CHAPTER V
DISCUSSION

This is the study to investigate the effect of single thoracic manipulation and single thoracic mobilization on chronic mechanical neck pain. The reliability of current study showed that the intra-tester reliability of cervical range of motion and PPT showed a high degree of reliability. The current study suggests that the single thoracic manipulation results in significantly greater improvements in pain level at rest, cervical range of motion in all directions and pressure pain threshold than those in the control group in patients with chronic mechanical neck pain. And the single thoracic mobilization results in significant improvements in cervical range of motion in the same directions. However, the current study reveals no significant differences in pain level at rest, cervical range of motion in all motion and pressure pain threshold between the single thoracic manipulation and the single thoracic mobilization in patients with chronic mechanical neck pain.

5.1 Reliability of the measurement tools

5.1.1 The Cervical Range of Motion (CROM) device

The results of the current study demonstrated that the intra-tester reliability of cervical range of motion showed a high degree of reliability in flexion, extension, left and right lateral flexion and left and right rotation (ICC range from 0.91 to 0.98).

The finding of the current study was comparable to the previous studies (Hole et al., 1995; Youdas et al., 1991). Youdas et al., (1991) investigated intratester reliability of cervical range of motion in patients with orthopedic disorders and found that the intra-tester reliability showed a good degree of reliability in all directions (ICC range from 0.84 to 0.95). The similar finding was also reported in the study of Hole et al., (1995). They tested intra-tester reliability of cervical range of motion in healthy subjects and found that the intra-tester reliability showed a high degree of reliability in all directions (ICC range from 0.92 to 0.96). However, the

previous studies differed from the current study in terms of the condition of the subjects. Youdas et al., (1991) investigated in subjects with orthopedic disorder, whereas the current study investigated in healthy subjects.

5.1.2 The pressure algometer

The results of the current study showed that the intra-tester reliability of PPT showed a high degree of reliability in all points of cervical muscles (ICC range from 0.95 to 0.98).

The finding of the current study was comparable to the previous studies (Delaney et al., 1993; Persson et al., 2004; Ylinen et al., 2007). Delaney et al., (1993) studied intratester reliability in patient with myofascial trigger point of trapezius muscle and found that the intra-tester reliability showed a good reliability (ICC range from 0.80 to 0.91). The similar finding was also found in the study of Persson et al., (2004). They investigated the intra-tester reliability in the trapezius and deltoid muscles in healthy women subjects and found that the intra-tester reliability was high (ICC range from 0.70 to 0.94). However, these two previous studies differed from the current study in terms of the difference of the muscle tested. The current study tested reliability in healthy subjects, whereas, the two previous studies tested the reliability in latent myofascial trigger points muscles. Furthermore, the two previous studies investigate in female subjects but the current study used both gender. It has been reported that PPTs may vary during the menstrual cycle (Cimino et al., 2000; Persson et al., 2004). Additionally, Ylinen et al., (2007) studied the intra-tester reliability in middle-aged women with non-specific neck pain and found that the intra-tester reliability showed a good reliability (ICC range from 0.78 to 0.93). However, the previous study differed from the current study in terms of the condition of the subjects, age and sex. The current study used the normal subjects both men and women and age between 19 to 31 years. Whereas, the previous study used the women with non-specific neck pain and age between 23 to 53 years. This reason may influence to vary of reliability of PPT.

5.2 Immediate effect of single thoracic manipulation and single thoracic mobilization on cervical range of motion

The finding of the current study suggested that after performing the single thoracic manipulation at the T6-T7 level, the cervical range of motion in patients with chronic mechanical neck pain were significantly increased in all directions ($p < 0.01$). The results in the single thoracic mobilization group significantly increased only in flexion, left and right lateral flexion and left and right rotation ($p < 0.05$), but there was no significant difference in extension. However, there were no significant differences of the cervical range of motion in all directions before and after in the control group.

The finding of the current study was similar to the study of Gonzalez-Iglesias et al., (2009), who showed that after performing a thoracic spine thrust manipulation combined with electro-therapy/thermal program could increase the cervical range of motion in all directions immediately ($p < 0.001$). However, the previous study differs from the current study because this study combined with electro-therapy/thermal program into the single thoracic manipulation and duration of symptom. In contrast, the study of Fernandez de las Penas et al., (2007) investigated the effectiveness of single thoracic manipulation in patients with mechanical neck pain. Their study shown that the cervical range of motion in all directions had no statistical significance ($p > 0.05$). However, the study of Fernandez de las Penas et al., (2007) is only a case series.

