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# The Possible Mechanisms of Massage Therapy

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Massage therapy is called "green medicine" by the World Health Organization. It has been used as an effective treatment for various conditions, diseases, symptoms, and disorders, which include pain syndromes, hypertension, fatigue, depression, cancer, aging problems, etc. In order to understand the mechanism of massage therapy this article reviews plenty of previous studies investigated the effects of massage, and discusses the different possible mechanisms of massage therapy which include biochemical mechanisms (passive muscle stiffness, range of motion, visual analog scale), physiological mechanisms (skin and muscle temperature, blood pressure, blood flow, heart rate variability, heart rate, pressure pain threshold), neurological mechanisms (Hoffman reflex, anxiety associated with scapulocostal syndrome, state anxiety inventory), and psychological mechanisms (heart rate variability, profile of mood states, salivary cortisol).

**Keywords: mechanism; massage therapy; review**

## INTRODUCTION

Massage therapy has been shown that have beneficial effects on varying conditions including preterm infants, prenatal depression, full-term infants, skin conditions, autism, pain syndromes (Daniel C. et al.,2011)and(Arroyo-Morales et al.,2011) hypertension, autoimmune conditions, immune conditions including human immunodeficiency virus and breast cancer and aging problems (Parkinson's and dementia) (T. Field,2016)and(Engen et al.,2010)

. Massage therapy also has been widely used in sports. Quick recovery from training and competition is recognized as the most important aspects for athletes, which can reduce the accumulation of exercise-induced fatigue (EIF), avoid overtraining, and prevent the risk of sports-related injuries(Neagu,2017). To achieve this goal, many methods are used, and therapeutic massage is one of the effective treatments. Evidence-based researches show massage can affect muscle fatigue, which include both the body's overall fatigue( Moraska, 2005) (Hidetoshi Mori et al.,2007) and the local fatigue, such as, thumb fatigue(Young et al.,2005) quadriceps fatigue(Rinder and Sutherland.1995)., lumbar muscle fatigue(Tanaka et al.,2002)enhance body recovery (Weerapong et al.,2005) , release the delayed onset muscle soreness(Mancinelli et al.,2006) , prevent injury, promote athlete performance, (Hemmings et al.,2006) etc.

The mechanism of massage therapy is a complex system. For this reason, the effects of massage therapy are most likely produced by more than one mechanism (Urbinati et al.,2000). The following are recognized as the major mechanisms

of massage therapy, which include biomechanical, physiological, neurological and psychological mechanism.

## MATERIALS AND METHODS

A comprehensive strategy was used to search all articles investigating the efficacy of massage therapy. Nine compute databases (PubMed, Science direct, SPORT Discus, Springer Link, ProQuest, PubMed, Google scholar, Medline and Europe PMC) were used to this literature, in addition to manual journal searches. The key words and phrases for searching include: 'sport massage', 'massage', 'massage therapy', 'mechanism', etc. The inclusion criteria of this review include: (1) all of the articles were published between January 1990 and December 2018; (2) at least one of the interventions was massage; (3) the study was a controlled trial. The exclusion criterion is the whole version of article was not available. Once the papers met all of the inclusion criteria, we recorded the following data from each study: the first author and publication year, subjects, intervention, markers, and results.

## RESULTS AND DISCUSSION

### Biomechanical mechanism of massage therapy

A summary of the experimental study statistics for the effects of massage therapy on biomechanical aspect as measured by joint arrange of motion, stiffness, is presented in table 1.

The study of Stanley et al. investigated the effects of massage therapy on passive stiffness. A 10-minute effleurage had no significant effect on the stiffness of the passive gastrocnemius when compared to a 10-minute rest. The reasons may be that the pressure of effleurage may not be sufficient to produce a mechanical effect of massage, or the effleurage could produce a reflective response, but the changes in muscle properties may be present in the contractile elements. (Stanley et al.,2000)

Several studies have been evaluated the effects of massage on flexibility of the body by measurement of the range of motion. For example, Crosman et al. found that 9-12 minutes massage for lower extremities can significantly increase the hip flexion and knee extension, (Crosman et al. 1984) and another study confirmed this result. Nordschow and Bierman used finger to floor test to evaluate the flexibility of lumbar, the results showed that massage can increase the lumbar range of motion.

