CHAPTER II
LITERATURE REVIEW

Mechanical neck pain is one of the most common problem in the general population. The aims of mechanical neck pain treatment are to reduce pain and increase range of motion. The cervical manipulation or mobilization has been commonly used to treat mechanical neck pain (Hoving et al., 2001; Gross et al., 2002). Recent studies have shown that performing thoracic spine manipulation on mechanical neck pain patient results in immediate improvements in symptoms and function on their neck (Cleland et al., 2005; Cleland et al., 2007; Fernandez-de-las-Peñas et al., 2004; Gonzalez-Iglesias et al., 2008).

2.1 Mechanical neck pain

Neck pain is a common complaint in the general population, especially in the working age group. The pathology of neck pain is not completely understood, but the source of symptoms has been reported to relate mechanical dysfunction of the cervical spine, especially the zygapophysial joints (Kanlayanaphotporn et al., 2009). The definition of neck pain is defined as stiffness and/or pain felt posterior in the cervical region between the occipital condyles and the C7 vertebral prominence (Ferrari & Russell, 2003). However, the diagnosis of neck pain is varied for example, neck sprain, myofascial pain syndrome, and mechanical neck pain (Ferrari & Russell, 2003). And mechanical neck pain is the most common type found in neck pain patients (Ahn et al., 2007).

The definition of mechanical neck pain is varied. Firstly, mechanical neck pain is defined as the pain having no specific, identifiable etiology, but could be reproduced by neck movement or provocation tests. Specifically, the pain had to be localized to the dorsal part of the neck in an area limited by a horizontal line through the most inferior portion of the occipital region and a horizontal line through the spinous process of the first thoracic vertebra (Evans et al., 2002). Secondly, it is defined as the pain confined in the area on the posterior aspect of the neck that can be exacerbated by neck movement or sustain neck posture (Fernandez-de-las-Penas et al., 2005). Thirdly, mechanical neck pain is defined as generalized neck and/or shoulder pain with mechanical characteristics, including symptoms provoked by maintained neck posture, neck movement, or palpation of the cervical muscles (Gonzalez-Iglesias et al., 2008; Mansilla-Ferragut et al., 2009; Martı´nez-Segura et al., 2006).

There are three stages of mechanical neck pain (Gross et al., 2008; Kay et al., 2008). Acute stage has symptoms duration less than 30 days, sub-acute stage has symptoms duration between 30 to 60 days and chronic stage has symptoms duration greater than 90 days. The current study was decided to assess the immediate effect of thoracic manipulation and thoracic mobilization on a patient with mechanical neck pain in chronic stage because the previous studies have a limited evidence to support the effectiveness of thoracic manipulation and thoracic mobilization directed at a single level on the thoracic spine in chronic mechanical neck pain.

2.2 Definition of spinal manipulation versus spinal mobilization

Spinal manipulation and spinal mobilization are two techniques of manual therapy which are commonly applied to the vertebral column (Bolton and Budgell, 2006). Cervical manipulation and mobilization have been showed effective for mechanical neck pain patients (Cassidy et al., 1992; Gross et al., 2002; Hurwitz et al., 2002; Hoving et al., 2001; Vernon et al., 1990). The aims of cervical manipulation and cervical mobilization are to reduce pain and increase range of motion for restoring a normal function of cervical spine (Martı´nez-Segura et al., 2006).

The techniques of spinal manipulation and mobilization are varied across specialties such as osteopathy, chiropractic, and physiotherapy. For physiotherapists, most of them follow Maitland approach. Spinal manipulation and spinal mobilization are defined as being different in biomechanical terms and biomechanical investigations confirm that in practice the two types of treatment are executed differently (Bolton and Budgell, 2006). The definition of manipulation is defined as a high-velocity and small amplitude movement applied at the end or just beyond an available joint range of motion, whereas mobilization is defined as a low-velocity and small or large-amplitude movement applied anywhere within a joint range of motion (Maitland et al., 2005). The manipulation and mobilization, based on Maitland approach are most common technique to treat the chronic mechanical neck pain in Thailand. Therefore, the current study aimed to assess the efficacy of the technique of thoracic manipulation and thoracic mobilization, based on Maitland approach, on chronic mechanical neck pain patients.