The results in the single thoracic mobilization group also significantly increased in flexion, left and right lateral flexion, and left and right rotation, but not in extension direction. It may result from the ceiling effect in extension direction due to the raw data of extension direction in the single thoracic mobilization at baseline already showed high degrees (baseline = 59.70 degrees, after = 62.70 degrees) (Appendix G).

The current study showed that the single thoracic mobilization could produce an increase cervical range of motion. Although, the mobilization technique was directed at the zygapophyseal joint of T6-T7, it is likely that the mobilization had a direct impact on the superior and inferior segments (Fernandez de las Penas et al 2008). Lee et al., (2005) investigated the effects of a grade III mobilization directed at

the C5 spinous process and found that the C2-C3 and C7-T1 segments also had movement. It may be assumed that the results of the current study performed unilateral PA directed at bilateral zygapophyseal joints T6-T7 could impact the segments above the target vertebrae. Therefore, the force from the thoracic mobilization may stretch paravertebral muscles and may induce a reflex inhibition of pain or reflex muscle relaxation by modifying the discharge of proprioceptive group I and II afferents (Pickar, 2002). It is also plausible that the thoracic mobilization could decrease spasm in paravertebral muscles while increasing cervical mobility. Moreover, the thoracic manipulation may restore the normal biomechanics of thoracic region, potentially lowering mechanical stress and increasing the distribution of joint forces in the cervical spine (Edmondston and Singer., 1997). It is possible that manipulation on the thoracic region can alter the biomechanics of the thoracic spine, which is related to the cervical spine (Norlander et al., 1997; Norlander and Nordgren., 1998). It is possible that a thoracic manipulation may affect the range of motion in the entire spine.

When comparing between each pair, the results showed that the cervical range of motion of single thoracic manipulation group significantly increased greater than the control group in flexion, extension, left lateral flexion and left rotation ($p < 0.05$), but there was no significant differences in right lateral flexion and right rotation ($p > 0.05$). This may due to the areas of pain of the subjects at the baseline. The raw data of subjects in single thoracic manipulation showed that eight out of eleven subjects have pain on their left side. This may be a reason why the cervical range of motion in the single thoracic manipulation group had no significant improvement in right lateral flexion and right rotation when comparing to the control group.

The results of the current study were similar to the previous studies (Gonzalez-Iglesias et al., 2009). Gonzalez-Iglesias et al., (2009) investigated that the effectiveness of thoracic spine thrust included electro-therapy/thermal program compared with electro-therapy/thermal program only. The result shown that the inclusion of an electrotherapy/ thermal program into a thoracic manipulation was effective in increasing cervical range of motion in all directions ($p < 0.001$) in patient with acute mechanical neck pain. However, the results were difficult to compare the

current study with the study of Gonzalez-Iglesias et al., (2009) that have been used co-intervention (electrotherapy/ thermal program) and difference in the duration of symptom.

When comparing between single thoracic manipulation and single thoracic mobilization, the results had no significant differences in all directions ($p > 0.05$). This may influence by the way to calculate the sample size. The sample size calculation in the current study was not based on identifying difference in cervical range of motion between the groups, but it was calculated based on the difference in pain at rest (Cleland et al., 2005).

The scientific has documented the effects of thoracic manipulation on the improvements of the cervical range of motion. The mechanisms of thoracic manipulation may be explained by possible two mechanisms.

Firstly, the thoracic manipulation provoked an increase in cervical range of motion could be explained by a possible reflection of thoracic manipulation on the cervical spine (Fernandez de las Penas et al., 2007; Maitland et al., 2000). The rational of thoracic manipulation in management of patients with neck pain results from hypothesis that disturbances in joint motion in thoracic spine may be contributed to joints motion in the cervical spine. The thoracic manipulation may restore the normal biomechanics of thoracic region, potentially lowering mechanical stress and increasing the distribution of joint forces in the cervical spine (Edmondston and Singer., 1997). Secondly, previous studies have found that association between decreased mobility of thoracic spine in patients with neck pain (Edmondston and Singer., 1997; Fernandez de las Penas et al., 2007). It is possible that manipulation on the thoracic region can alter the biomechanics of the thoracic spine, which is related to the cervical spine (Norlander et al., 1997; Norlander and Nordgren., 1998). It is possible that a thoracic manipulation may affect the range of motion in the entire spine. In addition, the effect on pain modulation in thoracic manipulation group can lead to changes in cervical range of motion (Fernandez de las Penas et al., 2007).

