ผลของโปรแกรมการรักษาหนึ่งเดือนของการขยับข้อต่อแนวกลางเป็นจังหวะจากด้านหลังไปด้านหน้า ในผู้ป่วยที่มีอาการปวดคอบริเวณแนวกลาง และ/หรือทั้ง 2 ด้านของคอ

นายประพัฒณ์ สิริประภาพร

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

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ปีการศึกษา 2550

EFFECT OF A ONE-MONTH COURSE OF CENTRAL POSTERO-ANTERIOR MOBILIZATION FOR TREATING PATIENTS WITH CENTRAL AND/OR BILATERAL NECK PAIN

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ประพัฒณ์ สิริประภาพร : ผลของโปรแกรมการรักษาหนึ่งเดือนของการขยับข้อต่อแนวกลางเป็นจังหวะจากด้านหลังไปด้านหน้า ในผู้ป่วยที่มีอาการปวดคอบริเวณแนวกลาง และ/หรือทั้ง 2 ด้านของคอ. (EFFECT OF A ONE-MONTH COURSE OF CENTRAL POSTERO-ANTERIOR MOBILIZATION FOR TREATING PATIENTS WITH CENTRAL AND/OR BILATERAL NECK PAIN) อ.ที่ปรึกษา : ผศ.ดร.รสลัย กัลยาณพจน์พร, อ.ที่ปรึกษาร่วม : ผศ.ดร.อดิษฐ์ จิรเดชนันท์, 97 หน้า.

การศึกษานี้ศึกษาประสิทธิภาพของการดัดดึงข้อต่อแนวกลางเป็นจังหวะจากด้านหลังไปด้านหน้า ในผู้ป่วยที่มีอาการปวดคอบริเวณแนวกลาง และ/หรือทั้ง 2 ด้านของคอ โดยให้การรักษาสัปดาห์ละ 2 ครั้ง เป็นเวลา 4 สัปดาห์ ผู้ป่วยจำนวน 18 คน (อายุระหว่าง 23 – 58 ปี) เข้าร่วมการศึกษาครบโปรแกรม โดยทำการวัดความเจ็บปวด และช่วงการเคลื่อนไหวของกระดูกสันหลังส่วนคอก่อนและ 5 นาทีหลังการรักษาทุกครั้ง ระดับความไม่สามารถในการทำกิจกรรมและระดับการรับรู้ผลการรักษาโดยรวมก่อนการรักษาครั้งที่ 5 และ 8 ภายหลังการรักษา 4 สัปดาห์ผู้ป่วย 72 เปอร์เซ็นต์รายงานระดับการรับรู้ผลการรักษาโดยรวมในระดับดีขึ้น ผลวิเคราะห์ข้อมูลทางสถิติด้วย One-way repeated measures analysis of variance และ post hoc analysis แสดงการลดลงอย่างมีนัยสำคัญของความเจ็บปวดและระดับความไม่สามารถในการทำกิจกรรม ($p < 0.05$) ไม่มีการเปลี่ยนแปลงอย่างมีนัยสำคัญของช่วงการเคลื่อนไหวของกระดูกสันหลังส่วนคอ ($p > 0.05$) ผลการศึกษาชี้ให้เห็นว่าการดัดดึงข้อต่อแนวกลางเป็นจังหวะจากด้านหลังไปด้านหน้านั้น มีประสิทธิภาพในการลดความเจ็บปวดและระดับความไม่สามารถในการทำกิจกรรม ขณะเดียวกันก็เพิ่มระดับการรับรู้ผลการรักษาโดยรวม ในผู้ป่วยที่มีอาการปวดคอบริเวณแนวกลาง และ/หรือทั้ง 2 ด้านของคอ ผลการรักษาต่อความเจ็บปวดและระดับความไม่สามารถในการทำกิจกรรมนั้น มีผลสะสมเมื่อทำการรักษาครั้งต่อๆไป อย่างไรก็ตามเทคนิคดังกล่าวไม่มีประสิทธิภาพในการเพิ่มช่วงการเคลื่อนไหวของกระดูกสันหลังส่วนคอ

ภาควิชา.....กายภาพบำบัด..... ลายมือชื่อนิสิต.....

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497 72038 37: MAJOR MUSCULOSKELETAL PHYSICAL THERAPY
KEY WORD: NECK PAIN / CERVICAL MOBILIZATION / CENTRAL POSTERO-ANTERIOR TECHNIQUE / RANGE OF MOTION

PRAPAT SIRIPRAPAPORN: EFFECT OF A ONE-MONTH COURSE OF CENTRAL POSTERO-ANTERIOR MOBILIZATION FOR TREATING PATIENTS WITH CENTRAL AND/OR BILATERAL NECK PAIN. THESIS ADVISOR : ASST. PROF. ROTSALAI KANLAYANAPHOTPORN, Ph.D., THESIS CO-ADVISOR : ASST. PROF. ADIT CHIRADEJNANT, Ph.D., 97 pp.

This study investigated the effectiveness of central postero-anterior (PA) mobilization technique in central and/or bilateral neck pain. A treatment was given twice a week for four weeks. Eighteen participants (23 – 58 years) completed the treatment course. Pain intensity and cervical range of motion (ROM) were assessed pre-treatment and five minutes after each treating appointment. Level of disability and global perceived effect (GPE) were assessed pre-treatment at the fifth and the eighth appointments. After four weeks, 72 percent of participants reported GPE as improved. One-way repeated measures analysis of variance and *post hoc* analysis demonstrated significant decrease in pain and level of disability ($p < 0.05$). No statistical differences in cervical ROM among appointments were found ($p > 0.05$). The results indicate that the central PA mobilization technique is effective in decreasing pain and disability while improving GPE in patients suffering from central and/or bilateral neck pain. The clinical effect on pain is cumulative with the subsequent applications of the mobilization. However, it is not effective in improving cervical ROM.