2.3 Mechanism of spinal manipulation and spinal mobilization

2.3.1 Biomechanical effects

The biomechanical changing is produced by vertebral movement during a spinal manipulation has been hypothesized. The mechanical force applied into the spinal column during a spinal manipulation may affect spinal structure, including the vertebral body, zygapophysial joint, intervertebral disc and paraspinal muscles (Maigne and Vautravers, 2003). During performance of the spinal manipulation, segmental biomechanics may be altered by releasing trapped meniscoids, releasing adhesions or reducing distortion of annulus fibrosus. Additionally, the mechanical force applied into the spinal column during a spinal manipulation may reduce mechanical stress or strain on soft and hard paraspinal tissues and could result in restoration of zygapophyseal joint mobility and joint play (Pickar., 2002). The goal of manipulation considers restoring normal anatomical, pain-free movement of the musculoskeletal system. In addition, biomechanical changes induced by the manipulation are thought to have physiological effect on inflow of sensory information to the nervous system by releasing trapped meniscoids, discal material or segmental adhesions. The mechanical input may reduce nociceptive input from receptive nerve endings in innervated paraspinal tissues (Pickar, 2002). Furthermore, the mechanical force could stimulate or silence nonnociceptive, mechanosensitive receptive nerve endings in paraspinal tissues, including skin, muscle, tendons, ligaments, facet joints and intervertebral disc. These neural inputs may influence pain producing mechanisms (Pickar, 2002).

a) Effects on the vertebral bodies

The thrust is applied either to a transverse or spinous process. The force of thrust is absorbed by the paraspinal soft tissues and is transmitted to promote the spinal segmental motion (Triano, 1992). A previous study proposed that several vertebral levels are moved simultaneously even though the manipulation is performed at a single vertebral level (Lee et al., 1995). They investigated the effect of a single vertebral level manipulation on lumbar spine and suggested that several levels are mobilized simultaneously. Furthermore, previous study investigated the effects of a grade III mobilization directed at the C5 spinous process and found that the C2-C3 segment had movement in extension and C7-T1 segment had movement in flexion (Lee et al., 2005).

b) Effects on the zygapophysial joint

The cracking sound characteristic of spinal manipulation is related to cavitation of a zygapophysial joint (Maigne and Vautravers, 2003). Unsworth et al., (1971) studied the cavitation at the metacarpophalangeal joints. They suggested that the cohesive forces prevent separation until the traction is sufficiently strong to create a pressure decrease within the joint and this leads to the formation of gas and vapor bubbles, sudden separation of the joint surfaces at a very high speed and displacing the joint fluid to the low-pressure areas. The reduction in the gaseous phase within the joint cavity produces a cracking sound. This sequence can be transposed to the spine. When the force of the thrust exceeds a threshold and high-velocity separation of the joint surfaces, a cracking sound will occur (Maigne and Vautravers, 2003). Moreover, the joint surface separation may release an entrapping synovial folds or intra-articular adhesions that limit motion (Indahl et al., 1997).

c) Effects on the intervertebral disc

Intradiscal pressure changes have been shown to occur during spinal manipulation (Maigne and Guillon, 2000). They studied the effect of manipulation in lumbar spine in cadaver and found that the intradiscal pressure increased during the first phase of the manipulation and then decreased during the late phase of the manipulation. Thus, lumbar spinal manipulations have a biomechanical effect on the intervertebral disc. The manipulation force exerts on the annulus fibrosus. At the end of the manipulation the vertebral endplates are separated and there is a decrease in inter-vertebral pressure. The spinal manipulation may return the nucleus pulposus to the central position by separating the vertebral endplates, pulling on the posterior longitudinal ligament and decreasing the intradiscal pressure (Maigne and Vautravers, 2003). This mechanism may return the protruding disc material to normal position or at least to a position further from the nerve root.

d) Effects on the paraspinal muscles

The effect of spinal manipulation on the paraspinal muscles has long been suspected, however it has been reported to be related to stretching paraspinal muscles (Maigne and Vautravers, 2003). They performed lumbar manipulation with the patient lying on the left side and found that after manipulation, the left muscle is stretched and the right muscle is relaxed. For instance, loading during manipulation stretches the paraspinal muscles and psoas on the same side and relaxes them on the other side. The force of spinal manipulation separates the zygapophysial joint, vertebras and stretches paraspinal muscles. This may lead to relaxation of the paraspinal muscles via three mechanisms.

In the first mechanism, the force of lumbar manipulation stretches the flexor muscles (psoas muscle), particularly when slow and gradual, inhibits the motor neurons innervating the antagonists (paraspinal muscles) via reciprocal Ia inhibition. Furthermore, forceful stretching activates the Ib fibers of the flexor muscle, thus inducing presynaptic inhibition of the afferent Ia fibers of the agonists (Dishman et al., 2000), which contributes to reduce the activity of extensor muscle alpha motor neurons. In the second mechanism, high-velocity thrust stretches the paraspinal nerve, which activates reflex contraction of the back muscles. This may contribute to reduced muscle spasm (Avela et al., 1999). This phenomenon, after passive stretching of the triceps surae, involves stimulation of Ia and II fibers, so that excitability of the motor neurons is reduced after stretching (Hultborn et al., 1996). This phenomenon has been documented at the upper limbs and probably occurs in the paraspinal muscles. The third mechanism may be related to stretching of the facet joint capsules, which has been shown to blunt the motor unit action potential of the paraspinal muscles (Bogduk et al., 1985).

