CHAPTER II

LITERATURE REVIEW

Our ability to continue exercise day after day is determined by how quickly our muscles recover after exertion. Recovery ensures that our body returns to a normal, balanced state through the restoration of body fluids, replenishment of energy stored, and repair of damaged muscle tissues. In addition, our immune system, which is compromised by strenuous exercise, can be enhanced with adequate rest and careful attention to nutrition. By taking the proper steps to aid our body's recovery from exercise, we will increase our level of performance during training session or competitive events. More importantly, overall health and strength will be improved.

THE THREE PHASES OF RECOVERY

Recovery from extended exercise is a complex process, but it can be broken down into three parts. The first phase of recovery, known as the rapid phase, occurs in the first thirty minutes after exercise. This is followed by the intermediate phase, which lasts up to two hours. The longer phase of recovery occurs during the remaining twenty hours before our next exercise session (Burke, 1999).

1. The Rapid Phase

The rapid phase of recovery begins when we finish our training session, and lasts for approximately thirty minutes. During this time, our body's metabolic rate slows and begins to return to pre-exercise levels. Our heart rate, respiratory rate, and body temperature start to return to their lower resting levels. Blood levels of certain hormones, such as cortisol and testosterone, which were elevated during exercise, begin to decrease. At the same time, our muscles start to replenish their stores of creatine phosphate and ATP, which were depleted to fuel activity. This is also the period during which our body removes excessive lactic acid that may have accumulated in our muscles. The majority of the lactic acid enters the bloodstream and circulates to the liver and inactive muscles, where it is reconverted into glucose.

The metabolic and physiological processes that occur during the rapid phase of recovery can be hastened by gentle exercise during the cool-down period. Exercising at 40 to 60 percent of maximum effort for five to ten minutes helps to keep our blood circulating at an increased rate. Keeping blood flow at a higher-than-normal rate during this phase aids in the removal of lactic acid from our muscles, and rapidly transports it to the appropriate sites for conversion.

2. The Intermediate Phase

The intermediate phase of recovery continues in the ninety minutes to two hours after exercise. During this time, our body begins the process of restoring fluid volumes, called rehydration. This is also the most critical period for the replenishment of muscle glycogen, in which the hormone insulin plays a vital role. Insulin facilitates the transport of glucose from blood into muscle cells. It also stimulates glycogen synthase, an enzyme in muscle cells that is responsible for converting glucose into glycogen for storage.

3. The Longer Phase

The longer phase of recovery spans from two to twenty hours following a workout. Carbohydrate replenishment continues in this interval, although at a lesser rate than during the first two hours following exercise. A crucial element in the long-term recovery process is muscle repair. During heavy exercise, the membranes of muscle fibers, the connective tissue surrounding them, and the actin and myosin filaments are damaged. Less strenuous exercise also damages muscles, but to a lesser degree. The long-term phase of recovery is the period in which muscles are repaired and adapt to exercise, which increases strength and endurance.

INCREASED LACTIC ACID LEVELS

Lactic acid (Burke, 1999) is a byproduct of anaerobic metabolism that cannot be used effectively by our working muscles. Instead, lactic acid diffuses into bloodstream and transport to heart, liver, and non-working muscles, where it is converted back into glucose. As we begin to sustain exercise larger aerobic, more lactic acid builds up in our muscles, and must be removed by increase in circulation. The lactic acid level of blood, therefore, continues to increase as exercise intensity increases. If this level of intensity is maintained, we will soon reach our lactate threshold, defined as the point at which the level of lactic acid in our blood is greater than the rate our body can metabolize. Figure 2.1 illustrates how blood lactate concentration increases with an increase in exercise intensity.