Chanawong et al found that Thai massage can provide improvements in some physical markers in soccer players, which indicated that Thai massage can increase blood flow and reduce muscle tension. The potential mechanisms of it maybe include the enhancement of reduced adhesion and muscle spasm and the stimulation of proprioceptors of muscles in the tissues being massaged. Which can be explained that Thai Massage can cause an increase in muscle blood supply, this allows the muscles to get more oxygen from the blood and provide enough nutrients for the muscles (Hongsuwan et al.,2015).

### Physiological mechanism of massage therapy

A summary of the experimental study statistics for the effects of massage on physiological aspect as measured by temperature, heart rate variability, blood flow, cortisol etc. is presented in table 2.

Some studies showed that massage can increase temperature of the subjects. Hidetoshi M et al. investigated the effects of 5 minutes massage on the lumbar region after 90 seconds back muscle contraction induced fatigue, the results showed that significant differences of skin temperature exist between massage group and control group, skin temperature of massage group $0.45^0$C higher than control group. (Hidetoshi Mori et al.,2007)

Drust et al. reported an increase in intramuscular and skin temperature of the vastus lateralis muscle irrespective of massage duration (Feng, 2003).. Miguel A et al. reported that massage can significantly increase preterm infants' temperature during massage and after massage. JoEllen M et al. reported that massage treatment can significant increase the temperature in five regions: anterior upper chest, posterior neck, upper back, posterior right arm, and middle back. [19] The reasons of it are not very clear, therefore, the increase of temperature may be due to massage, heat transferring from the hands of therapist, or both.

Many researchers believe that the mechanical pressure of massage can speed up blood flow, thereby increasing the rate of elimination of metabolites and the ability to supply oxygen. (Hidetoshi Mori et al.,2007),(Ouchi et al., 2006)

And (Sefton et al.,2010) reported that 5 minutes massage on the lumbar region can increase skin blood flow, muscle blood volume(Hidetoshi Mori et al.,2007)JoEllen M et al. investigated the effects of massage on peripheral blood flow by measurement of skin temperature.

**Table 1 The effects of massage therapy on biochemical makers**

| Study | Subjects | Intervention | Measurement | Results |
|---|---|---|---|---|
| **Stanley et al.** | Healthy subjects, n=19 | 10 minutes massage (effleurage) | Maximum tension; Passive muscle stiffness | Non- significant |
| **Wiktorsson-Moller et al.** | Healthy males, n=8 | 6-15 minutes massage(kneading) | Strength of quadriceps and hamstring muscles; ROM of lower extremities | Stretching can significantly increase the range of hip flexion and extension, hip abduction, knee flexion, and ankle dorsiflexion. |
| **Chanawong H et al.** | Soccer players, n=34 | 30minutes Thai massage | sit-ups; hand grip strength; VO2 max sit and reach; 40 yards technical agility; 50-meter sprint; push-ups; | All the outcomes were significantly improved after Thai massage. |
| **Nordschow and Bierman** | Normal subjects, N=25 | 30 minutes Swedish and Hoffa massage | Finger to floor test | Stretching can significantly increase the lumbar range of motion. |
| **Crosman et al.** | Normal female subjects, n=34 | 9-12 minutes massage for lower extremities | Range of motion | Massage can increase the hip flexion and knee extension. |
| **Leivadi et al.** | Female university dancer, n=30 | 30 minutes massage , twice a week, five weeks | State Anxiety Inventory; Profile of mood states; Visual analog scale; Neck extension; Shoulder abduction | Massage can increase the neck extension and shoulder abduction |

