascia), regenerate connective tissue and help to establish order when the collagen is being laid down during tissue regeneration.

Frequency

In "Periodization" Bompa, (1999), suggests that in order for athletes to improve their flexibility they need to stretch at least twice per day. In addition, each muscle group needs to be stretched at least three times per session. Repetition is vitally important. Learning movements and improvement of skills, both in infancy and adulthood, are dependent upon repetition. Repeated stimulation of the central nervous system integrates the new physical pattern, turning it into an automatic response.

The ongoing development of flexibility increases the elasticity in the tendons and muscles, increasing the sensitivity of the joint receptors. This aids in the processing of information, enabling the athlete to sense the significance of a physical stimulus and in turn affect a suitable motor response.

The habitual development of flexibility and the increase in muscle length will enable the athlete to recover faster post workout. DeVries, in his electromyography study, indicated the delay in the onset of muscular fatigue (DeVries and Adams 1972), and the prevention and alleviation of muscle soreness after exercise (DeVries 1961). With an increase in the functional range of motion there is a reduction in the incidence and severity of injury (Taylor et al. 1990). In short, the frequency of flexibility training helps to foster an increase in the threshold of EIIRS.

Duration

The optimal length to hold a stretch is approximately 60 seconds. On average for a stretch to progress from the middle of the muscle belly to the tendons, it takes 30 seconds. A token 10 – 15 second stretch may be beneficial to the muscle, but it has minimal influence on the ligaments and tendons, largely responsible for range of motion and flexibility.

A recent physiotherapy study in the United States, looking at the effect of duration of stretching of the hamstring muscle in an elderly population, concluded that a 60 second passive stretch produced the greatest increase in rate of gains with respect to range of motion (ROM). At the conclusion of the three month study, the group introduced to a 60 second stretch had an increase in degree gains of 2.4 per week as compared to a 30 second stretch and a 15 second stretch whose gains were 1.3 and 0.6 degrees per week respectively (Feland et al. 2001).

At the Serapis Stretch Therapy Clinic, clinical observations indicated that a stretch held greater than 60 seconds resulted in patients feeling tighter. The Golgi tendon organ may be the cause for this phenomenon. Prolonged, low intensity stretching of a muscle may cause the muscle to lengthen slightly beyond its normal resting length. Even though the intensity of the stretch was low, dampening the stretch reflex, the sensation of tension though light was still registered by the neuromuscular system. This stretch was sufficient to trigger a response from the Golgi tendon organ. This increase in tightness might have a direct effect on the connective tissue perpetuating EIIRS.

Sequential changes in the function of muscle will affect performance. A defining quality of an athlete is the maturation and coordination of the musculoskeletal system, a tempero-spatial development defined by the maturation of the neuromuscular system. It is suggested that specific behaviour and physical functions are associated with

definite anatomical structures of the nervous system (McGraw 1989). During recovery, there is an important need to place the body in a position conducive to relaxing the nervous system and eliminating the potential for muscle contraction. This state refers to the principle of Stability Balance and Control (SBC).

Trauma to the musculoskeletal system may stimulate the sympathetic nervous system (SNS) and its subsequent responses. This is not independent of sympathetic function (Blumberg et al. 1997). It is important to relax the nervous system for the constant activation of the SNS may lead to clinical conditions defined as sympathetically maintained pain (SMP) (ibid). SMP may be responsible for the development and maintenance of chronic pain experienced by athletes. This pain is exemplified by a response termed protective adaptation (PA), the adjustment of the musculoskeletal system to diminish and prevent the sensation of pain. PA is a by-product of EIIRS and its development occurs over many years of exposing the body to trauma and intense training without proper recovery. The cycle is a progressive physiological regulation of movement defined as an extensive decrease of the range of motion about a joint(s). This regulation changes the movement behaviour of the body, restricting the ability of the muscle to accelerate through a full ROM. The restriction to the connective tissue concerned with the proper execution of movement ultimately results in a decrease in athletic performance and longevity within the athlete's sport of choice.

Application of Microstretching

Lack of flexibility hampers the development of motor skills. The increase of speed is adversely affected since the athletes will accelerate their limbs over too short of a distance. Insufficient flexibility affects the motor efficiency of endurance sports. This decrease in range of motion translates into an increased strength effort requiring greater energy.