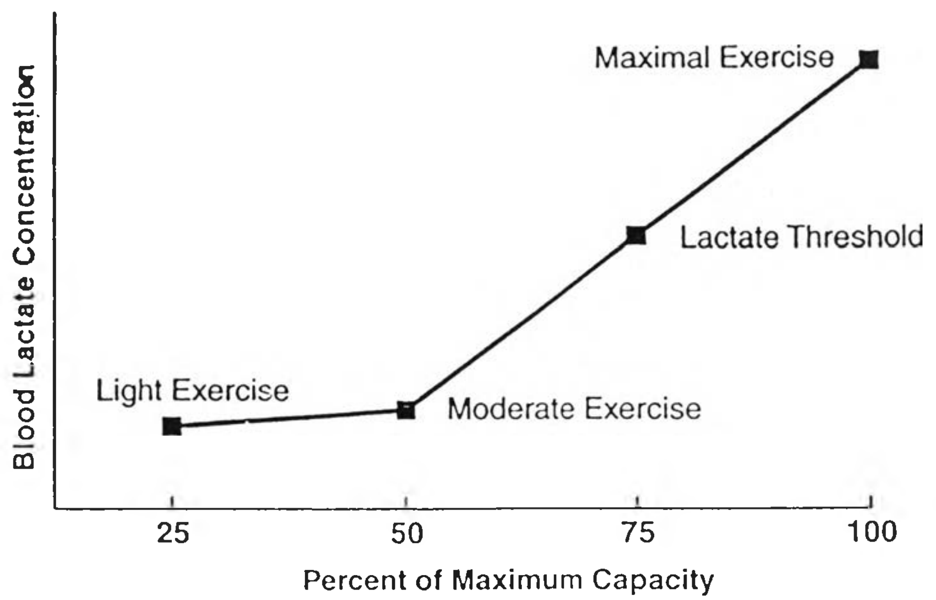

Figure 2.1. Blood lactate concentration during exercise. As exercise intensity increases, the lactic-acid level in the blood also increases (Burke, 1999).

Most coaches and scientists consider the lactate threshold to be an excellent indicator of an athlete's potential for endurance performance. The ability to exercise at a high intensity without accumulation of lactic acid is very beneficial. Generally, in two athletes with similar oxygen uptakes, the athlete with higher lactate threshold performs better in endurance activities. Laboratory and field experiments suggest that training can alter the amount of lactic acid produced and tolerated by athletes. This adaptation probably results from an increased efficiency of aerobic metabolism, as well as an increase in the number of capillaries that deliver oxygen to the muscles.

Lactic acid accumulation causes burning pain and muscle fatigue if it is not removed quickly from the muscles. Although lactic acid can be tolerated for short periods of time, our muscles should be allowed to relax at every opportunity. This allows our bloodstream to clear the lactic acid accumulation, and to supply our tissues with oxygen for aerobic metabolism (Burke, 1999).

Blood lactate removal is accelerated by performing active aerobic exercise in recovery. Apparently, the optimal level of recovery exercise is between 29 and 45% of the VO_2max for bicycle exercise, and 55 to 60% of VO_2max when the recovery involves treadmill running. Such variation probably is a result of the more localized muscle involvement in bicycling and reflects a lower threshold for lactate accumulation during this from of exercise (McArdle et al., 1996).

Figure 2.2 illustrates blood lactate recovery patterns for trained males who performed 6 minutes of supermaximal bicycle exercise. Active recovery involved 40 minutes of continuous exercise at either 35 or 65% of VO_2max. An exercise combination of 65% (7 minutes) followed by 35% (33 minutes) of VO_2max also was used to evaluate whether a higher-intensity exercise interval early in recovery expendited blood lactate removal. Clearly, moderate aerobic exercise in recovery facilitated lactate removal compared with passive recovery. Combining of higher-intensity exercise followed by lower-intensity exercise offered no greater benefit than a single exercise bout of moderate intensity. Recovery exercise above the lactate threshold might even prolong recovery by promoting lactate formation. In a practical sense, if left to their own choices, people voluntarily select their optimal intensity for recovery exercise for blood lactate removal (McArdle et al., 2000).

The reasons are not clear for the benefits of active compared to passive recovery. The facilitated removal of lactate with recovery exercise is likely the result of an increased perfusion of blood through "lactate-using" organs such as the liver and heart. In addition, increased blood flow through the muscles during active recovery certainly would enhance lactate removal because this tissue can oxidize lactate via Kreb's cycle metabolism

