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EFFECT OF TRADITIONAL THAI MASSAGE ON MUSCLE OXYGEN SATURATION IN LOW BACK PAIN PATIENTS: A PRELIMINARY STUDY

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ABSTRACT: Low Back Pain (LBP) is a common disease found in every age that affects daily life. LBP may cause poor posture of the lumbar spine, and decrease muscle performance which leads to muscle fatigue, reduce blood circulation and reduce muscle oxygen saturation. Traditional Thai Massage (TTM) has been used to treat patients with LBP for a long time with some evidence that it could increase muscle flexibility, improve blood circulation and decrease pain. However, its effect on muscle oxygen saturation has not been explored. This study uses one group pretest-posttest design to preliminary determine this effect. Twenty-three subjects (6 males and 17 females) who had non-specific LBP participated. Each of them was measured on muscle oxygen saturation, visual analog scale (VAS) and Sorensen's test before and immediately after having a 15-minute session of TTM. These measures were compared before and after those of a 15-minute rest period. The results showed significantly increase in muscle oxygen saturation ($p < 0.01$), increase endurance of back extension ($p < 0.05$), decrease pain intensity (3.46±2.65) ($p < 0.01$) and decrease anxiety level (4.04±2.30) ($p < 0.01$) after received TTM. In conclusion, TTM could improve muscle oxygen saturation level, decrease pain intensity, decrease anxiety level and increase the duration of hold while performing back muscle endurance tests.

Keywords: Low back pain, Muscle oxygenation, Thai massage, Anxiety, Muscle blood circulation

1. INTRODUCTION

Lower back muscles are the part of body structure that used to stabilize the body in upright position where the main muscle that acts in this position is erector spinae (ES) muscle. ES muscle is responsible for thoracic and lumbar flexion from the upright position since it acts as antagonists to gravity [1]. Low back pain (LBP) is one common disease resulting from disorder of lower back muscle and lumbar spine [2]. LBP has high prevalence in adult population (70-85 %), especially rate of incidence in females was higher than males in all age groups [3][4][5].

The individual with LBP which effects on daily life can develop chronic low back pain (CLBP) [6]. LBP could be divided into two types as specific and non- specific base on pathology where most of the cases are non-specific LBP [7][8]. CLBP can affect poor posture of lumbar spine, poor balance in sitting position. Causes of LBP may induce inefficient muscular stabilization of spine, psychological distress and prolong workload is promoting muscle fatigue, reduce blood flow and reduce muscle oxygenation [9][10][11][12] Nowadays, many kinds of treatments have been suggested to treat low back pain such as massage, stretching exercise, strengthening exercise, etc., because they could improve muscle flexibility, muscle activity, blood circulation, and oxygen saturation.

Oxygen is the most important to bodywork in each working process. Oxygen is transported in hemoglobin and myoglobin. Therefore, oxygen saturation separated two types as arterial oxygen saturation and muscle oxygen saturation. From the previous study, Murthy, G. [13] reported that the importance of muscle oxygen saturation when muscle ischemia that affects to decrease blood volume and muscle oxygenation, it causes muscle fatigue. The study of Bengtsson, A. [14] reported that "hypoxia in combination with muscle work causes pain as well as energy depletion" and when oxygen is raising, it can delay the onset of muscle fatigue [15].

At present, there are several studies that show therapeutic evidence base about traditional Thai massage, but none of the studies has provided the level of muscle oxygen saturation of TTM on lower back muscle. Thus, TTM still needs more evidence to support beneficial effects such as treatment guidelines. Therefore, this study will preliminarily determine the effects of traditional Thai massage on level of muscle oxygen saturation and muscle endurance of lower back muscles in low back pain

patients.

2. METHODOLOGY

This study used one group pretest-posttest design, conducted in the department of Physical therapy, faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen Province, Thailand. This study was approved by Ethics Committee of Khon Kaen University.

2.1 Participants

Male and female participants with LBP age between 20 – 45 years old were recruited by using bulletin boards and oral requests. They were screening by researcher according to the inclusion criteria; subacute (3 weeks to 3 months) or chronic low back pain of non-specific low back pain (> 3 months), body mass index (BMI) = 18.5-24.9 kg/m^2 [16], visual analog scale ≥ 3/10, good communication and cooperation, no contraindication to either TTM, no fracture, non-smoking [17] and adipose tissue thickness (ATT) ≤ 6.7 mm. All participants must refrain from drinks containing alcohol and caffeine before attending in 24 hours.