The natural ability to increase performance is through the proper implementation of a recovery-regeneration programme. This will ensure a synchronised nerve-muscle connection, fostering the subsequent development of an instinctive response to an athlete's environment(s). This response confers a unique quality on the muscle's related motor axon(s). The modulated neuron will, in turn, effect and determine new structural and/or functional relations, defining and, in turn, being defined by new muscle patterns that are both flexible and dynamic with a high degree of structural order.

Repetition is the means by which athletes learn the patterns specific to their sport. If an athlete has had an injury or a growth spurt and stretching exercises are not prescribed specifically to increase range of motion about the joint(s) it will result in an altered pattern of muscle use, affecting proper skill acquisition. The successful handling of training and the treatment of an injury will impart a conviction to the athlete to continue flexibility training.

Flexibility develops a natural continuity of exercises, a rhythmical function of the main muscle groups, as well as the ease of regulating the loads of training (intensity, volume and frequency). Coordination is fully enhanced and developed through the proper development of flexibility. The athlete's coordination is determined by the repertoire of skills.

When training for either explosive or endurance events the training for the development of the flexibility system is the same. The changes imposed on the function of the musculoskeletal system are a derivative of a developmental structural change. For instance if the angle of the joint movement is compromised due to a structural change, as a result of an injury or repetitive strain, this will impede the maximal development of motor control, a function of the neural system. The neural system is important because it gathers and processes information with a subsequent

motor action. Flexibility training helps to foster an adaptive physical response, aiding in the production of a harmonious and economic function of movement.

A true state of the integrity of the musculoskeletal system is its "cold state". This refers to connective tissue whose core temperature has not been increased due to a warmup or during and after a physical activity. The information relayed to the central nervous system of the "cold state" is essential in perceiving the slightest strain and pain. This acts as a prophylactic mechanism warning the athlete to spend extra time on the issue at hand. If such a step is neglected the outcome could be catastrophic.

The application of stretches following the guidelines of microstretching offers several advantages to athletes, circumventing the limitations imposed on stretching routines of the past. Many athletes will be able to re-adjust the biological adjustments of the musculoskeletal systems introduced and designed to protect the connective tissue. This will help to re-establish proper locomotor mechanics. Greater compliance of the muscles, tendons and ligaments will help the athlete to perform with maximal force and acceleration.

The principles of microstretching were presented to athletes of various disciplines. The learned activities were dependent upon their background attitudes, posture, training and previous injuries. These parameters are responsible for the patterning of learned physical behaviour. The athletes were monitored for their tolerance to and the subsequent recovery from pain and discomfort. The athletes noticed an increase to the tolerance of pain as a result of the increase in their range of motion, with a decrease in the recovery time post activity. It is believed that the underlying neural mechanisms are modified through proper stretching restructuring the synapses and synchronicity of the connective tissues.

Microstretching was developed to increase the range of motion about a joint and to

address the increase of inflammation due to training and injury. It is not prescribed as a pre-warm up stretch routine, dynamic flexibility will suffice, for it will aide in the preparation of the connective tissue. Upon cessation of training, it is important to allow the body to cool down. Therefore, microstretching is to be performed two hours post training. When the body has cooled down significantly, one can recognise tightness and strain, allocating more time to proper stretching in order to prevent injury and the potential for the development of chronic musculoskeletal disorder.

In summary, the increase in flexibility as a result of microstretching, will be beneficial for the development of the track and field athlete. This increase in range of motion is the common denominator, with the specific demands of the sport determining its use.

Conclusion

The musculoskeletal system and the behaviour correlated with its function and development are a complex and dynamic organisation. When the training is intense the tendency is for the connective tissue to be traumatised, resulting in an injury defined as Exercise Induced Injury Response Syndrome (EIIRS). The effectiveness of the body is measured in its ability to overcome this trauma, repairing itself and adapting to a new level of training. This unique evolution is enhanced by the implementation of a proper recovery-regeneration programme designed to accelerate the healing process in between training. Unlike conventional methods that produce pain, microstretching is relevant to the healing process by depressing the response of the sympathetic nervous system and dampening the muscle spindles and Golgi tendon organ ameliorating the inflammatory response. Clinical experience attained at the Serapis Stretch Therapy Clinic, has resulted in the development of the microstretching guidelines. Implementation of these guidelines in a clinical setting results in the athlete's ability to train at greater loads and volume increasing their performance level.

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