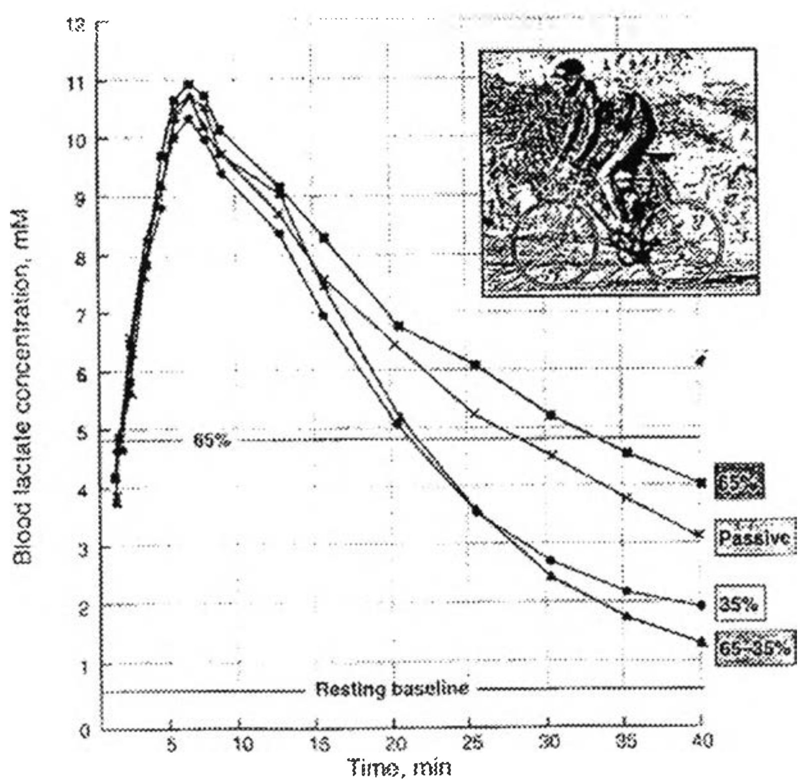

Figure 2.2. Blood lactate concentration after maximal exercise during passive and active exercise recoveries at 35%VO_2max, 65%VO_2max, and a combination of 35% and 65% of VO_2max. The horizontal solid orange line indicates the level of blood lactate produced by exercise at 65% of VO_2max without previous exercise. (McArdle et al., 2000).

Lactic acid (Gupta, 1996) is produced in any kind of muscular exercise. In strenuous exercise there is a discrepancy between the demand and the availability of energy from the aerobic process of exercising which results in a large production of lactic acid in the muscle subjected to exercise. The accumulation of an excess amount of lactic acid (LA) in muscles under stress is a contributing factor to fatigue. Most of the LA produced during rigorous exercise is removed by direct oxidation (55-70 %) while the balance amount is converted to glycogen (<20 %), protein constituents (5-10 %) and other compounds (<10 %) (Gaesser and Brooks, 1984). Although these indications and tendencies have been established in experiments with rats and were supported by the investigation on Excess Post exercise Oxygen Consumption (EPOC) (Bahr et al., 1992), it is not clearly understood when applied to human beings (Astrand et al., 1988). In many events, like boxing, wrestling and weightlifting, inter-bout rest periods are short; whereas, in football, hockey and basketball, a longer recovery interval is allowed between the halves of the game. There is a need to develop a suitable method to enhance the rate of recovery in such disciplines. The removal rate of LA is higher during light aerobic exercise than during a period of resting recovery, following heavy exercise (Belcastro and Bonen, 1975; Bulbulian et al., 1987; Rontoyannis, 1988). Information regarding other modes of recovery has been found to be inadequate (Cafarelli et al., 1990). In recent years, sports massage has gained popularity among amateur as well as professional competitors (Samples, 1987).

THE ROLE OF MASSAGE IN THE MANAGEMENT OF THE ATHLETE

Massage has been a therapeutic modality in all cultures since early civilization and has had a long tradition of use in the sporting context. However, there has been a paucity of scientific evidence of the physiological, psychological and therapeutic effects of commonly used massage techniques. Little agreement was found on the efficacy of massage and there were contradictory findings as to the optimum technique and length of time of application. It is clear that the role of massage is a time consuming technique for a physiotherapist to perform needs to be evaluated further in order to resolve some contentious issues arising about this mode of treatment and to justify its use.