Twenty-three participants (26.70 ± 6.18 years of age; height 1.63 ± 0.09 m.; weight 56.14 ± 8.99 kg.; BMI 20.88 ± 1.71 kg/m2; ATT 4.37 ± 1.49 mm.) were signed informed consent before joining in this study.

2.2 Procedure

Twenty-three participants were measured physical examination (e.g. heart rate, blood pressure, the severity of pain and level of exhausted at that time), anxiety level by STAI-Y1, Visual analog scale (VAS), muscle oxygen saturation (SmO_2) and endurance of back extension by Sorensen's test for baseline. After that, they received TTM for 15 minutes per session on lower back muscle in prone position. The participants rest 15 minutes before receiving TTM.

Massage points including 2 lines and in this study performed along energy lines or Sen-sib which is call "Ping-kha-la" or "Ei-tha" [18] depends on pain side. The massage therapist was measure 2 fingers base from the spine and pressed at T1 to S1 to apply gentle, gradually increasing, pressure through the massage therapist's thumb or palmar. Pressure applied until the participants begin to feel slight uncomfortable then hold 5-10 seconds per time. The massage therapist applied several times until 15 minutes [19]. The participants can request to stop the massage therapists or researchers at any time if they feel pain. And re-measured in the same baseline after finished TTM (Fig.1).

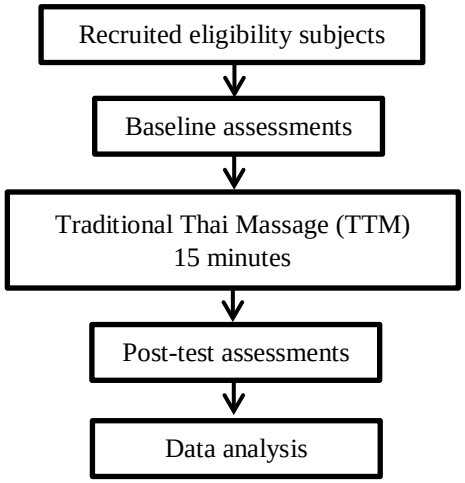

Fig.1 Overview of study design

2.3 Measurements

2.3.1 Muscle oxygen saturation (SmO_2) using MOXY

Muscle oxygen saturation chooses as a primary outcome measure in this study and used MOXY to measure muscle oxygen saturation. The participants were lying in prone position; the researcher cleans up on lower back at L1 to L5. Then the researcher palpated L3 for place MOXY monitor on the center of erector spinae [20] (Fig.2). The data recorded in peripedal (software of MOXY) and exported in Microsoft excel. The validity of this tool is consider-ably strong (ICC; r = 0.773–0.992) [21]. The researcher has an intra-class correlation coefficient at 0.98.

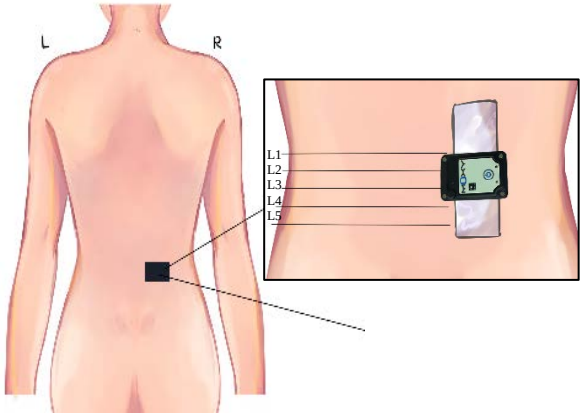

Fig.2 The location of Moxy monitor placed on low back muscle

2.3.2 Endurance of back extension using Sorensen's test

The participants were prone by the lower part of the body on the bed and anterior superior iliac spine place on edge of the bed after that the researcher strapped to the three-point: level of greater trochanter of the femur, knee creases and level of lateral [22]. The chair placed in front of the participant to support the upper part of the body and the participant placed both hands on the chair for the starting position. Beginning the participant lift the upper part and hand from the chair and both arms crossed on the chest. The upper part of the body was horizontal to the bed. They hold the horizontal position until fatigue or the body can't lift to horizontal (Fig.3). The researcher measured the time by stopwatch. [23] [22] [24]. The validity of the Biering-Sorensen test has 0.77 [22]. This assessment time was 5 minutes approximately.