Department.....Physical Therapy…Student's signature…….....
Field of study....Physical Therapy…Advisor's signature…….……...…
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LIST OF ABBREVIATIONS

ANOVA	=	Analysis of variance
CROM	=	Cervical range of motion instrument
EMS	=	Electrical muscle stimulation
GPE	=	Global perceived effect
ICC	=	Intraclass correlation coefficient
mm	=	Millimeter
MDC	=	Minimal detectable change
MRI	=	Magnetic resonance imaging
NDI	=	Neck disability index
NSD	=	No data of symptom distribution reported
RCT	=	Randomized controlled trial
ROM	=	Range of motion
Rx	=	Treatment
SD	=	Standard deviation
SEM	=	Standard error of measurement
SMT	=	Spinal manipulative therapy
VAS	=	Visual analogue scale

CHAPTER I

INTRODUCTION

1.1 Background and rationale

Cervical mobilization is one of many interventions found to be effective in managing neck pain condition. It is commonly performed as a set of small or large amplitude oscillatory movement applied anywhere within the joint range of motion (ROM) at the speed that a patient is able to prevent the movement (Maitland et al., 2005).

Numbers of clinical studies have investigated the effectiveness of the cervical mobilization and found that cervical mobilization was effective in reducing pain; improving cervical ROM, global perceived effect (GPE), and functional ability of the patients (Brodin, 1983; Cassidy et al., 1992; David et al., 1998; Hoving et al., 2002; Hurwitz et al., 2002; Korthals-de Bos et al., 2003; Martinez-Segura et al., 2006). However, the techniques of cervical mobilization used are various among studies and most studies applied more than one technique to each patient. Therefore, a specific cervical mobilization technique has not been well investigated.

For Maitland approach, a guideline for selection of the mobilization treatment technique was proposed. It suggested that the patients with central or bilateral symptom should be treated with the central postero-anterior (PA) technique while the

patients with unilateral symptom should be treated with unilateral PA technique (Maitland et al., 2005). Previous study found that Maitland cervical manipulation technique produced significant reduction in pain; improvement in cervical ROM and disability in four weeks (Wood et al., 2001). However, no study has ever been conducted to support this guideline for mobilization technique. This study was therefore conducted to investigate the effectiveness of the 4-week treatment course of central PA mobilization technique on pain, cervical ROM, level of disability, and GPE.

1.2 Objective

The objective of this study was to investigate the treatment effects of the cervical central PA mobilization technique on pain, cervical ROM, level of disability, and GPE in patients with central and/or bilateral neck pain throughout the 4-week treatment course.

1.3 Specific objectives

(1) To investigate the effect on pain at rest, pain on worst movement, and cervical ROM after receiving cervical central PA mobilization technique at each appointment

(2) To investigate the effect of cervical central PA mobilization technique on level of disability at the fifth and the eighth appointments of the treatment course

(3) To calculate the proportion of the participants who were considered as "improved" and "unchanged" at the fifth and the eighth appointments of the treatment course

1.4 Hypotheses

(1) There would be statistically significant differences in pain at rest, pain on worst movement, and cervical ROM measured post-treatment at each appointment from baseline.

(2) There would be statistically significant differences in level of disability measured pre-treatment at the fifth and the eighth appointments of the treatment course.

1.5 Scope of the study

This study was conducted to investigate the effects of the treatment course of central PA mobilization technique on pain, cervical ROM, level of disability, and GPE. Participants who suffered from central and/or bilateral neck pain were recruited into the study. Throughout the 4-week period, they received treatment twice a week for eight appointments.

1.6 Brief method

Participants whom were recruited into the study gave written informed consent. A physical therapist interviewed and screened the participants. Next, an assessor

performed the baseline measurements. The participants were asked to indicate the intensity of their pain at rest and pain on worst movement. After that, their cervical ROM was measured. Then, the physical therapist performed full assessment and treated the participants with the central PA mobilization technique. After treatment, the assessor collected post-treatment data in the same manner as being described for the baseline data. Finally, the participants were appointed for the next treatment until the treatment course was completed. NDI and GPE were assessed at the fifth and the eighth appointments before the treatment.

1.7 Advantage of the study

This clinical trial would provide the evidence for using the central PA mobilization technique for treating the patients with central and/or bilateral neck pain.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter describes the definition of neck pain, the effectiveness of cervical mobilization, and the application of Maitland cervical mobilization.

2.2 Neck pain

Neck pain is a general term that describes symptom in the neck area. It has been defined as stiffness and/or pain that is typically felt dorsally in the area between the occipital condyles and the spinous process of the seventh cervical spine which can result in the stiffness in one or all directions of cervical movements (Ahn et al., 2007; Ferrari and Russell, 2003). In some patients, neck pain can be accompanied by headache, pain in the upper extremities, pain in the region of upper thoracic spine and surrounding musculature, pain in the head and face areas, and pain along the cervical myotomal patterns (Ferrari and Russell, 2003).

Neck pain is a common symptom found in population. It was found to affect 14.2 – 71 percent of the general population during their lifetime (Cote et al., 1998; Fejer et al., 2006). A 1-year prevalence was reported to range from 6.9 – 54.2 percent with a mean of 29.8 percent in adult population (Fejer et al., 2006). Approximately 40

percent of people experienced neck pain at least once within six months (Cote et al., 1998). Recently, the incidence of neck pain has been shown to be more frequent than back pain (Niemelainen et al., 2006). Moreover, approximately 10 percent of neck pain patients have symptom that lasts longer than 30 days every year (Niemelainen et al., 2006).

The cost of neck pain treatment is also tremendous. This includes the direct cost (i.e. medical and paramedical care) and the indirect cost (i.e. loss from work and disability). In The Netherlands, the cost of neck pain treatment per patient ranged from €447-€1,297 each year (Korthals-de Bos et al., 2003). In Germany, the cost of neck pain treatment per patient over 3 months ranged from €925-€1,564 (Willich et al., 2006).

2.3 Classification of neck pain

In clinical practice and research, neck pain is widely categorized by the cause of symptom, the duration after onset of the symptom, and the symptom distribution area. However, up to present, the classification of neck pain is still inconclusive. In regard to the **cause of symptom**, neck pain can be categorized into non-mechanical and mechanical neck pain (Ferrari and Russell, 2003). The cause of non-mechanical neck pain is commonly associated with tumor, metabolic bone disease, infection, and injury to cervical structures (Ferrari and Russell, 2003; Solomon, 2005). Mechanical neck pain is defined as generalized neck and/or shoulder pain with mechanical characteristics, including symptom provoked by (i) maintained neck posture, (ii) neck movement, or (iii) palpation of the cervical muscles (Martinez-Segura et al., 2006). It

is associated with mechanical dysfunction of various structures around the neck such as zygapophyseal joint, intervertebral discs, paravertebral muscles, ligaments, or neural tissues (Bogduk and Aprill, 1993). The exact etiology of the mechanical neck pain is still not well understood. However, its prevalence was reported to be higher than the non-mechanical neck pain (Binder, 2007).