TYPES OF MASSAGE

There are numerous forms of massage which are used by therapists to attempt to promote muscle or connective tissue healing and functional recovery or to stimulate muscles in athletes. Three commonly employed massage techniques used primarily in athletic settings are effleurage, petrissage, and tapotement (Lehn and Prentice, 1994). Effleurage involves light or deep muscle stroking; petrissage involves muscle kneading and rolling manipulations; and tapotement involves a series of percussive blows administered to muscles with relaxed hands (Lehn and Prentice, 1994). The first two are used by therapists primarily for muscle "restorative" effects and the third is used for muscle "stimulation" (Lehn and Prentice, 1994). Other types of massage used in athletic settings include mechanical vibratory massage (Cafarelli et al., 1990) and massage using pressurized water (Stock et al., 1996 ; Viitasalo et al., 1995).

In addition to techniques listed, there have been many other variations with differences in masseur expertise and time of application. This lack of standardization renders comparison of studies difficult (Table 2.1).

Table 2.1. Summary of massage regimens described in literature.

Author	*Masseur*	*Technique*	*Area*	*Time*
Wakim et al, 1949	Physician	Deep stroking, Kneading	Whole lower limb	15-20 min
		Frictions, Modified Hoffa technique		each limb
Ebel and Wisham, 1952	Not specified	Kneading, Deep stroking	Calf muscle	10 min
Barr and Taslitz,1970	Physical therapist	Conventional	Back	20 min
Hansen and Kritensen, 1973	Qualified physical therapist	Effleurage	Calves	5 min
Hovind and Nieleen, 1974	Physical therapist	Petrissage and tapotement	Vastus lateralis, Brachioradialis	2 min each group
Arkko et al, 1983	Experienced therapist	Shaking, Kneading, Frictions, Stroking	Whole body massage	60 min
Wiktorrson et al, 1983	Professional masseur	Kneading	All major leg muscles	6-15 min
Ernst et al, 1987	Not specified	Standard manual massage	Whole body	20 min
Day et al, 1987	Physical therapist	Effleurage, Petrissage	Back	30 min
Balke et al, 1989	Not specified	Vibratory mechanical massage	Upper and lower leg muscles	3 min each group
		Manual massage not specified		
Carafelli et al, 1990	Not specified	Vibratory mechanical massage	Quadriceps group	4 min
Morelli et al, 1990	Not specified	Petrissage one-handed 30 manipulat^{n}/min	Calf muscle	3 min

Table 2.1. Summary of massage regimens described in literature (next).

Author	*Masseur*	*Technique*	*Area*	*Time*
Sullivan et al, 1991	Person experienced in massage	Petrissage one-handed 0.5 Hz rhythm	Calves and hamstrings	4 min each group
Boone et al, 1991	Sports massage therapist	Alternating deep strokes broad cross fibre strokes	Lower extremities	30 min
Drew et al, 1991	Not specified	Not specified	Not specified	30 min
Harmer, 1991	Licenced massage technician	Effleurage, Petrissage	Total body	30 min
Dolgener and Ann, 1993	Not specified	Tapotement, Hacking	Lower extremities	20 min
Mayberry, 1994	Not specified	Not specified	Upper extremities	15 min
Smith et al., 1994	Physical therapist	Not specified	Upper extremities	30 min
Rodenburg et al., 1994	Physical therapist	Not specified+warm up+streething	Upper extremities	30 min
Tiidus and Shoemaker, 1995	Not specified	Effeurage massage	Quadriceps muscle	long term
Gupta et al, 1996	Qualified physiotherapist	Kneading and Stroking	Upper+Lower limbs	10 min
Hemmings et al., 1998	Qualified therapist	Not specified	Legs, Back, Shoulders, Arms	20 min

BACKGROUND TO TRADITIONAL THAI MASSAGE

The instinctive act to touch, rub, or knead different parts of the body when there is pain or discomfort can probably be traced back to the beginning of human evolution. Many different kinds of mammals will rub themselves with their paws or lick wounds that hurt them. With our superior intelligence, we learned to memorize, differentiate, and systematize our ways of touching and their effects on our body; hence, various systems of massage developed.

The earliest historical records of massage appear to be from China over 5,000 years ago during the reign of the Yellow Emperor. Huang-Ti. Recommendations for massage as a means of helping the body to heal itself also appeared in the Indian book of Ayur Veda around 1800 B.C. There are also numerous references to the benefits and uses of massage in the medical literature of many other cultures around the world. Even in the Bible there are many references to the "laying-on-of-hands" as a method of curing sickness.