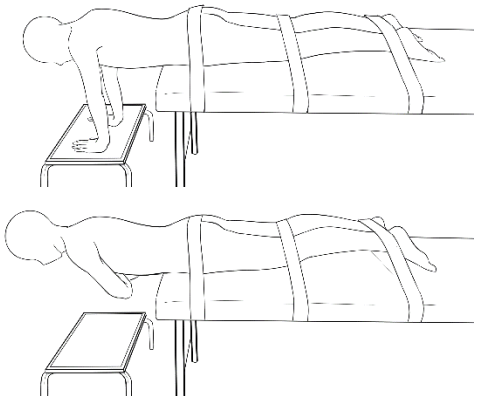

Fig.3 Endurance of back extension by Sorensen's test

2.3.3 Pain intensity using Visual analog scale (VAS)

The pain intensity was assessed by 10 cm. visual analog scale. Range 0-10 which 0 is "no pain" and 10 is "most pain". The participants were marked on the scale of pain intensity.

2.3.4 Anxiety level by STAI-Y1 (Thai version)

The participants requested to state-trait anxiety inventory Y1 has 20 item State anxiety items include: 'Not at all; I fell a little bit; I fell quite a lot" and I fell very so much'. Higher scores mean greater anxiety. The score of STAI-Y1 separate to 3 levels of anxiety, there are including; 20-39 scores: Low anxiety, 40-59 scores: Moderate anxiety and 60-80 scores: High anxiety.

2.4 Statistical analysis

Data analysis was used by SPSS version 23 in this study. Descriptive data of continuous data such as age, weight, etc., are presented in terms of mean and standard deviation. The categorical data such as gender, occupation, etc., are presented in proportion and percentages. Demographic data are presented as mean ± standard deviations (SD) and percentage. Mean and standard deviations of the values were calculated for each variable. This study aimed to analyze each outcome in the period before and after treatment, the different times by the immediate effect of each outcome. Paired t-test and Wilcoxon used to compare outcome variables at baseline with outcome variables after received treatment immediately within the group. Friedman's 2-way ANOVA used to compare the change of outcome measure at different times within group. This study estimates the adjusted mean difference and the 95 percentages confidence interval for each outcome measure.

3. RESULTS

3.1 Muscle oxygen saturation

Table 1 showed that the immediately after received TTM had significantly increased between Soren1-Recovery, TTM-Recovery and Base5M-Recovery (p-value < 0.01). In addition, there are three pairs that have significantly different at p-value < 0.05: Rest1-Recovery, Soren2-Recovery, and Rest2-Recovery. Table 2 showed SmO_2 was significantly improved after receiving TTM where was 8.17% increased.

Figure 7 showed that changes in muscle oxygen saturation in each period with the following changes: In Soren1 when the participant extends back in Sorensen's test, the muscle oxygen saturation was decreasing from baseline and increasing after resting 15 minutes. Next, the massage therapist applied massage on the affected side, the muscle oxygen saturation was decreasing again and increasing after resting 15 minutes. In the same result of Soren1 in Soren2 but the muscle oxygen saturation decreased lower than Soren1. The last recovery period was increasing more than all period and significant increasing after received the treatment.

3.2 Endurance of back extension muscle

Table 2 showed the endurance of back extension was also significantly improved about 0.11 min after receiving TTM, significantly improved at p-value < 0.05.

Endurance of back extension muscle has significantly increased after received TTM and it's not normal distribution because some participants had decreasing of time when doing Sorensen test 2 (Fig.4).

3.3 Pain intensity and anxiety level

Pain intensity was significantly decreased at p-value < 0.01 and anxiety level was significantly improving at p-value < 0.01 after received TTM from baseline (Fig.5) (Fig.6).

