CHAPTER 2

LITERATURE REVIEWS

Weightlifting is defined as the sport in which athletes attempt to lift the maximal weight. Injuries in weightlifting can occur in a simple mechanic. The loads used in weightlifting may put the back at risk of injury such as symptomatic back pain, strain, spondylolysis, spondylolisthesis or discal injuries (3). In normal population, the low back pain (LBP) may affect between 60-80% (22). In athletes, the incidence of low back pain that related to sport injury is 67.8% (22). Recent survey from the Neuro-Musculoskeletal & Pain Research Unit (NMPRU), Chiang Mai University showed approximately 33% of Thai women national weightlifters had musculoskeletal pain over the back area. Study by Raske and Norlin found that around 85% of low back pain was recurrent in 2-3 months and 2-3 % of athletes with low back pain developed chronic back pain (4).

Weightlifting is a sport in which competitors attempt to lift heavy weights. The characteristics and structures of muscle fibers in weightlifters can adapt specially to the training program (23, 24). Training program has a relationship between the different properties of fiber type and muscle fiber composition. Training program with using heavy weights can recruits the fast-twitch B (FT-B or type IIB) fibers greater than the slow-twitch (ST or type I) and the fast-twitch A (FT-A or type IIA) fibers (23). The characteristics of the fast-twitch B (FT-B or type IIB) fibers are high force production activities, very sensitive to fatigue, and used for short anaerobic (23).

Adverse consequences of highly intense training are reflected in the athletes' health (25). An increasingly high incidence of amenorrhea and other menstrual cycle disorder has been recorded among female athletes. Prevalence of amenorrhea is 5% in female population and 44% in female athletes (26). The factors of high intensity training, specific type and amount of training, decrease body weight, lower percentage of fat tissue, and psychological stress have been put forward as potential factors responsible for menstrual irregularities in female athletes (25).

1. Lumbopelvic stability training

Potential management of the low back pain (LBP) has been given to the concept of spinal stabilization (27). The segmental instability and its contribution to lumbar dysfunction has been presented by Panjabi (6). The interaction between the passive, active and neural control systems and the state of normal spinal function are achieved through a segmental stabilization during movement. The lumbar stabilization exercise programs have become a common treatment of low back pain and this type of exercise also increase using by athletes to improve the performance and prevent injury (28).

Many therapeutic exercise strategies for rehabilitation have been including training muscle performance and re-education control of the component. There were some of studies investigated the relation between the stabilization and back pain. Hodges et al (7) investigated the recruitment patterns of the trunk and back muscles in people with and without low back pain during movements of the arm. This study used EMG recordings of the deltoid, lumbar multifidus, transversus abdominis, external oblique, internal oblique and rectus abdominis. The result showed that deep core muscles especially the transversus abdominis were the feed forward prime mover of the arm in abduction, flexion and extension. The study also showed that the participants with LBP demonstrated a delay in contraction of deep core muscles and they never get recruitment of the trunk muscles before the prime mover of movement. The study concluded that people with LBP have dysfunction of motor control of the trunk muscles, especially transversus abdominis muscle. The delayed of contraction in transversus abdominis indicates a dysfunction of motor control and inefficient muscle stabilization of the spine.

Hides et al (29) studied the effectiveness of lumbar stabilization exercise in management of acute low back pain. Patients in group 1 received only medical treatment. Patients in group 2 received medical treatment and specific-localized exercise therapy (isometric multifidus contraction in standing position with the lumbar spine in neutral position) that aimed to re-educate the co-contraction of the deep lumbar musculatures. The outcome measures in this study were pain, disability, range of motion, and also the cross sectional area of deep trunk muscle especially for multifidus. The study showed that after a 4-week treatment period, the pain decreased significantly but the multifidus muscle recovery was not spontaneous on remission of painful symptoms in patients in group 1. Muscle recovery was more rapid and more complete in patients in group 2 who received exercise therapy (P = 0.001). Other outcome measurements were similar for both groups after the 4-week re-evaluation, but patients in group 1 had decreased multifidus muscle size at the 10-week follow-up examination. They also pointed that the multifidus was not automatic recovery in the patients group 1. There was a deficit in the muscular stabilization and there might be one reason for the high recurrent rate of low back pain.