2.3.2 Neurophysiological effects

The neurophysiologic mechanisms of spinal manipulative therapy are effective in reducing pain but are not completely understood, however it has been suggested that pain is modulated at either the spinal cord or in the higher centers of the central nervous system (Wright et al., 1995).

In the first mechanism, spinal manipulation has been suggested to affect gate control. It has been suggested that stimulation of large diameter myelinated neurons (A fiber), low threshold mechanoreceptors by spinal manipulation may modulate and inhibit the incoming nociceptive information from small myelinated neurons (C fiber) at the spinal cord level (Katavich et al., 1998). Manipulation would activate mechanoreceptors and may therefore provide pain relief by activating this spinal gate control mechanism (Melzack and Wall, 1965).

In the second mechanism, the mechanical stimulation of joint capsule proprioceptors and muscle spindles may induce a reflex inhibition of pain, reflex muscle relaxation, and improved mobility (Mart´ınez-Segura et al., 2006). Pickar (2002) demonstrated that spinal manipulation modifies the discharge of groups I and II afferent. Korr (1975) proposed that spinal manipulation increases joint mobility by producing a barrage of impulses in muscle spindle afferents and smaller-diameter afferents ultimately silencing facilitated gamma motoneurons. It is hypothesized that gamma motoneuron discharge is elevated in muscles of vertebral segments responding to spinal manipulation. The high gain of the gamma loop would impair joint mobility by sensitizing the stretch reflex to abnormally small changes in muscle length. Korr (1975) further hypothesized that spinal manipulation stimulates muscle spindle afferents.

In the third mechanism, spinal manipulation may stimulate descending inhibition of pain from higher centres in the central nervous system. These descending pain modulatory pathways are activated by endogenous opioid peptides (Vernon et al., 1986). Furthermore, the dorsal periaqueductal grey region (dPAG) of the brain has been suggested to be involved in manipulation-induced hypoalgesia (Vincenzino et al., 1998). In this mechanism it is possible that spinal manipulation may stimulate descending pain control systems projecting from periaqueductal grey to spinal cord (Wright, 1995). The regions within PAG which control analgesia can be separated into two regions. The PAG can be divided into a dorsal periaqueductal grey (dPGA) which includes the dorsomedial, dorsolateral and lateral subdivisions and ventral periaqueductal grey (vPAG) including the ventrolateral subdivision and the dorsal raphe nucleus (Morgan, 1991). A previous study of Morgan (1991) investigated analgesic effects by stimulation of vPAG in rats is characterized association with immobility. The analgesic effect was blocked by naloxone. These results exhibit tolerance with repeated stimulation and were consequently described as being an opioid from analgesia. In contrast, analgesic effect by stimulation of dPAG in rats is associated with fight behaviour. The analgesic dPAG was not blocked by naloxone and was consequently described as being an non-opioid from analgesia.

2.4 Effectiveness of spinal manipulative therapy on outcomes of neck measurement

Spinal manipulation has been proposed to have a number of therapeutic benefits, including the stretching of shortened and thickened peri-articular soft tissues to improve range of motion, improved drainage of fluid within and surrounding the joint, and changes in pain motor activity and proprioception. Numerous theories have been proposed to explain the effectiveness of spinal manipulative therapy. These theories are that changes in the normal anatomical, physiological or biomechanical of vertebrae can affect function of the nervous system (Pickar, 2002).

2.4.1 Effectiveness of spinal manipulation and spinal mobilization on cervical range of motion

Mechanical neck pain patients show reduction in mobility of the cervical spine (Mart´ınez-Segura et al., 2006). Cervical manipulation is commonly employed in rehabilitation for joint hypomobility from mechanical neck pain (Cassidy et al., 1992; Gross et al., 2002; Howing et al., 2001; Mart´ınez-Segura et al., 2006; Kanlayanaphotporn et al., 2009). The previous study has compared the effect between cervical manipulation and cervical mobilization in neck pain patients (Cassidy et al., 1992) and their study demonstrated that both cervical manipulation and cervical mobilization showed an increasing in active cervical range of motion. Additionally, Martı´nez-Segura (2006) proposed that single cervical manipulation is more effective in increasing cervical range of motion than a control mobilization group. Moreover, Kanlayanaphotporn et al (2009) investigated effect of cervical mobilization in patients with unilateral neck pain and suggested that after cervical mobilization, active cervical range of motion could be increased. In addition, recent studies have shown that performing a thoracic spine manipulation on mechanical neck pain patient results in immediate improvements in cervical range of motion (Gonzalez-Iglesias et al., 2009). Gonzalez-Iglesias (2009) performed a thoracic spine thrust manipulation combined with electro-therapy/thermal program in mechanical neck pain and suggested that thoracic spine thrust manipulation had an effective in increasing cervical mobility in patients with mechanical neck pain.