5.3 Immediate effect of single thoracic manipulation and single thoracic mobilization on pain level at rest

The result of the current study demonstrated that the pain level at rest (VAS) in subjects with chronic mechanical neck pain significantly decreased after receiving the single thoracic manipulation ($p = 0.007$). This result demonstrated that the single thoracic manipulation can relieve pain in subjects with chronic mechanical neck pain, however there were no significant differences in the single thoracic mobilization and the control group on pain level at rest.

The finding of the current study also suggests that the thoracic manipulation in subjects with chronic mechanical neck pain significantly reduced pain level at rest ($p = 0.007$) and the finding was comparable to the previous studies (Cleland et al., 2005; Fernandez de las Penas et al., 2007; Gonzalez-Iglasias et al., 2009). Cleland et al. (2005) reported a decreasing in pain level at rest in subjects with receiving thoracic manipulation and found that the pain level was significantly changed from 41.6±17.8 mm to 26.1±17.2 mm ($p < 0.01$). The similar finding was also in the study of Fernandez de las Penas et al., (2007). They performed a single thoracic spine manipulation in subjects with chronic mechanical neck pain and demonstrated a decreasing in pain level at rest and found that the pain level was significantly changed from 5.4±1.5 to 2.9±1.4 ($p < 0.001$) by using an 11 point numerical pain rate scale (NPRS). However, these two previous studies differed from the current study in terms of the condition of the subjects. The current study used subjects in a chronic stage, whereas the two previous studies used subjects in an acute and sub-acute stage. Furthermore, the study of Fernandez de las Penas et al., (2007) was only a case series study and they investigated effects of thoracic manipulation on several levels, whereas the current study investigated only one level at thoracic spine. In addition, Gonzalez-Iglasias et al., (2009) performed combination of thoracic spine thrust manipulation and electro-therapy/thermal program in patients with acute mechanical neck pain. The study demonstrated a 50 per cent decreasing in pain level at rest ($p < 0.001$). However, this previous study differs from the current study due to the combination of thoracic manipulation and electro-therapy/thermal program. Therefore, the result may be confounded by the co-intervention.

The scientific has documented the effects of thoracic manipulation on the improvements of the pain on the neck. It has been suggested that pain is modulated at either the spinal cord or in the higher centers of the central nervous system. The mechanism of pain relief for thoracic manipulation may be explained as follows:

a) The first, the thoracic manipulation may produce pain relief by activating the spinal component of the gate control mechanism. The mechanical force from manipulation activated mechanoreceptors via large diameter myelinated neurons (A fiber). The signal from large diameter myelin neurons will modulate and inhibit the response of dorsal horn neurons to nociceptive stimuli from small diameter unmyelinated neurons (C fiber) (Melzack and Wall., 1965).

b) The second, the mechanical stimulation from the thoracic manipulation may induce a reflex inhibition of pain or reflex muscle relaxation by modifying the discharge of proprioceptive group I and II afferents (Pickar, 2002). These afferents produced by the spinal manipulation which would reduce the gain of the gamma motoneurons. It is also plausible that thoracic manipulation decreases pain and spasm while increasing mobility through changes in muscle electrical activity.

c) The third, the spinal manipulation can activate descending inhibitory mechanisms resulting in hypoalgesic effects in distant areas. This mechanism, that is the periaqueductal gray (PAG), has important association with as a key control centre for endogenous mechanism. The thoracic manipulation may induce ventral PAG of the brain which activated endogenous opioid peptides resulting in hypoalgesic effects in distant areas (Paungmali et al., 2003; Vernon et al., 1986; Vicenzino et al., 2001; Wright, 1995). In addition, the thoracic manipulation may induce dorsal PAG of the brain resulting in hypoalgesia which associate sympathoexcitation (Wright, 1995).