Several studies used different stabilizing exercises to strengthen the muscles of the trunk. O'Sullivan et al (30) evaluated the specific stabilizing exercise in patients with spondylolysis and spondylolisthesis. The specific stabilizing exercise train the deep abdominal muscles (e.g. transversus abdominis) to co-contract with the lumbar multifidus through the use of the pressure biofeedback. A randomized controlled test-retest trial using EMG to measure the activity of upper rectus abdominis, internal oblique, and transversus abdominis. The results of the study showed that the specific exercise group has the ratio of activation of the deep trunk muscle relative to the rectus abdominis more than the control group. The study concluded that the muscle patterns in patient with chronic LBP may be changed by specific exercise intervention. Kladny et al (31) investigated the effect of a specific stabilizing exercise (isometric co-contraction) in patients with low back pain and lumbar disk disease on muscle function of transversus abdominis and multifidus muscles. There were the intervention group (50 patients) and the control group (49 patients). This study measured baseline at the beginning of the treatment and reassessed at the end of the treatment and follow-up again at three month using the Oswestry Low Back Pain Disability Questionnaire, the Hannover Functional Ability Questionnaire (FFbH-R), the pain scale and a numeric rating scale. The results of this study showed that there were improvement in a functional ability and pain decrease in both groups after 3 months, but at the end of treatment, the result only demonstrated the improvement in functional ability in the exercise group. This study concluded that a specific stabilizing exercise can improved functional ability and reduce pain, it can be effective in conservative treatment programs of low back pain and lumbar disk disorders.

Hicks et al (32) investigated the effect of a stabilization exercise program in 54 patients with non-specific low back pain. Exclusion criteria were as follows: previous spinal fusion surgery, LBP attributable to current pregnancy, acute fracture, tumor, or infection, and presence signs of nerve root compression such as lower-extremity strength, sensation, or reflexes. The stabilization exercise program consisted of abdominal bracing, bracing with bridging, quadruped arm lifts, side support with knees flexed and extended. The experimental design was a prospective, cohort study. The outcome measure was changing score before the stabilization exercise program and after 8 weeks of a stabilization exercise program by using the Oswestry Disability Questionnaire scores to evaluate for the improvement in patient. The results of the study showed that 21 subjects were improved in the Oswestry Disability Questionnaire scores from 11.3±4.8 to 30.0±10.7 after receiving the stabilization exercise program. The study concluded that a stabilization exercise program in patients with LBP can be used to relief symptom of the low back pain.

There are numbers of researches to show a link between exercise and pain modulation. Interestingly, pain modulation also can be detected initially after performing a single set of some kinds of exercise program. For example, a study of Kadetoff and Kosek (33) investigated the pressure pain threshold in fibromyalgia patients and healthy control subjects. The authors investigated the change of the pressure pain threshold (PPTs) at before, 5 minutes and 15 minutes post-contraction exercise of deltoid and quadriceps femoris muscles. The two sites for pressure algometer assessments were midway between the groin and the apex of the patella, and lateral part 10 cm below acromion process. The contraction was held until exhaustion or for a maximum of 5 min. During the contraction period PPTs were assessed every 30 s alternating between the contracting of the deltoid and quadriceps femoris muscles. The result of the study showed that the PPTs was increased significantly from baseline ($P < 0.001$) at 5 min of contraction, in both patients and normal control groups ($P < 0.001$) and remained at this level during the rest of the contraction period and during the 15 min postcontraction assessment. From this study, it demonstrated that therapeutic exercise can modulate pain as change in the pressure pain threshold (PPT) level for both pathologic as well as normal subjects. Therefore, the pressure pain threshold (PPT) can be a sensitive outcome to detect change in pain modulation immediately after performing therapeutic exercise program.

The manual treatments are thought to alter the mechanoreceptor activity in the soft tissues and decrease tissue tenderness. Thereby, the pressure pain threshold (PPT) is the same with tenderness, evaluating the pressure pain threshold (PPT) provides a method for measuring the anti-nociceptive effect of manual treatments (34). Potter et al (34) investigated intra-rater PPT assessment by algometer over the belly of four pairs of spinal muscles (iliocostalis, multidus, gluteus maximus and trapezius) in healthy subject. The reliability within-session (ICC > 0.91) and between-session (ICC > 0.87) with a moderate measurement error. Furthermore, the technique is easy to perform and suitable for an objective measure of a subject's pain perception (34). The pressure algometer could be used as a single pre-test and post-test measure (34).