In regard to the **duration of the symptom**, neck pain can be subclassified into acute, sub-acute, and chronic stages. But the time duration for each stage varies among studies, for example, it was stated as acute, sub-acute, and chronic neck pain when the symptom presented less than 30 days, between 30 and 90 days, and more than 90 days, respectively (Aker et al., 1996; Vonk et al., 2004). In other study, the symptom presented less than 21 days, between 28 and 84 days, and more than 84 days were considered as acute, sub-acute, and chronic neck pain, respectively (Jensen and Harms-Ringdahl, 2007).

In regard to the **symptom distribution area**, neck pain can be categorized into of central, bilateral, and unilateral neck pain (Maitland et al., 2005). It is considered to be central neck pain when the symptom is perceived in the area over the spinous process of the cervical spine (Figure 2.1). Bilateral neck pain is the symptom perceived on both sides of the spine equally. Unilateral neck pain is perceived on one side of the neck.

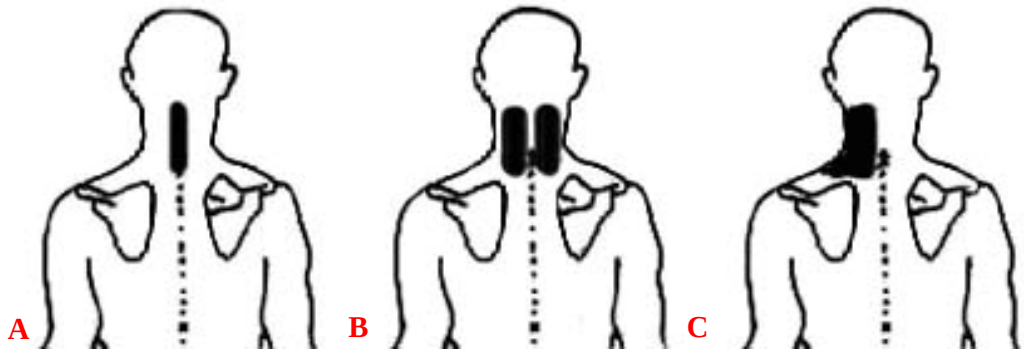

Figure 2.1: Areas of symptom distribution for neck pain

A = Central neck pain, B = Bilateral neck pain, and C = Unilateral neck pain (left).

2.4 Management of neck pain

There are number of physical therapy interventions used for managing neck pain. These include exercise, acupuncture, electrotherapy, transcutaneous electric nerve stimulation, traction, laser, analgesics, postural advice, and spinal manipulative therapy (SMT) (Binder, 2007). The general aim of treatment for neck pain is to reduce pain, reduce disability, restore normal function, and increase cervical ROM of the cervical spine (Jensen and Harms-Ringdahl, 2007; Martinez-Segura et al., 2006). However, their effectiveness have not all been established.

There are number of studies investigating the effectiveness of SMT in the treatment of neck pain over the last decade. The SMT consists of two forms of technique including manipulation and mobilization. Manipulation is defined as a high-velocity, small amplitude thrusting technique performed at the limit of the available passive range at the speed beyond the patient's control (Maitland et al., 2005). Mobilization

is defined as a set of small or large amplitude oscillatory movement technique performed anywhere within the joint range of motion at the speed that the patient is able to prevent the movement (Maitland et al., 2005).

Most of these studies investigated on cervical manipulation while a small number of studies investigated on thoracic manipulation and cervical mobilization. Table 2.1 summarizes the findings from these clinical studies. The general outcome measurements commonly used to express the effectiveness of the treatment in different perspectives are pain, cervical ROM, disability, and GPE. The pain intensity reflects the quantity of an unpleasant feeling that is perceived by the patients. The cervical ROM shows the extent of neck movement limitation. The disability represents how much the neck pain has affected one's ability to manage everyday activities. The GPE reflects patients' satisfaction with the treatment outcome.

Table 2.1: Summary of the effectiveness of the SMT in the studies for managing neck pain.

Study	Method	Treatment technique	Comparative treatment	Participants	Conclusion
Studies on cervical manipulation					
Jordan et al (1998)	RCT	Manipulation (n = 40) 2 Rx/week, 6 week	Muscle training (n = 40) 2 Rx/week, 6 week Physical therapy (n = 239) 2 Rx/week, 6 week	Chronic neck pain	All three treatments demonstrated significant improvement in pain and disability. No clinical difference between three treatments.
Giles and Muller (1999)	RCT	Manipulation (n = 23) 6 Rx over 3-4 weeks	NSAIDs (n = 12) for 3-4 weeks Acupuncture (n = 15) 6 Rx over 3-4 week	Chronic neck pain	All three treatments demonstrated significant improvement in pain. Cervical manipulation appeared to be more effective than medication and acupuncture.
Pikula (1999)	RCT	Manipulation at the same side of pain (n = 12) Manipulation at the contra-lateral side of pain (n = 12)	Detuned ultrasound (n = 12)	Acute unilateral neck pain	Both manipulation groups demonstrated immediate significant improvement in pain and cervical ROM in some directions.
Wood et al (2001)	RCT	Cervical manipulation (n = 15) 8 Rx over 4 weeks	Instrumented manipulation (n = 15) 8 Rx over 4 week	Sub-acute and chronic neck pain	Both manipulation demonstrated significant improvement in pain, disability, and cervical ROM.
Bronfort et al (2001)	RCT	Manipulation with sham microcurrent treatment (n = 64) 20 Rx over 11 weeks	Manipulation with low-tech exercise (n = 64) Hi-tech strengthening and aerobic exercise (n = 63) 20 Rx over 11 weeks	Chronic neck pain	All treatments demonstrated significant improvement in pain and disability. No significant difference between treatments.