Unit recently, not only in the West, but in Thailand too, the popularity of massage has been marred by the general population's puritanical attitude to the body. Massage is now once more regarded as a legitimate method of health care because of the surge of interest in the many alternative approaches to conventional medicine, particularly in the types of body-oriented therapy.

In the past, the art of massage has been developed into many different schools. There are institutes or teaching centres in many countries around the world. Currently the most popular are, the Swedish style (which, in fact, was developed from Chinese massage by a Swede named Per Henrik Ling) and the Japanese massage (shiatsu or acupressure).

Traditional Thai massage is believed to have come from India along with the expansion of Buddhism and Indian culture into Thailand. Some scholars speculate that possibly there might have been Chinese influences on Thai culture, through trading relationships over a long period, which also played a part in the development of Thai massage. This, of course, spanned many centuries of history and during this time the art has been refined and shaped into its present system.

At present traditional Thai massage is still taught and practised at many Buddhist temples and massage facilities throughout the country. The most well-known school is at Wat Pho (the Temple of the Reclining Buddha) in Bangkok.

Massage exemplifies the "Four Divine States of Mind" of Buddhist teaching: loving kindness, compassion, vicarious joy, and equanimity. These are collectively known in Thai as the "Promwihan See". They embody the spirit in which Thai medical services were traditionally given, as opposed to the motivating forces of commercialism which are so apparent nowadays in Thailand.

For this reason, Traditional Thai massage had a clear role to play in the activities of the Buddhist temples. It formed part of the social services for which the temples took responsibility. However, with the advent of government-funded health care, the role of the temples has become unclear. The government has promoted and financed primary health care services in the villages which concentrate on a Western medical approach; therefore the popularity of Thai massage has declined. At the same time there has been an over-reliance on treatment by drugs. These drugs are often inappropriately prescribed, are very costly for the villagers and may cause harmful side effects.

The Foundation for Village Doctors, a group of concerned physicians, pharmacists and other health professionals based in Bangkok has set up workshops in many provinces of Thailand, in a project called "Thai Massage Revival Project", to try to re-awaken Thai interest in the traditional art of massage. The foundation is also trying to set up formal courses in massage which it is hoped will in time gain official recognition by the medical profession (Sombat, 2000).

EFFECT OF MASSAGE

1. Circulatory and tissue fluids

1.2 Arterial blood flow

Massage dilates superficial blood vessels and increases the rate of blood flow. This effect, first measured for gentle massage, supported conclusions from a previous experiment, with local anaesthesia that arteriolar dilation is primarily controlled by local axon reflexes (Goats, 1994).

Forceful massage in a healthy adult increases both local blood flow and cardiac stroke volume. The local vascular response is mainly due to histamine release, and increased stroke volume reflects improved venous return. These effects are longer lasting than those of gentle pressure and represent a potent means to accelerate healing. Flow rates usually return to normal 1 h after deep massage. Vasodilator drugs administered at the same time as deep massage cause longer lasting hyperaemia (Goats, 1994).

Such effects upon blood flow also suggest that massage should improve the performance of fatigued muscle. Massage muscle fibres display less spasm, an increased force of contraction and enhanced endurance compared with muscle simply rested. These massage effects are abolished by arterial occlusion.

Some massage techniques promote blood flow more effectively than others. Clearance studies with the radioisotope ^{113}Xe showed that moderate exercise was a less efficient way to improve blood flow in large muscle groups than tapotement (hacking). Petrissage (kneading) had little effect (Goats, 1994).

When massage is applied to one limb, blood flow increases in the other (Severini and Venerando, 1967). This provides a useful way to promote muscle performance and healing in injured tissue that is too sensitive for direct massage. These referred effects are exploited extensively by techniques such as connective tissue manipulation (CTM), a specialized type of massage used extensively to increase blood flow to deeply seated organs. Here, skin over the thoracic and lumbar spine is vigorously stimulated manually, triggering cutaneovisceral reflexes (Goats and Keir, 1991), that cause vasodilation. Experimental observations support the hypothesis that CTM mainly affects sympathetic autonomic activity (Barr and Taslitz, 1970) and can have physiological effects that are independent of any change in blood flows. Less invasive conventional massage provokes a milder response but probably acts in a similar way.