2. Sport massage

Besides the use of lumbar stabilization for rehabilitation of LBP, the use of massage for reducing the symptom of LBP is also be a choice of treatment options among athletic population. The sport massage has also been used in preparation for competition, between competitions and in assisting recovery from competition (35). It incorporates classic Swedish strokes with compression, trigger-point therapy, effleurage technique, petrissage technique, tapotement technique, vibration technique, and cross-fiber friction techniques (10). Sports massage techniques mainly include: effleurage (stroking), petrissage (kneading), compression (static contact) and friction massage. Effleurage (stroking) is one of the techniques that can assist the circulation by increasing blood flow and lymph, stretch muscle and fascia and release painful or soreness area. Stroking is delivered with the hand following the body with deep of pressure. Petrissage (kneading) is a technique that can reduce muscle soreness, muscle tone and local swelling and release adhesions between tissues. Compression (static contact) is a technique involves light pressure put through the skin with whole of hands and no movement. This technique is often performed to stimulate the muscle spindle and muscle tissue. Friction massage is a deep stroke and the effects of friction massage can increase local circulation, and reduce trigger point activity (10).

Massage can provide several benefits such as increase blood circulation or reduce muscle tension (36-38). There are some studies that investigated the benefits of sport massage. Hinds et al (37) investigated the effects of sport massage on the femoral artery blood flow (FABF), skin blood flow (SKBF), skin temperature (SKT), and muscle temperature (MT) after dynamic quadriceps exercise. The massage protocol consisted of a combination of deep effleurage and petrissage. This study used the 6-minute of sport massage treatments at quadriceps muscles after concentric quadriceps exercise and measures of FABF, SKBF, SKT, MT, blood lactate concentration (BLa), heart rate (HR), and blood pressure (BP) at baseline (pre-exercise), immediately after exercise, and measures at the mid-point and at the end of the massage. The result demonstrated that skin blood flow elevated after massage compared to the control group ($P < 0.05$). Muscle temperature increased by an average of 2.5 ^{o}c from rest to post-exercise ($P < 0.05$). Blood lactate concentration increased significantly from rest to post-exercise ($P < 0.05$). They concluded that the massage has potential therapeutic effects as an aid to recovery in post-exercise settings.

Preyde (38) investigated the effectiveness of massage therapy in subacute low-back pain patient that absence of pathology such as bone fracture or nerve damage. The components of massage therapy was soft-tissue manipulation and remedial exercise with posture education. Subjects with subacute low-back pain were randomly assigned into 4 groups. First, the comprehensive massage therapy ($n = 25$). Second, soft-tissue manipulation only ($n = 25$). Third, remedial exercise with posture education only ($n = 22$) and a placebo of laser therapy ($n = 26$). Each subject received 6 treatments within 1 month and measured baseline (before treatment), after treatment and follow-up 1-month. The duration of comprehensive massage therapy was between 30-35 minutes at trunk, hips, and thighs. The primary outcome measures used the Roland Disability Questionnaire to measure level of function when performing daily tasks, the Present Pain Index (PPI) and Pain Rating Index were used to measure pain. From the study, the result showed that the comprehensive massage therapy group had improved in average function scores from 4.2 to 8.3, and average pain had greater decreased when compared with the other 3 groups. At 1-month follow-up 63% of subjects in the comprehensive massage therapy group had no pain. 27% of the soft-tissue manipulation group, 14% of the remedial exercise group and 0% of the placebo of laser therapy group reported no pain. The study concluded that the comprehensive massage therapy group and the soft-tissue manipulation group showed improvement function in patients with subacute low back pain.

Effect of sport massage in athlete also have been investigated. Dawson et al (39) investigated the effectiveness of massage in enhancing recovery after exercise in the runner athlete. Subjects were 12 healthy subjects (8 males, 4 females). The outcome measures were quadriceps and hamstring muscle strength, thigh circumference (measured at a point 15 cm from the base of the patella) and soreness (used an adapted Graphic Ratings Scale: GRS). Each participant had one leg random massaged while the non-massaged leg as the control. The study used the sport massage treatments (effleurage, petrissage, tapotement) in approximately 30 minutes and measured the strength, pain, and circumference at pre- and immediately post-race. The result of the study found that the strength, pain, and circumference were changed significantly. The findings of this study suggest that the massage has a potential on the physiological of muscle recovery. There also have some indications that the massage could influence the functional recovery after exercise.