Table 2.1: Summary of the effectiveness of the SMT in the studies for managing neck pain. (continued)

Study	Method	Treatment technique	Comparative treatment	Participants	Conclusion
Hutwitz et al (2002)	RCT	Manipulation with/with heat and EMS (n = 171) No data of Rx dose over 6 week	Mobilization with/with heat and EMS (n = 165) No data of Rx dose over 6 week	Acute, sub-acute, and chronic neck pain	Both manipulation and mobilization demonstrated significant improvement in pain and disability. Manipulation was as effective as mobilization.
Giles and Muller (2003)	RCT	Manipulation (n = 18) 2 Rx/week up to 9 week	Medication (n = 13) Acupuncture (n = 19) 2 Rx/week up to 9 week	Chronic neck pain	Manipulation demonstrated greater improvement in pain than medication and acupuncture.
Studies on thoracic manipulation					
Fernandez-de-las-Penas (2007)	Case reports	Thoracic manipulation (n = 7) 1 Rx	-	Chronic neck pain	Thoracic manipulation demonstrated immediate and 48-hour follow-up significant improvement in pain.
Cleland et al (2005)	RCT	Thoracic manipulation (n = 19) 1 Rx	Placebo thoracic manipulation (n = 17)	Chronic neck pain	Thoracic manipulation demonstrated significant immediate improvement in pain.

Table 2.1: Summary of the effectiveness of the SMT in the studies for managing neck pain. (continued)

Study	Method	Treatment technique	Comparative treatment	Participants	Conclusion
Studies on cervical Mobilization					
Brodin (1985)	RCT	Mobilization (n = 23) + daily aspirin + neck school 9 Rx over 3 weeks	Daily aspirin (n = 23) over 3 weeks Daily aspirin + neck school + mock therapy (n = 17) 9 Rx over 3 weeks	Chronic neck pain	Mobilization demonstrated significant improvement in pain and cervical ROM greater than aspirin.
Cassidy et al (1992)	RCT	Mobilization (n = 48)	Manipulation (n = 52)	Acute, sub-acute, and chronic neck pain	Both manipulation and mobilization demonstrated immediate significant improvement in pain and cervical ROM. Manipulation produced 1.5 times greater pain reduction.
David et al (1998)	RCT	Mobilization (n = 35) 6 Rx over 6 weeks	Acupuncture (n = 35) 6 Rx over 6 weeks	Chronic neck pain	Mobilization was as effective as acupuncture in pain and cervical ROM improvement.
Hoving et al (2002)	RCT	Mobilization (n = 60) 1 Rx/week over 6 weeks	Physical therapy (exercise) (n = 59) 2 Rx/week over 6 weeks General practitioner care (n = 64)	Acute, sub-acute, and chronic neck pain	Mobilization is a favorable treatment option for patients with neck compared with physical therapy or continued care by a general practitioner.
Martinez-Segura et al (2006)	RCT	Manipulation (n = 34) 1 Rx	Mobilization (n = 37) 1 Rx	Sub-acute and chronic neck pain	Both manipulation and mobilization demonstrated immediate significant improvement in pain and cervical ROM in most directions. Manipulation was more effective than mobilization.

SMT = Spinal manipulative therapy; RCT = Randomized controlled trial; Rx = Treatment; NSAIDs = Non-steroidal anti-imflammatory drugs; EMS = Electrical muscle stimulation.

Several clinical trials suggest that both interventions are effective in providing an immediate and long-term effect in pain reduction, improvement in cervical range of motion (ROM), and disability (Bronfort et al., 2001; Bronfort et al., 2004; Cassidy et al., 1992; David et al., 1998; Hoving et al., 2002; Hurwitz et al., 2002; Martinez-Segura et al., 2006). In general, a greater immediate improvement in pain and cervical ROM is commonly shown following cervical manipulation than mobilization. In contrast, both interventions tended to provide comparable effect on pain and disability when the outcomes were measured after a single application for two weeks and thereafter (Hurwitz et al., 2002). After one application of cervical manipulation and cervical mobilization for 13 weeks, the effect on neck pain and disability decreased (Figure 2.2) (Hurwitz et al., 2002). When the cervical mobilization was applied repeatedly over the 6-week treatment course, 68 percent of the patients reported the GPE as improved (Hoving et al., 2002).

However, almost all of these studies measured the treatment outcomes after the completion of the treatment course. Only one study investigated the effectiveness of SMT during an ongoing treatment course (Hoving et al., 2002). In most studies, the recruited patients were not homogeneous and various manipulation and mobilization techniques were employed during the treatment. The conclusion on the effectiveness of an individual manipulation or mobilization technique is then limited.