Massage appears to be better for improving blood flow than other techniques routinely used for the purpose. Tracer experiments have shown that effleurage, one of the least penetrating massage techniques, significantly increased blood flow while shortwave diathermy and therapeutic ultrasound caused little change. Once effleurage ceased, blood flow slowed markedly and returned to normal after 2 min (Hansen and Kristensen, 1973). Patients with flaccid paralysis of a limb responded in the same way, indicating that this effect is not entirely dependent upon spinal reflexes (Goats, 1994).

1.2 Venous blood flow

Deep massage promotes venous return and increases cardiac stroke volume. The few attempts to measure this effect concern external pneumatic compression. An optimum regime expelling 80 ml blood per minute from the veins of the lower leg required a maximal pressure of 40 mmHg, rising at a rate of 8 mmHg s^{-1} with an interval of 1 min between each cycle. Firm manual massage may reasonably be expected to cause similar venous flow (Goats, 1994).

1.3 Blood enzyme concentrations

Deep massage causes sufficient muscle damage to elevate the serum concentrations of myoglobin and the enzymes glutamic oxaloacetic transaminase, creatine kinase and lactate dehydrogenase. Manual therapy may therefore confound diagnoses or biochemical measures of performance based upon the concentration of these substances (Goats, 1994).

2. Connective tissue

Most sports therapists acknowledge that preliminary warming up exercise are a necessary preparation for safe athletic activity. Unfortunately, many sports people still prepare inadequately for exercise and risk connective tissue damage. Many warm-up regimes include massage but few have been evaluated. One comparative study weighed the efficacy of a standard athletic warm-up programme against massage or stretching exercises. Stretching exercises produced the greatest flexibility in connective tissue around joint, although massage had a significant beneficial effect. The warm-up exercises were least effective (Wiktorsson-Moller et al., 1983).

Friction massage is another powerful technique used to maintain or improve the mobility of ligaments, tendons and muscle; and prevent adherent scars forming (Chamberlain, 1982). Friction massage was pioneered by Cyriax, the father of modern manipulation technique, and deliberately causes limited tissue damage, hyperaemia and mild inflammation (Cyriax, 1984). During the subsequent phase of accelerated healing, collagen fibrils are encouraged to realign in patterns better adapted to function by careful positioning and exercise (Cyriax, 1984). Deep frictions used to treat athletes suffering from overuse injuries to the knee proved more effective for reducing pain than a conventional treatment regime of rest, ice, stretching exercises and ultrasound (Schwellnus et al., 1992). Manipulation combined with massage is an effective treatment for frozen shoulder (Zumo, 1984).

3. Muscle

Muscle spasm is extremely uncomfortable, being both the product and the cause of pain. Massage reduces discomfort, relieves the associated muscle spasm and permits improved function. Postexercise effleurage reduces subsequent muscle soreness by rapidly reducing the concentration of lactate in the muscle cells. This is a more effective treatment than either rest or a conventional active warm-down programme (Bale and James, 1991). Percussive massage, once advocated as part of postexercise therapy, fails to influence the rate at which muscle recovers from fatigue (Cafarelli et al., 1990) and is unlikely to assist the athlete.

Massage can also be used to prevent denervated muscle from losing both bulk and contractile capability, thus assisting subsequent rehabilitation. Denervated cat muscle treated with effleurage and petrissage for 10 min daily for a month showed a slight weight loss but retained an almost unimpaired ability to generate force. These results appear significantly better than those seen for conventional electrical stimulation. Although the evidence is somewhat contradictory, therapists faced with rehabilitating a nerve-injured athlete should consider the potential benefits of massage (Goats, 1994).

4. The nervous system

4.1 Pain

Massage has traditionally been used to relieve pain although research has only recently provided an acceptable physiological explanation to this observation.

Massage produces short-lived analgesia by activating the pain gate mechanism (Bowsher, 1988). Cutaneous mechanoreceptors are stimulated by touch and transmit information within large nerve fibres to the spinal cord. These impluses block the passage of painful stimuli entering the same spinal segment along small, slowly conducting neurons (Watson, 1981). The many physical therapies acting upon this mechanism include thermal and electrical treatments (Goats, 1990), CTM (Goats, 1991) and joint manipulation (Cyriax, 1984). Massage is a potent mechanical stimulus and particularly effective for the pain gate process.