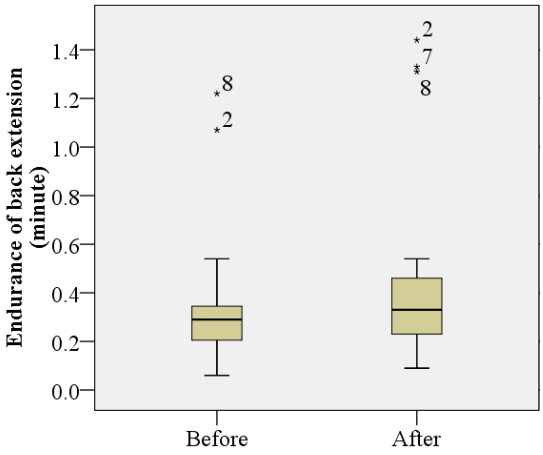

Fig.4 The change after received TTM of the endurance of back extension

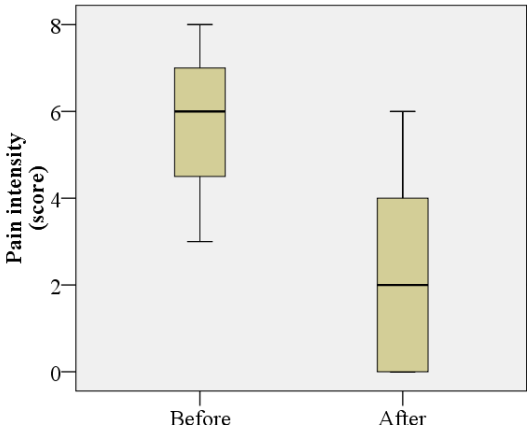

Fig.5 The change after received TTM of pain intensity

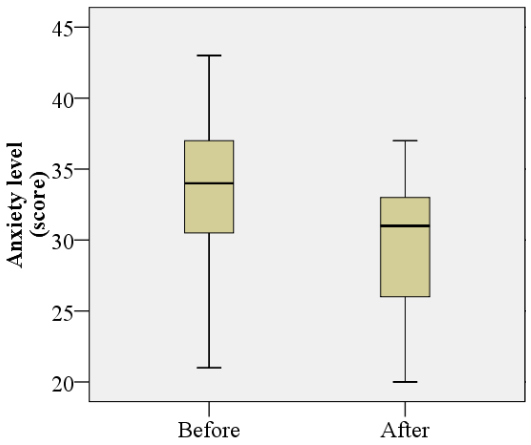

Fig.6 The change after received TTM of anxiety level

4. DISCUSSIONS

This study was preliminarily determining the immediate effects of traditional Thai massage (TTM) on level of the muscle oxygen saturation (SmO_2), Visual analog scale (VAS), State trait anxiety Y1 (STAI-Y1) and muscle endurance of lower back muscle in low back pain (LBP) patients.

The results showed that SmO_2, muscle endurance, VAS, and STAI-Y1 had significant increasing. The result showed that traditional Thai massage can increase level of the muscle oxygen saturation and muscle endurance of lower back muscles in low back pain patients immediately after received treatment. Beside pain scale and anxiety levels have improved in the same way.

Table 1 Participants outcome of Muscle oxygen saturation (SmO_2)

Item	S.E.	P-value
Baseline-Sorensen 1	0.637	1.000
Baseline – Resting 1	0.637	1.000
Baseline – TTM	0.637	1.000
Baseline – Resting 2	0.637	1.000
Baseline – Sorensen 2	0.637	1.000
Baseline – Recovery	0.637	0.001**
Sorensen 1 – Resting 1	0.637	1.000
Sorensen 1 – TTM	0.637	1.000
Sorensen 1– Resting 2	0.637	0.510
Sorensen 1 – Sorensen 2	0.637	0.785
Sorensen 1 – Recovery	0.637	0.001**
Resting 1 – TTM	0.637	1.000
Resting 1 – Resting 2	0.637	1.000
Resting 1 – Sorensen 2	0.637	1.000
Resting 1 – Recovery	0.637	0.003**
TTM – Resting 2	0.637	1.000
TTM – Sorensen 2	0.637	1.000
TTM – Recovery	0.637	0.001**
Resting 2 – Sorensen 2	0.637	1.000
Resting 2 – Recovery	0.637	0.022*
Sorensen 2 – Recovery	0.637	0.012*

Note: * p value < 0.05, ** p value < 0.01 and S.E.: Standard error

4.1 Immediate effect on increasing muscle oxygen saturation level

This study found muscle oxygen saturation increased after receiving TTM. Changes in muscle oxygenation depend on the exertion level, blood flow, myoglobin, and hemoglobin dissociation curve. The muscle had myoglobin that was carrying oxygen to the muscle which will be transmitted through the capillaries and changes the amount of myoglobin depend on the concentration in skeletal muscle fibers. [27]

Table 2 Comparison outcome of all outcomes

Items	Baseline (Mean ± SD)	Post-test (Mean ± SD)	Difference (95% CI)	P-value
Muscle oxygen saturation	78.88 ± 14.11	87.05 ± 8.95	8.17 (60.52 to 98.33)	0.001**
Endurance of back extension	0.34 ± 0.38	0.45 ± 0.28	0.11 (0.010 to 0.21)	0.015*
Pain intensity	5.67 ± 1.52	2.22 ± 2.04	3.46 (2.65 to 4.27)	0.001**
Anxiety level	33.61 ± 5.46	29.57 ± 4.83	4.04 (2.30 to 5.78)	0.001**