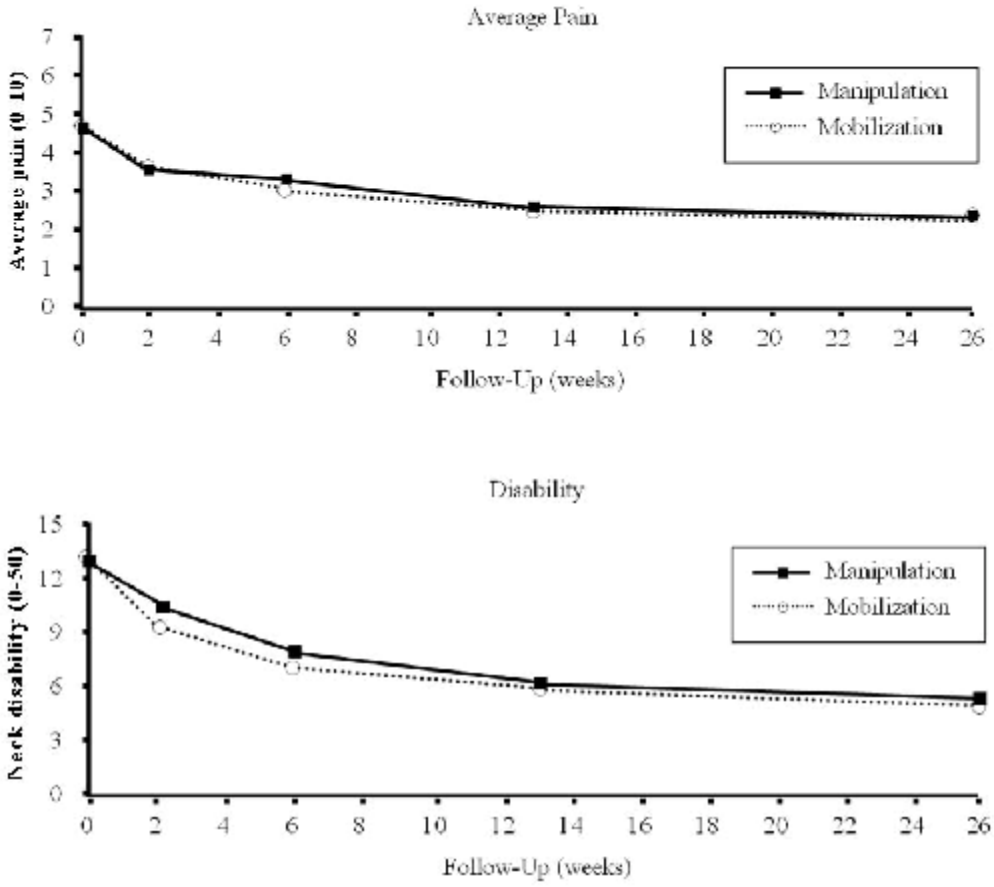

Figure 2.2: Means of the pain and neck disability scores measured after a single treatment with cervical manipulation and mobilization measured up to 52 weeks (modified from Hurwitz et al., 2002).

Due to the relatively lower risk of adverse effects after cervical mobilization than cervical manipulation (Ernst and Canter, 2006; Hurwitz et al., 2005), the application of cervical mobilization prior to cervical manipulation is therefore advised (Maitland. One of the widely used mobilizations is that described by Maitland et al. (2005) as a small or large amplitude oscillatory movement anywhere within the joint range in the manner that the patients can prevent the movement. This study is therefore focus on the cervical mobilization.

2.5 Cervical mobilization for neck pain

2.5.1 Effects of cervical mobilization

Although it has been demonstrated that cervical mobilization is effective in reducing pain and disability, and improving cervical ROM, the mechanisms that produce these therapeutic effects are not clearly understood. It has been proposed that the therapeutic effect is produced either through the mechanical mechanism or the neurophysiological mechanism (Pickar, 2002; So, 1986; Wright, 1995).

2.5.1.1 Mechanical mechanism

Mechanically, it has been proposed that spinal mobilization may produce soft tissue elongation which in turn resulting in an improvement in joint mobility and spinal ROM (Maitland et al., 2005). It was reported in a cadaveric study that various ligaments of the cervical spine would be elongated to rupture if it was stretched with the force up to 244.4 newtons (Ivancic et al., 2007). However, the manual forces applied on an asymptomatic subject by the therapist during the PA mobilization were found to be much lower. It ranged from 20.4 – 52.5 and 16.2 – 51.5 newtons when the forces were applied centrally and unilaterally to the cervical spine, respectively (Snodgrass et al., 2007). Consequently, the force application during cervical mobilization might probably not be sufficient for producing permanent tissue elongation.

Nevertheless, the force applied during cervical mobilization may alter the viscoelastic property of cervical ligaments. Previous study using interventional magnetic

resonance imaging during PA mobilization reported that the force applied at one spinal segment not only produced movement at the target vertebrae but also produced movement of the entire cervical spine (Lee et al., 2005). The cervical vertebra being mobilized translated anteriorly while the upper and the lower motion segments extended and flexed, respectively (Lee et al., 2005; McGregor et al., 2001). These intersegmental movements of the cervical spine occurred during the application of the PA mobilizaion over a spinous process of a cervical vertebra is illustrated in Figure 2.3. However, these intersegmental movements were found to be so small in magnitude that it could produce any increase in spinal mobility (McGregor et al., 2001). The associated increase in cervical ROM after cervical mobilization should therefore be a result of other mechanisms.

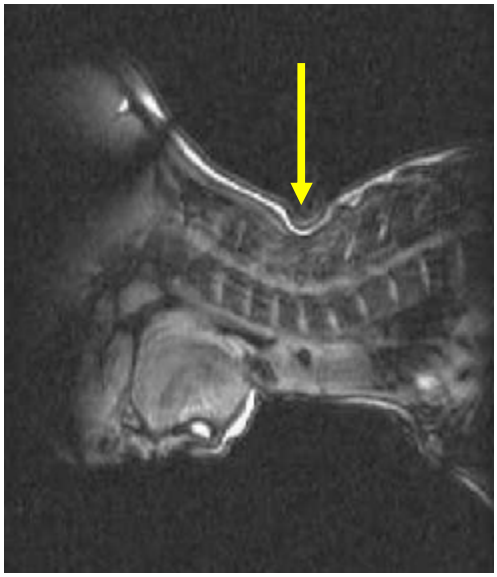

Figure 2.3: Sagittal MRI image obtained during PA mobilization of the sixth cervical vertebra (from McGregor et al., 2001). The arrow points the application point of the PA mobilization.

2.5.1.2 Neurophysiological mechanism

It has been proposed that mobilization may produce the hypoalgesic effect via the neurophysiological mechanism (Pickar, 2002; So, 1986; Wright, 1995). It is widely recognized that the central nervous system controls the transmission of the nociceptive afferent impulses either through the spinal cord control system or through the descending control system projecting from brain to spinal cord (Wright, 1995).

Regarding the spinal cord control system, the perception of pain is limited through the gate control mechanism which acts as the gate for pain transmission (So, 1986). The nociceptive afferent impulses open the gate whereas the afferent impulses from the large diameter myelinated fibers close the gate. Under painful condition, the nociceptive afferent impulses are transmitted through the small nonmyelinated fibers into the spinal cord. With the application of mobilization, the joint and soft tissue mechanoreceptors are activated which causing them to send afferent impulses along the large diameter myelinated fibers into the spinal cord. As a result, an immediate pain reduction would be observed.

The descending control system relates to the activation of the pain inhibitory pathways projecting from periaqueductal gray area within midbrain (Wright, 1995). The activation of the descending pain inhibitory pathways in the dorsal/lateral periaqueductal gray (dPAG) induces the immediate hypoalgesic effect within 15 seconds of the mobilization application. The activation of the descending pain inhibitory pathways in the ventrolateral periaqueductal gray (vPAG) induces latent hypoalgesic effect which demonstrates 20-45 minutes after the application of

mobilization. Taking in combination, these findings suggest that mobilization is able to produce both immediate and long-term hypoalgesic effects.