Longer lasting pain control appears to be mediated in large part by the descending pain suppression mechanism (Watson, 1982). Unpleasant cutaneous sensations stimulate nuclei within the midbrain. These nuclei in turn initiate activity in the descending spinal tracts that release endogenous opiates (inhibitory neurotransmitters) within the spinal segment receiving the painful input. This diminishes the intensity of pain transmitted to the higher centres. Vigorous manipulation and massage can reinforce a naturally occurring discomfort, cause much greater release of opiates and achieve more profound pain suppression. CTM results in a moderate release of β-endorphin lasting for about 1 h (Kaada and Torsteinbo, 1989). Clearly the many other treatments that cause discomfort, including vigorous conventional massage, transverse frictions (Chamberlain, 1982) and certain percussive techniques, will act in similar manner.

4.2 Relaxation

Manual therapy is a well documented aid to relaxation. Massage has long been used to relax the sick or prepare those about to undertake some demanding physical task and most people know of the pleasurable relaxation that follows a gentle massage. Physical relaxation, whether induced for enjoyment or the treatment of pain, can improve blood flow, reduce muscle tone and tension in connective tissue and thus accelerate physical repair. Relaxation will also increase individual tolerance to further, less comfortable, therapy or athletic trial (Goat, 1994).

Review of the related literature

Cafarelli and co-workers (Cafarelli et al., 1990) percussive vibratory massage has long been purported to offset the negative effects of muscular exercise. The purpose of this experiment was to determine the effect of this type of massage on recovery from repeated submaximal contractions. Twelve male subjects performed repeated static contrations of the quadriceps at 70% maximal voluntary contration (MVC), with periodic MVCs performed after every fourth subject. This pattern continued until the subject could no longer produce the required 70% (T_{lim}). The entire procedure was repeated three times with rest periods between each series. The rate of fatigue (ROF) was calculated from a regression line fit to the decline of the periodic

MVCs. We studied the ROF during static exercise alone, as well as during static exercise following cycling for 30 min at 75% VO_2max. In the control conditions, the subjects rested for 5 min between each of the there series of contractions. In the experimental conditions the subjects received 4 min of percussive vibratory massage and 1 min of rest. The results showed that three was no significant difference in ROF in either static or following dynamic exercise between the control and vibrated conditions. Although ROF was the same in all experimental conditions, T_{lim} occurred sooner following dynamic exercise because the initial MVC was significantly lower than static

($p<.008$).We have therefore concluded that short-term recovery from intense muscular activity is not augmented by percussive vibratory massage.

Rodenburg and co-workers (Rodenburg et al., 1994) studied the effect of a combination of a warm-up, stretching exercise and massage on subjective scores for delayed onset muscle soreness (DOMS) and objective functional and biochemical measures was studied. Fifty people, randomly divided in a treatment and a control group, performed eccentric exercise with the forearm flexors for 30 min. The treatment group additionally performed a warm-up and underwent a stretching protocol before the eccentric exercise and massage afterwards. Functional and biochemical measures were obtained before, and 1, 24, 48, 72 and 96 h after exercise. The median values at the five post-exercise time points differed significantly for DOMS measured when the arm was extended ($p = 0.043$). Significant main effects for treatment were found on the maximal force ($p = 0.026$), the flexion angle of the elbow ($p = 0.014$) and the creatine kinase activity in blood ($p = 0.006$). No time by treatment interactions were found. DOMS on pressure, extension angle and myoglobin concentration in blood did not differ between the groups. This combination of a warm-up, stretching and massage reduces some negative effects of eccentric exercise, but the results are inconsistent, since some parameters were significantly affected by the treatment whereas others were not, despite the expected efficacy of a combination of treatments. The objective measures did not yield more unequivocal results than the subjective DOMS scores.