Note: * p value < 0.05, ** p value < 0.01

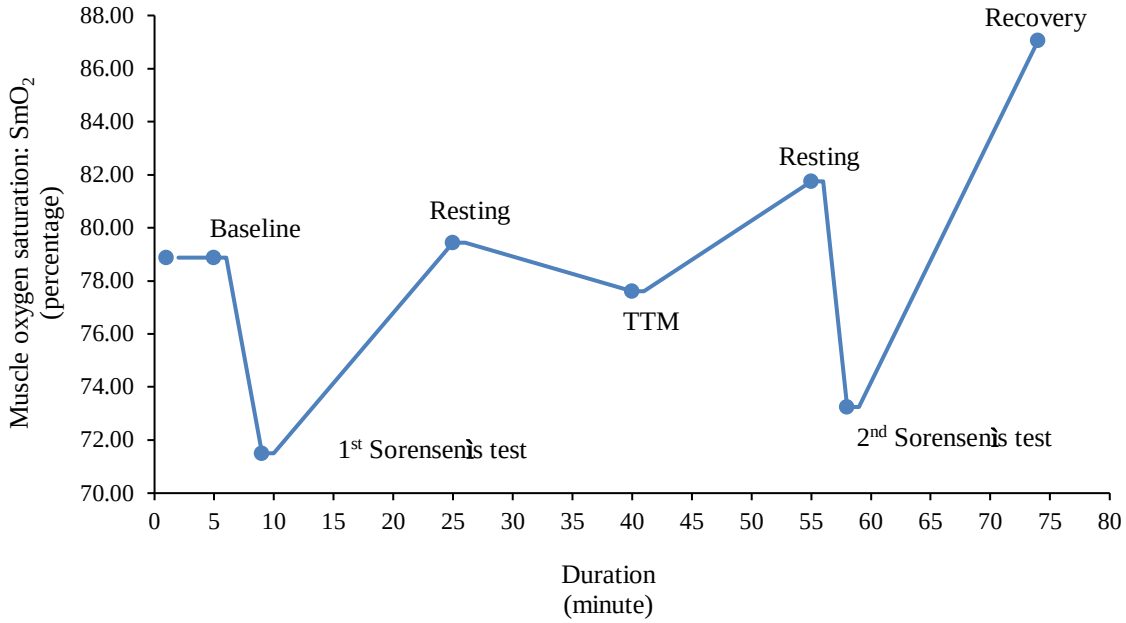

Fig.7 The change of muscle oxygen saturation (SmO_2) baseline until recovery.

Baseline measurement was measured 5 minutes and the SmO_2 level was high or low depending on the muscle tension and blood flow on the lower back in each person. According to the previous study, who had a myofascial trigger point or muscle spasm often had vasoconstriction that affects poor blood circulation, poor oxygenation, and fatigue easily [26]. Next, Sorensen's test 1 showed SmO_2 was decreasing for baseline because they had muscle contraction when performed back extension, causing the vessels were occluded. So, the SmO_2 level was increasing after resting 15 minutes in period 1. After that, the massage therapist applied the pressure and while doing massage had changes of SmO_2 rise and fall because when she applied the pressure, had compress to vessel in the muscle and then the massage therapist slowly released pressure, causing the blood vessels to gradually relaxed and increased blood circulation [25]. Then, the participants were resting 15 minutes showed the SmO_2 level was higher than the baseline, causing muscle relaxation that improved blood circulation and improved oxygenation [26]. In Sorensen's test, 2 showed the SmO_2 level had decreased while doing back extension but it's decreasing less than Sorensen's 1.

The last recovery period showed that the SmO2 level had significantly increased with each period. Since, there were both relaxing massage and increasing strength of isometric back extension the effect of the possible mechanism might be promoted parasympathetic to relaxation and

improve vasodilation by reducing heart rate, blood pressure, and endorphins as relaxation substances. Parasympathetic is part of the autonomic nervous system that controls the body rest and balance homeostasis cause muscle relaxation. While massage in the prone position on erector spinae, it involved pressure on the muscle tissue which may decreased muscle tension and increase skin temperature. Consequently, it may induce vasodilation, improve circulation. Since oxygen in the muscles is bined to myoglobin in capillaries, massage could increase SmO2 level immediately after applying TTM on the tight back muscles.