When comparing between each group, the current study demonstrated no statistically significant differences for pain level at rest (VAS) between groups ($p > 0.05$). The results of the current study differ from the previous studies. Cleland et al., (2005), who compared between thoracic manipulation and placebo in neck pain patients. Their result showed that the VAS in thoracic manipulation decreased greater than placebo group ($p < 0.001$). Furthermore, the study of Gonzalez-Iglasias et al., (2009) has compared between thoracic spine thrust manipulation include electro-therapy/thermal program and electro-therapy/thermal program alone in acute

mechanical neck pain patients. This study reported that the neck pain at rest of patients who received thoracic spine thrust manipulation was changed more than those who receiving electro-therapy/thermal program alone ($p < 0.001$). In addition, Cleland et al., (2007) compared between manipulation and mobilization at thoracic spine in patients with neck pain. The results suggested that the neck pain level at rest in patients with receive manipulation decrease greater than patients with receive mobilization ($p < 0.001$). However, the previous studies differ from the current study in terms of the duration of symptom. The current study used chronic mechanical neck pain (duration>3 months), whereas the previous studies (Cleland et al., 2005, 2007 Gonzalez-Iglasias et al., 2009) used acute to sub-acute mechanical neck pain (duration<3 months). Additionally, the study of Cleland et al., (2007) investigated the short term effect of 24 hours, not immediate effect and performed in several levels direct in thoracic spine. Moreover, the previous studies differed from the current study in terms of pain level at rest on baseline. The current study has a pain level at rest on baseline lower than the previous studies (Cleland et al., 2005, 2007; Gonzalez-Iglasias et al., 2009). The pain level at rest on baseline of single thoracic manipulation in the current study was 43.58 mm, whereas the study of Gonzalez-Iglasias et al., (2009) was 56 mm and Cleland et al., (2007) was 53 mm. Thus, the pain level at rest of previous studies was possible to reduce greater than that in the current study.

5.4 Immediate effect of single thoracic manipulation and single thoracic mobilization on pressure pain threshold

The results of the pressure pain threshold in the current study demonstrated that the single thoracic manipulation group was increased immediately after performing intervention in all point of cervical muscles ($p < 0.05$). However, there were no significant differences in the single thoracic mobilization group ($p > 0.05$) and in the control group ($p > 0.05$).

The finding of the current study also suggests that the single thoracic manipulation group was increased immediately after performing intervention in all points of cervical muscles. Comparing this result with other research findings should be caution because of the identified lack of studies that used thoracic manipulation in chronic mechanical neck pain on PPT at neck muscles in mechanical neck pain.

However, the finding of the current study was similar to the study of Vernon et al (1990) who found that after performing a cervical manipulation could increase in the PPT at paracervical muscle in chronic mechanical neck pain patients. Additionally, the previous study of Fernandez de las Penas et al., (2008) investigated the effectiveness of cervicothoracic junction manipulation on pressure pain threshold in healthy subjects. This study suggested that the application of a cervicothoracic junction manipulation induced changes in PPT in both right and left C5-C6 zygapophyseal joints in healthy subjects ($p < 0.05$). However, these two studies differed from the current study in terms of assessed muscles.

When comparing between the single thoracic manipulation and the control group, the current study found that there was a significant difference of PPT at left levator scapulae ($p = 0.01$), but they have no significant differences in other areas. This may due to the areas of pain of the subjects at the baseline. The raw data of subjects in the single thoracic manipulation showed that eight out of eleven subjects have symptoms on their left side. This may be a reason why the PPT at left levator scapulae in the single thoracic manipulation has improved significantly than that in the control group.

5.5 Strengths of the study

The current study followed the principle of a good methodology for conducting a randomized controlled trial. There are a few strengths of the current study. Firstly, the current study used a stratified randomized allocation for random allocation of all subjects into each group. Secondly, the outcome measures of the current study were tested for their reliability and the results showed a high degree of the reliability.

5.6 Limitations of the study

There are some limitations of the current study. Firstly, we examined only the immediate effects of a single thoracic manipulation and a single thoracic mobilization on a chronic mechanical neck pain patient. Future study should examine the short term and long term effects of a single thoracic manipulation and a single thoracic mobilization in patient on chronic mechanical neck pain. Secondly, it should also be

recognized that all subjects in the current study were recruited from only one physical therapy department, so the subjects may not be able to represent for general population with chronic mechanical neck pain. Thirdly, the current study used one physical therapist for doing both treatments and measurement outcome. Therefore, further study should provide the research assistance for the measurement outcome in order to blind the assessor. Finally, the current study used the screw thrust and unilateral posterior-anterior technique grade III on facet joints T6-T7. Further study should investigate the effectiveness of thrust manipulation and mobilization at a different level on the thoracic spine for patients with chronic mechanical neck pain.