**Table 2: The effects of massage therapy on physiological makers**

| Study | Subjects | Intervention | Measurement | Results |
|---|---|---|---|---|
| Miguel A et al. | Preterm infants, n=72 | 15 minutes massage | During temperature; Post temperature | Massage can significantly increase temperature of the subjects. |
| Hidetoshi M et al. | Healthy male, n=29 | 5 minutes massage on the lumbar region | Visual Analogue Scale; skin temperature; muscle blood volume ; Skin blood flow | Massage can increase skin temperature, muscle blood volume, and skin blood flow, and can decrease the score of Visual Analogue Scale. |
| Tessa H et al. | healthy male volunteers, n=13 | 12 minutes massage (effleurage and petrissage) | muscle temperature; skin temperature; femoral skin blood flow; artery blood flow | Massage can significantly increase the skin temperature and muscle temperature, however, no significance for blood flow. |
| JoEllen M et al. | healthy volunteers, n=17(9 male and 8 female) | 20 minutes neck and shoulder massage | skin temperature | The massage therapy can significant increase the skin temperature |
| Surussawadi B et al. | physiotherapy students, n=36 | 90 minutes Thai massage | stress perception rating; heart rate; blood pressure; Saliva cortisol level | When compared with baseline within group, the cortisol level and heart rate were significant reduction, but no significant differences in cortisol level. |
| Lindgren L et al. | healthy volunteers ,n=22 (11 male and 11 female) | 80 minutes Thai massage on hands and feet | blood glucose; saliva cortisol; heart rate variability; heart rate; serum insulin | Total heart rate variability and all heart rate variability components decreased during intervention. Insulin levels and saliva cortisol decreased significantly after massage. |
| Buttagat V et al. | Patients with back pain, n=36 | 30 minutes traditional Thai massage on back muscle | Body flexibility; State anxiety inventory; Pressure pain threshold; muscle tension; Pain intensity; Heart rate variability; | Traditional Thai massage can significantly increase total LF, HF, PPT and body flexibility, significantly decrease muscle tension, anxiety , and self-reported pain intensity. |

The finding was that massage can significantly increase the temperature in five regions: anterior upper chest, posterior neck, upper back, posterior right arm, and middle back, then the study concluded that massage can increase the peripheral blood flow. **(**Sefton et al.,2010) In another study, light massage on the back can increase regional cerebral blood flow of the subjects with prone position. (Ouchi et al., 2006) However, Tessa H et al. reported that there were no significances for blood flow which includes femoral artery blood flow skin blood flow.

Massage has shown some experimental evidence for increasing parasympathetic activity through reducing blood pressure and heart rate, increasing heart rate variability, reducing cortisol level. (Chompoopan et al., 2016), (Bennett et al., 2015),(Lindgren et al.,2010) (Buttagat, 2011) .( Smith et al., 2013**)** Warangkana C et al. investigated the patients with depression. The results showed that traditional Thai massage can reduce the heart rate. Surussawadi B et al. reported that when compared with baseline within group, the cortisol level and heart rate were significant reduction, but no significant differences in cortisol level between the two groups.

**Neurological mechanism of massage therapy**

Massage therapy is believed to decrease muscle tension and stimulate sensory receptors by reducing neuromuscular excitability which can be measured by the changes in the Hoffman reflex (H-reflex) amplitude. .( Morelli et al.,1990)]( Morelli et al.,1999) (Sullivan et al.,1991)and( Morelli et al.,1991**)** One study reported Hoffman reflex (H-reflex) amplitude of each massage condition were reduced compare to the control group, the reason maybe not due to the mechanical stimulation of cutaneous receptors, but for the deeper mechanoreceptors (see table 3).