2.5.2 Effectiveness of cervical mobilization on neck pain

Six studies have been identified to examine the effectiveness of cervical mobilization on neck pain as summarized in Table 2.2. The cervical mobilization used however appeared in various forms, for example, Maitland mobilization, chiropractic mobilization, and muscle energy technique. The form that was investigated most frequently was the Maitland mobilization which is one of the most widely used in clinical practices. As a result, this study would focus on the studies on the Maitland mobilization.

Table 2.2: Summary of the mobilization studies for managing neck pain.

Study	Characteristics of participants	Treatment	Mobilization technique	Additional Rx	Results
Martinez-Segura et al (2006)	Sub-acute and chronic neck pain Unilateral symptom	1 Rx	Sustained mobilization in manipulated position	-	Pain - Significant pain reduction ROM - Significant improvement in some directions
Cassidy et al (1992)	Acute, sub-acute, and chronic neck pain Unilateral symptom	1 Rx	Muscle energy	-	Pain - Significant pain reduction ROM - Significant improvement
Hutwitz et al (2002)	Chronic neck pain NSD	1 Rx	Chiropractic mobilization	Stretching, strengthening, and flexibility exercise	Pain - Significant pain reduction at 2 weeks NDI - Significant improvement at 6 weeks
Brodin (1985)	Chronic neck pain NSD	3 Rx/week over 3 weeks	Maitland mobilization, No data of specific technique	Massage Electric stimulation Relaxing traction	Pain - Significant pain reduction at 3 weeks ROM - Increased summation* of ROM at 3 weeks
David et al (1998)	Chronic neck pain NSD	6 Rx over 6 weeks	Maitland mobilization, mixed technique	-	Pain - Significant pain reduction at 6 weeks ROM - Significant improvement at 6 weeks
Hoving et al (2002)	Acute, sub-acute, and chronic neck pain NSD	1 Rx/week over 6 weeks	Maitland mobilization, No data of specific technique	Massage Coordination technique	Pain - Significant improvement at 7 weeks ROM - Significant improvement at 7 weeks NDI - Significant improvement at 7 weeks GPE - 68.3 percent recovery

NSD = No data of symptom distribution reported; Rx = Treatment; ROM = Range of motion; NDI = Neck disability index; GPE = Global perceived effect; * = Summation of the cervical ROM in all directions.

Generally, the studies in Table 2.2 demonstrated that good outcomes on pain, cervical ROM, neck disability, and GPE could be obtained from Maitland mobilization. Although these results showed the effectiveness of the Maitland mobilization, they did not provide any data on the effectiveness of an individual mobilization technique. This is due to the application of more than one mobilization technique were performed on the patients throughout the treatment period. The therapeutic benefit of each mobilization technique is therefore unclear. As a whole, this leads to an uncertainty in deciding of which mobilization techniques should be included in the treatment intervention and which should not. To be able to claim the effectiveness of a mobilization technique, a study that is designed to deliver a single mobilization technique in one treatment needs to be conducted.

2.5.3 Maitland mobilization

Maitland mobilization can be performed in two forms as a sustained stretching and a passive oscillatory movement (Maitland et al., 2005). Based upon the characteristic of the movement produced, the passive oscillatory movement can be classified into passive physiological intervertebral movement and passive accessory intervertebral movement. The former movement is described as the movement that patients themselves can perform such as flexion and extension. On the other hand, the latter movement is described as the movement that patients themselves cannot perform actively but can be applied by other person such as PA glide.

The techniques of the passive accessory intervertebral movement are described by the direction and location of the force applied into five techniques which include central

PA, left and right unilateral PA, and left and right transverse techniques (Maitland et al., 2005). In the cervical spine, the central PA technique is a technique performed when the patients lie in prone position on a couch with their forehead resting on their overlapped palms. A physical therapist stands over the patients' head using both thumbs to apply pressure rhythmically over the spinous process of the cervical spine in the PA direction (Figure 2.4). The same starting position is also used for performing the unilateral PA. The physical therapists use both thumbs to apply pressure rhythmically in the PA direction over a cervical zygapophyseal joint when performing the unilateral PA technique. For the transverse technique, the physical therapist stands on one side of the patients and the pressure was applied on the side of the spinous process in the transverse direction.

Figure 2.4: Application of the techniques.

A = Central PA technique, B = Unilateral PA technique, C = Transverse technique

In order to apply a proper mobilization treatment, the physical therapist should take several factors into account (Maitland et al., 2005). They are grade of movement, frequency of oscillatory movement, amount of mobilization, and techniques of mobilization.

2.5.3.1 Grade of movement

According to Maitland et al. (2005), grade of movement is classified by the type of amplitude and the range of application into four grades; Grade I is a small-amplitude movement performed near the starting range, grade II is a large-amplitude movement that occupy the range that free from any stiffness or muscle spasm, grade III is also a large-amplitude that moves into stiffness or muscle spasm, and grade IV is the small amplitude movement stretching into stiffness or muscle spasm (Figure 2.5). However, the grade of movement can be adjusted to perform as a stronger or gentler technique. The stronger technique is executed by oscillating further towards while the gentler technique is carried out with relatively away from the end of the physiological range. These grades of movement are represented by plus and minus signs as shown in Figure 2.6. To select the grade of movement, it was suggested that grades I, II, and III are suitable for pain dominant problem and grade IV is suitable for stiffness dominant problem.

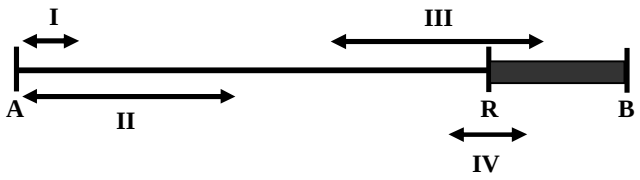

Figure 2.5: Grades of movement.