Tiidus and Shoemaker (Tiidus and Shoemaker,1995) studied the effects of effleurage massage on long term strength recovery, and DOMS sensation following intense eccentric quadriceps muscle work. They tested these assumptions by daily (for four days) massaging the quadriceps muscles of one leg on subjects who had previously completed an intense bout of eccentric quadriceps work with both legs. Immediate post-exercise isometric and dynamic quadriceps peak torque measures had declined to approximately 60-70% of pre-exercise values in both legs. Peak torques for both the massage and control leg tended to slowly return toward pre-exercise values through the subsequent four days (96 hrs). There was no significant difference between the isometric and dynamic peak torques between massage and control legs up to 96 hours post-exercise. Leg blood flow was estimated by determining femoral artery and vein mean blood velocities via pulsed Doppler ultrasound velocimetry. Massage of the quadriceps muscles did not significantly elevate arterial or venous mean blood velocity above resting levels, while light quadriceps muscle contractions did. The perceived level of delayed onset muscle soreness tended to be reduced in the massaged leg 48-96 hours post-exercise. It was concluded that massage was not an effective treatment modality for enhancing long term restoration of post-exercise muscle strength and its use for this purpose in athletic settings should be questioned.

Gupta and co-workers (Gupta et al., 1996) studied the comparison of blood lactate removal during the period of recovery in which the subjects were required to sit down as a passive rest period, followed by active recovery at 30%VO_2max and short term body massage, as the three modes of recovery used. Ten male athletes participated in the study. Exercise was performed on a bicycle ergometer with loads at

150%VO_2max , each session lasting 1 min, interspaced with 15 sec rest periods, until exhaustion. Blood lactate concentration was recorded at recovery periods of 0, 3, 5, 10, 20, 30, and 40 min, while VO_2, VCO_2 and heart rate were recorded every 30 sec for 30 min. The highest mean lactate value was found after 3 min of recovery irrespective of the type of modality applied. Significantly lower half life of lactate was observed during active recovery (15.7 $\pm$ 2.5 min) period, while short term massage as a means of recovery required 21.8 $\pm$ 3.5 min and did not show any significant difference from a passive type of sitting recovery period of 21.5 $\pm$ 2.8 min. Analysis of lactate values indicated no remarkable difference between massage and a passive type of sitting recovery period. It was observed that in short term massage recovery, more oxygen was consumed as compared to a passive type of sitting recovery. It is concluded from the study that the short term body massage is ineffective in enhancing the lactate removal and that an active type of recovery is the best modality for enhancing lactate removal after exercise.

Hemmings and Graydon (Hemmings and Graydon, 1998) studied the effects of massage on psychological regeneration following amateur boxing training. These findings suggest that massage may be an effective method of reducing perceptions of fatigue and increasing perceptions of recovery following amateur boxing training. Moreover, our results lend some scientific support for enhanced psychological regeneration following massage, which may assist in the prevention of overtraining. The finding that perceptions of fatigue and recovery differed following massage and touching control conditions suggest that some aspect of massage treatment itself may be responsible for a change in psychological status, rather than anticipation of the massage and its purported psychological benefits leading to positive mood enhancement.

Hemmings and co-workers (Hemmings et al., 1998) studied the effects of massage on psychological regeneration and repeated amateur boxing performance. These findings suggest that massage is effective at reducing perceptions of fatigue and increasing perceptions of recovery following amateur boxing performance. However, these perceptions were not accompanied by any effects on repeated performance, which decreased in both experimental conditions. Positive perceptions of recovery may point to a potential benefit of massage; however, no performance effects may question the use of massage as a performance-enhancing modality.

From this research study it can be concluded that massage has good effect and it is advantageous as it does not bring any bad effects. Another advantage of the massage is it increases the efficiency of local circulation, cellular permeability and the soothing effect on the central and peripheral nerves. This research shows that a massage can give a positive or negative results depending on the method and the period it is used (Geoffrey, 1994 and Tiidus, 1997). Massage and game do always go together. In Olympic games, all American athletes get a massage regularly from the expert masseurs who are the members of American Massage and Therapy Association (Weatchaphead and Palaviwat, 1993).

Moreover, it is found that the studies involving massage used in the circle of sports are still in small amount. In Thailand, it is found that is related studies are rarely found while many sport associations have used massage in games. Some have their own masseurs, but in some associations, the coaches or the athletes have to massage for each other. The Traditional Thai massage which is used for recovering in between the competition rounds (in order to remove lactic acid faster) is much in use nowadays, however it is still yet to be studied.