Numerous studies investigated the effects of massage on pain, and the results of several studies have shown that massage can relieve pain. **(**Buttagat et al.,2012) (Wamontree et al.,2016) (Buttagat et al.,2016),(Best et al.,2008) (Chan et al., 2015. .( Büyükyılmaz and Aştı,2013)and (Mackawan et al., 2007) (Chatchawan et al., 2014)There are several mechanisms about it. Traditional Thai massage that can relieve patients with headaches can be used to explain their physiological effects. Traditional Thai massage may stimulate blood and lymph circulation and autonomic nervous system by pressing skin and muscles. As a result, the discretion of toxins and residual substances inside the body improves, and the flow of nutrients to tissues is enhanced, thereby reducing swelling and pain. Another famous possible mechanism is the gate control theory. The pressure of Traditional Thai massage acts on the skin and muscles, which can stimulate the pressure receptors and inhibit the transmission of pain perception at the spinal cord or the “gate”. Traditional Thai massage may modulate pain transmission at spinal cord level by closing the gate, which can be explained by inhibiting transmission cell (T cell) activity via substantia gelatinosa (SG cells). The techniques of Traditional Thai massage can influence SG cells through stimulating the mechanosensitive afferent fibers in spinal joints and muscles. In addition, Traditional Thai massage also can decrease the level of pain in biochemical transmission temporarily, substance P, thereby the nerve conductivity to a higher center was limited. (Buttagat et al.,2012) .( Büyükyılmaz and Aştı,2013),(Buttagat, 2011) Uraiwan et al. found that Traditional Thai massage can be used as an effective treatment for patients with headache and other pain related with neuromuscular disorders. The mechanism of it maybe include: firstly, myofascial trigger points (MTrPs), which constitute an important source of chemical mediators (bradykinin, calcitonin gene–related peptide, serotonin, and substance P may be present in active MTrPs), Traditional Thai massage may break down any MTrPs adhesions. Secondly, massage reduces muscle tension and improves blood flow may wash out pain metabolites (such as lactic acid and substance P) and lead to reduced muscle tension and pain. Thirdly, Traditional Thai massage provides deep pressure, which may stimulate proprioceptors, such as the Golgi tendon organ and spindle cells, in the target muscles. Reducing muscle adhesion and spasm in tissues will reduce the intensity of pain (Chatchawan et al., 2014)

**Psychological mechanism of massage therapy**

Massage has been presented that can affect the psychological factors of receivers, such as, reduce psychological stress, increase body relaxation, decrease the anxiety (Leivadi et al., 1999). (Hemmings et al.,2006),(Chompoopan et al., 2016) (Field et al.,2007), (Buttagat et al.,2012) (Delaney et al.,2002)**,**(Sripongngam, et al.,2015) (Toro-Velasco et al.,2009) (see table 4).

Firstly, massage therapy can decrease the anxiety. Warangkana et al found that traditional Thai massage can significantly decrease the anxiety level of all depression patients. They think

that although mechanisms of traditional Thai massage on depression are not very clear, but traditional Thai massage can provide care and love to the depression patients(Chompoopan et al., 2016). Field et al. found that moderate pressure of massage contributed to increased dopamine which leads to decreased norepinephrine levels; therefore anxiety levels are decreased(Field et al.,2007) Since massage is a kind of pressure massage, the same mechanism may at least lead to a reduction in anxiety partially. When a relaxation reaction occurs due to massage, the stress response is suppressed and the level of anxiety is lowered. Decreased stress is accompanied by increased diminished activity of the sympathetic nervous system and vagal outflow (Buttagat, 2011)

.Secondly, increase body relaxation and reduce stress. The decreased feeling of muscle tension after receiving massage therapy may be explained by the theory of relaxation response. Delaney et al. suggested that the decreased muscle tension is probably the result of an overall reduction in the defence-arousal response and an increased relaxation response. (Delaney et al.,2002) The result of Thanarat et al. showed that the decreased heart rate, and increased time domain indices and high frequency of heart rate variability, and automatic nerve system activity. Which indicated that massage therapy can decrease sympathetic activity and increase parasympathetic activity (Sripongngam, et al.,2015).