A = Starting of the range, R = Beginning of the resistance from stiffness or muscle spasm, B = End of the range (modified from Maitland et al., 2005; page 175)

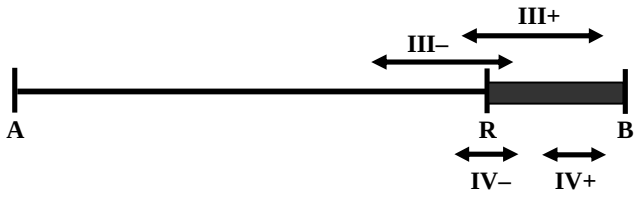

Figure 2.6: Grades of movement.

A = Starting of the range, R = Beginning of the resistance from stiffness or muscle spasm, B = End of the range (modified from Maitland et al., 2005; page 176)

2.5.3.2 Frequency of oscillatory movement

Frequency of the oscillatory movement can be varied from 0.5 – 2 Hz (Maitland et al., 2005). It has been suggested that the treatment aimed to relieve pain should be carried out at low frequency with smooth oscillation whereas the treatment aimed to improve mobility should be executed at high frequency with less smooth oscillation (Maitland et al., 2005). In previous study, frequency was found to vary between physical therapists within a range of 0.54 – 1.75 Hz (Snodgrass et al., 2007).

2.5.3.3 Amount of mobilization

It has been suggested that the amount of the mobilization given in one treatment session should be considered from patients' clinical presentation (Maitland et al., 2005). Approximately three sets of a mobilization technique are applied to each symptomatic level, each lasting between 30 seconds – one minute (Petty and Moore, 2004). However, these numbers are given as a guideline only so they can be adjustable under the therapists' justification.

2.5.3.4 Techniques of mobilization

Selection of the mobilization technique has been proposed to be based on the area of symptom distribution (Maitland et al., 2005). Figure 2.6 shows the sequence of selection of techniques. A guideline for selection of the mobilization treatment technique suggests that the patients with central or bilateral symptom should be first treated with the central PA technique while the patients with unilateral symptom should be treated with unilateral PA technique or rotation technique (Maitland et al., 2005). However, this guideline for selection is a clinical recommendation from the experienced clinicians that has never been studied in the clinical trial before. The study of the effectiveness of a specific mobilization technique for a specific distribution is, therefore, needed.

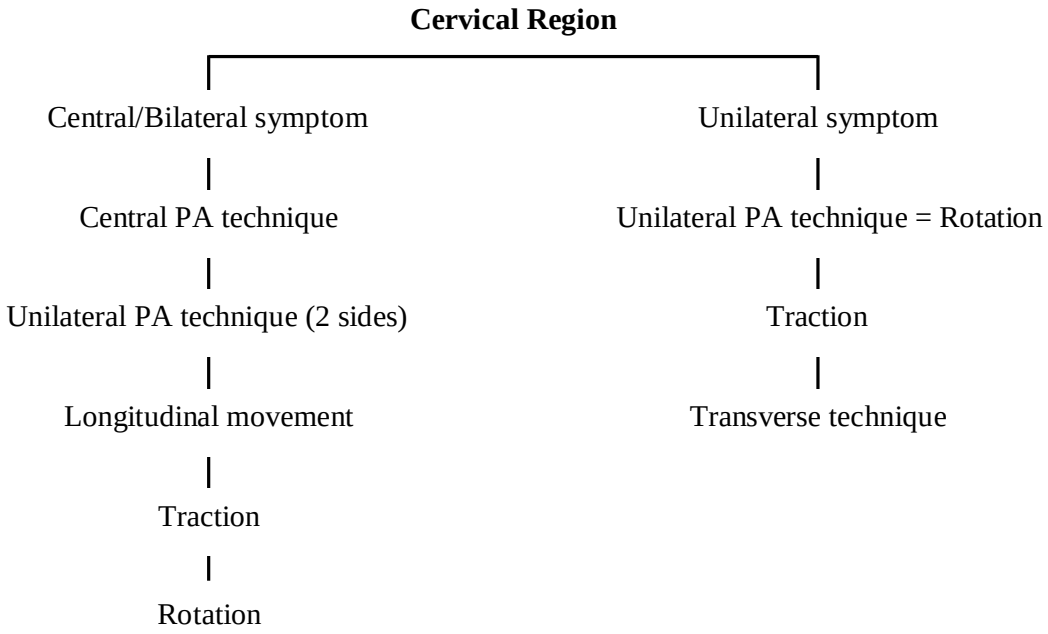

Figure 2.7: Sequence of selection technique (from Maitland et al., 2005; page 184).

2.6 Summary

Neck pain is a common symptom found in population. Cervical mobilization is one of many interventions found to be effective to manage the condition. However, no study has ever been conducted to investigate the effectiveness of the treatment technique specified to the symptom distribution as suggested in the clinical guideline. Therefore, this study was conducted to investigate the ongoing effect of the 4-week treatment course of the central PA mobilization technique for treating patients with central and/or bilateral neck pain.

CHAPTER III

METHODS

3.1 INTRODUCTION

This chapter describes the study design, characteristics of participants, materials, procedure, and data analysis.

3.2 STUDY DESIGN

A clinical trial, repeated measures design, was used to investigate the treatment effect of the cervical central PA mobilization technique. Ethical approval was granted by the Ethical Review Committee for Research Involving Human Subjects and/or Use of Animal in Research, Health Science Group of Faculties, Colleges and Institutes, Chulalongkorn University, Thailand (Appendix AI). The details of the study were given to the participants (Appendix AII) and all questions were answered. Informed consent was obtained from each participant prior to entry into the study (Appendix AIII).

3.3 PARTICIPANTS

Participants with central and/or bilateral mechanical neck pain who presented at the Health Sciences Service Center from September 2007 to January 2008 were recruited.

The central and/or bilateral symptoms were defined as the symptom located over the posterior aspects of the neck which could refer bilaterally down to both upper extremities equally (Ahn et al., 2007). They were included into the study if they (1) aged more than 20 years, (2) had pain and/or stiffness in the neck for at least 2 weeks, (3) had pain at rest and pain on worst movement greater than 20 out of 100 millimeters (mm) on a visual analogue scale (VAS) to permit a clinical change to be demonstrated (Ostelo and de Vet, 2005), and (4) had no communication problem.