4.2 Immediate effect on improving endurance of back extension

This study found that endurance of back extension was significantly improved after received TTM according to massage could be decreased muscle spasm, muscle tension, and improved flexibility, causing there was improved blood flow [25] [29] and improved oxygen saturation. The previous study reported repetitive exercise could improve circulation after knee flexion and extension. In addition, Sorensen's test was the isometric exercise of back extension, it could be improved strengthening the cause of participants could hold the upper body longer from baseline. Isometric exercise could improve blood circulation in 2004 reported massage group with isometric exercise has muscle blood volume higher than isometric without massage. While muscle contraction that affects to squeeze vessel after slowly released muscle contraction the vessel will dilate that improved blood flow on localizing muscle [32].

4.3 Immediate effect reducing pain intensity

This study showed that the level of pain intensity was significantly decreased after the treatment. Mechanism of pain is some part of the body received pain signal after that refers to dorsal horn in the spinal cord, that sends to the brain and first transmission cell (T cell). Substantia gelatinosa in spinal cord functions as the gate control system, which consists of small fiber, densely packed cells that form a functional unit extending the length of the spinal cord. Gate control theory of pain mechanism is substantia gelatinosa on the afferent fiber stimulated large fiber (L-fiber) and decrease the activity of small fiber (S-fiber) that effect to close gate control of pain. [30]. In addition, TTM promoted vasodilation, exchanges oxygen and decreased lactic acid cause of fatigue

4.4 Immediate effect on improving anxiety level

The study found that after the participants received the massage, there was a better anxiety condition before a received massage. Anxiety will fluctuate with various substances in the body and the work of that receptor or hormone, found that noradrenergic (NA) and serotonergic receptors (5-HT) play an important role in anxiety. Concerns about changes in NA also depend on the function of the endocrine glands. Normally, NA releases secretion of noradrenaline, but in anxiety, triggering locus coeruleus (LC) results in a decrease in the rate of signaling. NA stimulation, including after noradrenaline. There is also an increase of corticotropin-releasing factor (CRF) and adreno-corticotropic hormone (ACTH, corticotropin) in the body, resulting in increased heart rate, increased blood pressure and neophobic behaviors that people with this condition will have fear to do somethings result in a decrease in the activity. Traditional Thai massage will be stimulation parasympathetic effect that causes the body to release noradrenaline, serotonin (5HIAA), dopamine and reduce cortisol CRF, ACTH, and corticotropin.

The results of this study were consistent with previous studies, that showed the immediately TTM on back muscle 30 minutes could improve pain intensity and improve the level of anxiety which accordance with this study [19]. TTM was promoted relaxation, activated parasympathetic and decreased sympathetically. Moreover, massage the whole body in pregnancy could increase serotonin (5HIAA), increased dopamine, decreased cortisol that might be explained about improving anxiety level [31]

5. FOLLOW UP

The researcher followed up the participants about pain intensity for 1 day after receiving the massage and found no adverse effect.

6. LIMITATIONS AND FURTHER STUDY

This study has some limitations. Firstly, this study has small sample size because it was a preliminary study without a control group for comparison. Secondly, the study has no blinded assessor and patients which could be prone to be bias. Thirdly, data collection in some patients was failed due to excessive sweating after performing Sorensen's test that caused unfirmed skin contact during measurement of muscle oxygenation. The lastly, results of this study could be explained only the immediate effects of TTM on the observed parameters. Long-term effects have not yet to be explored.

To validate the effects of TTM on muscle oxygen saturation and muscle endurance, a randomized control trial using either parallel or

crossover design is recommended for further study. Moreover, long-term effects of it should be explored for clinical practice.

7. CONCLUSION

The aim of this study was to preliminarily determining the immediate effects of traditional Thai massage on level of the muscle oxygen saturation and muscle endurance of lower back muscles in low back pain patients. Based on the results of the study, it is concluded that muscle oxygenation could be improved after receiving a single session of 15-minute traditional Thai massage on lower-back muscles in low back pain patients. Moreover, it could also have decreased pain intensity, decreased anxiety level and improved back muscle endurance.

This study is the first research regarding traditional Thai massage on muscle oxygen saturation in low back pain patients. The treatment technique of traditional Thai massage used in this study could produce beneficial results without any adverse effect either immediately on one day after receiving the massage session. Thus, this protocol of 15-minute of traditional Thai massage could be an alternative treatment for pain management of low back pain patients.

8. ACKNOWLEDGMENTS

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