Zainuddin et al (11) investigated the effects of massage on delays onset muscle soreness (DOMS), muscle strength, range of motion (ROM), swelling, and a biochemical marker of muscle damage. The study used an arm-to-arm comparison model. One arm was the control, and the other arm was a treatment condition. Sport massage was used in the treatment condition after the eccentric exercise for 3 hours. The outcome measures were maximal isometric and isokinetic voluntary strength, range of motion, upper arm circumference, plasma creatine kinase (CK) activity and muscle soreness. The result demonstrated that the upper arm circumference increased significantly (P = 0.04) post-exercise in both conditions, and the massage arm was smaller in arm circumference than the control arm (P = 0.04). The plasma creatine kinase (CK) activity increased significantly post-exercise for both conditions (P = 0.01) and the massage resulted in a 20% to 40% decrease in the severity of soreness compared with no treatment in the same individuals. The study concluded that the sport massage can reduce muscle soreness, muscle swelling and creatine kinase (CK) efflux in comparison with the control condition (no massage). However, this study found that the sport massage had little effect on muscle strength and range of motion (ROM) or the function recovery.

Not all reports supported the positive outcome of massage in sport population. There were some studies demonstrated no benefit effects of massage. Tanaka et al (40) investigated the effect of massage on localized back muscle fatigue. Twenty-nine healthy subjects participated in two experimental sessions (massage and rest conditions). Subjects received massage on the lumbar region for 5 minutes duration. The amplitude and power spectrum analysis of electromyographic (EMG) signals and the Visual Analog Scale were used to evaluate and estimate the degree of muscle fatigue. There was no significant difference in median frequency (MDF), the mean power frequency (MNF) or the root mean square (RMS) value change between pre- and post- massage in both conditions. On electromyographic (EMG) analysis, there were no significant differences to conclude that massage influenced the myoelectrical muscle fatigue, which is associated with metabolic and electrical changes. It is possible that the short massage duration (i.e., 5 minutes) as in this study may be a limitation that is responsible for "no beneficial effect" of sport massage in this study. Further study that increase the duration of sport massage is needed to determine the effect of sport massage.

Robertson et al (41) investigated the effects of leg massage compared with passive recovery on lactate clearance, muscular power output, and fatigue characteristics after repeated high intensity cycling exercise. Nine healthy subjects performed a standardized light warm up (consisting of five minutes of cycling at 80 W) and a short stretching period (three minutes of static stretches of hamstrings, calf, and quadriceps muscle groups). After subjects completed six standardized high intensity exercise on a cycle ergometer, subjects received five minutes of active recovery (80 W) and a 20-minute intervention. The intervention was either 20 minutes of passive supine rest or 20 minutes of leg massage. The massage was applied for five minutes to the back of the left leg followed by five minutes to the back of the right leg with the subject in a prone position. Subjects were in a supine position, and massage was applied to the front of the right then left leg (each for five minutes). Performance in the high intensity exercise bout after the intervention (Wingate test) was not significantly different between trials. No difference in blood lactate concentration after the intervention period between passive recovery or massage. Again, the “no beneficial effect” of this research study may be from the limitation factors of small sample size (i.e., n = 9) and short of massage duration (i.e., 10 minutes) most study recommended that a duration of 20-30 minutes of sport massage may be sufficient for its therapeutic management (10).

Evidence to support the effects of sport massage is still insufficient. Most studies contain methodological limitations including inadequate therapist’s clinical anatomy and knowledge in massage, insufficient duration of treatment, few subjects or low methodological quality. Further study should consider these limitations.

The sport massage with lumbopelvic stability training may be useful to relieve symptoms, promote healing process and facilitate the recovery of musculoskeletal pain. Moreover, this present research study may be helpful in management program, prevention of repetitive trauma and promotion of healing process for Thai women national weightlifters. Furthermore, benefits of this study may demonstrate the potential physiological effect of the sport massage and the lumbopelvic stability training. This will be the research evidence for better understanding on the effect of these 2 methods (passive strategy: massage; active strategy: lumbopelvic stability control).