The mechanical force applied into the spinal column during a cervical manipulation reduces mechanical stress or strain on soft and hard paraspinal tissues and could induce restoration of zygapophyseal joint mobility and joint play. And it was claimed that cervical manipulation may alter segmental biomechanics by releasing trapped meniscoids, releasing adhesions or reducing distortion of annulus fibrosus (Pickar, 2002). Thoracic manipulation found also provokes an increase in active cervical range of motion and a decrease in neck pain (Cleland et al., 2005; Fernandez-de-las-Peñas et al., 2004; Gonzalez-Iglesias et al., 2008). These effects could be explained by a possible repercussion of the thoracic intervention on the biomechanics of the cervical spine. The thoracic spine manipulation may restore the normal biomechanics of the thoracic spine, potentially lowering mechanical stress and improving the distribution of joint forces in the cervical spine (Edmondston and Singer, 1997). So, the thoracic spine manipulation procedure may influence the range of motion improvement in the entire spine.

2.4.2 Effectiveness of spinal manipulation and spinal mobilization on pain

Pain is an important problem in neck pain patients. Previous studies have reported cervical manipulation to be effective for pain relief (Cassidy et al., 1992 Schalkwyk and Parkin-Smith, 2000; Hurwitz et al., 2002; Mart´ınez-Segura et al., 2006). These studies reported that cervical manipulation could reduce a pain in patients with neck pain. Moreover, Kanlayanaphotporn et al (2009) investigated effect of cervical mobilization in patients with unilateral neck pain and demonstrated that cervical mobilization could decrease pain at rest and pain on most painful movement on the cervical spine.

Recent studies proposed that the thoracic manipulation have been also shown to decrease pain (Cleland et al., 2005; Fernandez-de-las-Peñas et al., 2004; Gonzalez-Iglesias et al., 2008). Additionally, Cleland et al., (2007) investigated the effect of manipulation versus mobilization directed at multiple levels of thoracic spine in patients with neck pain and found that thoracic manipulation could reduce in pain level more than thoracic mobilization does in patients with neck pain. The exact mechanism of pain relief from manipulation is unclear, but it has been suggested that pain is modulated at either the spinal cord or in the higher centers of the central nervous system (Wright et al., 1995). Manipulation has been suggested to affect pain processing at the spinal cord level via the gate control theory. And descending inhibition of pain from higher centers in the central nervous system may induce hypoalgesia. These descending pain modulatory pathways activate endogenous opioid peptides (Vernon et al., 1986). Furthermore, manipulation has been suggested to activate the dorsal periaqueductal grey region (dPAG) of the brain, which controls pain perception (Wright et al., 1995).

2.4.3 Effectiveness of spinal manipulation and spinal mobilization on pressure pain threshold

Mechanical neck pain patients have shown reduction in pressure pain threshold (PPT) of tissue around the cervical spine. Previous studies have reported cervical manipulation to be effective for PPT increase. The study of Vernon et al., (1990) who found that cervical manipulation could increase in the PPT at paracervical muscle in chronic mechanical neck pain patients. Additionally, Vicenzino et al., (1996) investigated the effect of cervical mobilizations on PPT level over the elbow region in patients with lateral epicondylalgia. The result showed that the PPT in the cervical manipulation group significantly increased at lateral epicondyle. Moreover, Sterling et al., (2001) investigated changes in PPT levels over C5-C6 zygapophyseal joints after a cervical joint mobilization in idiopathic neck pain and Fernández-delas-Peñas et al., (2008) investigated changes in PPT levels over C5-C6 zygapophyseal joints after a C7-T1 thrust manipulation in healthy subjects. They found that the cervical manipulation and mobilization could increase the PPT levels over C5-C6 zygapophyseal joints. These findings suggest that neurophysiological effects of manipulation and mobilization may include both segmental and central mechanisms. The mechanical force applied into the spinal column during a spinal manipulation may alter chemical mediators or activat segmental inhibitory pathways and stimulat descending inhibitory pathways (Skyba DA, 2003; Saíz-Llamosas et al., 2009).

To date, there is no evidence to support the effectiveness of either thoracic manipulation or thoracic mobilization on pressure pain threshold. Therefore, the current study aims to assess effect of thoracic manipulation and thoracic mobilization on pressure pain threshold at cervical muscles.