**Table 3: The effects of massage therapy on neurological makers**

| Study | Subjects | Intervention | Measurement | Results |
|---|---|---|---|---|
| Morelli M et al. | Neurologically healthy adult, n=12 | 3 minutes massage (one-hand petrissage) | Hoffman reflex (H-reflex) amplitude | Hoffman reflex (H-reflex) amplitude decreased. |
| Sullivan S et al. | undergraduate students and university staff, =16 (8 men, 8 women) | 5 minutes massage | Hoffman reflex amplitude; M-responses | Massage can decrease H-reflex amplitude. |
| Buttagat V et al. | Patients with scapulocostal syndrome, n=20 | 30 minutes tradition Thai massage | anxiety; muscle tension; pressure pain threshold; | Results showed that the tradition Thai massage group showed a significant improvement in all parameters. |
| Funda et al. | Patients with undergone total hip or knee arthroplasty,n=60 (42 women, 18 men) | One hour massage | blood pressure; State Anxiety Inventory; McGill Pain Questionnaire Short Form; | Back massage can decrease anxiety and pain. |
| Chatchawan U et al. | participants who had headache, n=72 | 25 minutes massage and 5 minutes stretching | Suboccipital and neck range of motion; pressure pain threshold; Visual analog scale | tradition Thai massage can increase pressure pain threshold and reduce headache intensity |

**Table 4: The effects of massage therapy on psychological makers**

| Study | Subjects | Intervention | Measurement | Results |
|---|---|---|---|---|
| Buttagat V et al. | patients with back pain, n=36 | 30 minutes traditional Thai massage | body flexibility; pressure pain threshold; muscle tension; heart rate variability; anxiety; | Results showed that significant increase in HRV which include increased high frequency and total power frequency. |
| Leivadi et al. | 30 dance students | 30 minutes whole body massage (petrissage, effleurage, and friction) | Visual analog scale; Profile of mood states; State Anxiety Inventory; Salivary cortisal | Massage can significantly decrease the salivary cortisol, Profile of mood states, and State Anxiety Inventory. |
| Hemmings et al. | Amateur boxers, n=8 | 20 minutes whole body massage (petrissage and effleurage) | Heart rate; Blood lactate; Perceived recovery scale; Boxing performance | Results showed a significant increase in perceived recovery. |
| Cristina et al. | patients with headache, n=11 | 40 minutes head-neck massage | pressure pain thresholds; mood states; heart rate variability; | Massage can produce a decrease in tension and an immediate increase of index HRV. |
| Sripongngam et al. | healthy participants, n=29 | 60 minutes traditional Thai massage | heart rate variability; salivary alpha-amylase levels; plasma renin activity | Massage can cause stress reduction as indicated by a reduced salivary alpha-amylase levels and an increased high frequency of HRV. |

## CONCLUSION

Massage is called "green medicine" by the World Health Organization because of its remarkable effect, low price and no toxic side effects. Its mechanism of action involves many disciplines such as physiology, biochemistry, electrophysiology, and biomechanics. The previous studies show that massage therapy can affect the biochemical makers (passive muscle stiffness, range of motion, visual analog scale), physiological makers (blood flow, skin and muscle temperature, blood pressure, heart rate, heart rate variability, pressure pain threshold), neurological makers (Hoffman reflex, anxiety associated with scapulocostal syndrome, state anxiety inventory), and psychological makers (heart rate variability, profile of mood states, salivary cortisol). Understanding the mechanisms of massage therapy will help to guide clinical practice. Although many research results have been achieved in the mechanisms of massage therapy, however there are still many problems need to be examined, solved, and explained in the future. Such as the effects of different types of massage therapy (Traditional Thai Massage, Swedish Massage, Traditional Chinese Massage, and so on), the effects of different kinds of the massage techniques (Petrissage, Stroking, Kneading, Effleurage).

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

## AUTHOR CONTRIBUTIONS

Houyong Zhong designed and performed the experiments and also wrote the manuscript. Zhen Wan and Jinpei Lei performed data collection and analysis. Cuimei Wang designed experiments, reviewed the manuscript and performed the language polishing. All authors read and approved the final version.



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