Participants were excluded if they had the following features: (1) contraindications to cervical mobilization such as signs of malignancy, infection, inflammatory disorder, and fracture in the cervical spine (Maitland et al., 2005), (2) recent history of whiplash injury, (3) having been treated with cervical mobilization or manipulation within the past month, and (4) history of neck surgery.

3.4 MATERIALS

3.4.1 Visual analogue scale (VAS)

Pain intensity was assessed by the VAS which is a commonly used instrument to assess pain intensity (Figure 3.1) (Ostelo and de Vet, 2005). It is a 100-mm horizontal line with two ends labeled as “no pain” and “pain as bad as it could be”. Participants were asked to indicate their pain intensity by drawing a perpendicular line on the VAS. The distance from the “no pain” end to the mark made by the participants was recorded as pain intensity score that could range from zero to 100 mm (Ostelo and de Vet, 2005). The VAS was suggested to have good construct validity and it was found to be more sensitive than other instruments with the

minimally clinically important change of 20 mm (Von Korff et al., 2000). Thai version of VAS was used in this study (Appendix AIV).

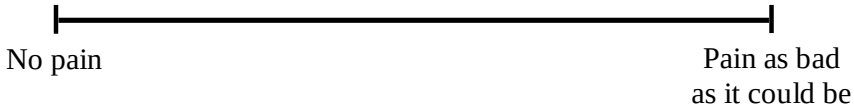

Figure 3.1: Visual analogue scale (VAS).

3.4.2 Cervical Range of Motion Instrument (CROM)

The CROM (Performance Attainment Associates, Minnesota, The United States of America) was used for measuring cervical ROM (Figure 3.2). The CROM consists of three separated inclinometers which are attached to the frame. The inclinometers in the sagittal and the frontal planes use a gravity-dependent needle while the inclinometer in the horizontal plane uses a magnetic needle and a magnetic neck brace worn in the neck to indicate ROM. Six directions of cervical ROM were collected. They were flexion, extension, left lateral flexion, right lateral flexion, left rotation, and right rotation. The criterion validity of the CROM determined by correlating the measures on all six directions with those obtained from the radiograph and the optoelectric system was shown to be excellent (r ranged from 0.82 – 0.98) (Tousignant et al., 2000; Tousignant et al., 2002; Tousignant et al., 2006). It was shown to be highly reliable with the intraclass correlation coefficients (ICCs) ranging from 0.84 – 0.95 for intra-observer and 0.73 – 0.92 for inter-observer reliability (Jordan, 2000). Prior to conducting this study, our pilot study also demonstrated high intra-observer reliability with the $ICC_{(2,2)}$ ranging from 0.89 – 0.98 and the minimal detectable changes were less than 3 degrees (Appendix B).

Figure 3.2: Cervical range of motion instrument (CROM)

A = A frame attached with three inclinometers, A1 = An inclinometer for the frontal plane measurement, A2 = An inclinometer for the sagittal plane measurement, A3 = An inclinometer for the horizontal plane measurement, B = A magnetic neck brace.

3.4.3 Neck Disability Index (NDI)

NDI is the questionnaire designed to assess how much the neck pain has affected one's ability to manage everyday activities. It consists of 10 sections concerning pain, headaches, ability to perform personal care, lifting, reading, concentration, working, driving, sleeping, and recreation. Participants choose the statement that best describes their situation from six choices in each of the ten sections. For each section, the score ranges from zero when the first choice is chosen to five when the last choice is chosen. The total score could range from zero to 50. The greater score reflected the greater level of disability. In this study, participants were assessed by the Thai version of the NDI which was translated by Luckumnueporn (Appendix AV) (Luckumnueporn, 2007). The reliability was reported to be high with the ICC of 0.90 and a minimal detectable change (MDC) of 7.40 percent (Luckumnueporn, 2007).

3.4.4 Global Perceived Effect (GPE)

The participants' perceived recovery effect was measured by a 7-point GPE scale. The instrument has seven choices which range from number one to seven that represented "completely recovered", "much improved", "slightly improved", "no change", "slightly worsened", "much worsened", and "worse than ever", respectively (Ostelo and de Vet, 2005). The participants were asked to indicate their perceived recovery effect by choosing the number that best described their feeling compared to baseline. They were considered as "improved" when they rated their perceived recovery as number one or two and they were considered as "unchanged" when they rated their perceived recovery as number three or four (Ostelo and de Vet, 2005). In this study, Thai version of GPE was used (Appendix AVI).

3.4.5 A height-adjustable couch

A height-adjustable couch (Gymna Uniphy, Bilzen, Belgium) was used to lift or lower the participants during an assessment and treatment (Figure 3.3).

Figure 3.3: A height-adjustable couch.

3.4.6 Wooden Chair

A wooden chair with back rest was used for the participants to sit on during the cervical ROM measurement. It is a 90-centimeter tall wooden chair with the 45-centimeter tall back rest. The chair has the 40 x 45 centimeters dimension seat for fully supporting the participants during the measurement. The back rest is also slightly inclined to provide comfort and relaxation.

3.4.7 Pillow

A pillow with the 50 x 40 centimeters dimension was used for the participants to rest their arms so that their shoulders would be relaxed during the cervical ROM measurement.

3.4.8 Mirror

A mirror with the 150 x 30 centimeters dimension was used during the cervical ROM measurement. It was placed in front of the participants to allow them to see themselves so they could avoid an undesirable movement during the measurement.

3.4.9 Tissue

A little piece of tissue was placed over participants' nose where the nose piece of the CROM made contact with their skin for sanitary purpose.

3.5 PROCEDURE

A physical therapist with 3-year experience in manual therapy and one assessor involved in this study. Throughout the study, the physical therapist was blinded to all outcome measurements. The study was conducted at the laboratory room number 1305, Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University.

Initially, all participants were screened and interviewed by the physical therapist to find out whether they were suitable to be included into the study. Next, they were informed about the study protocol and the participants who agreed to undertake the study were required to sign consent form before participating the study. The physical therapist collected the general data (Appendix AVII) and escorted the participants to the treatment unit to introduce them to the assessor (Figure 3.4). The physical therapist then left the treatment unit and the assessor collected the "pre-treatment" data which consisted of level of neck disability, pain intensity, and cervical ROM.

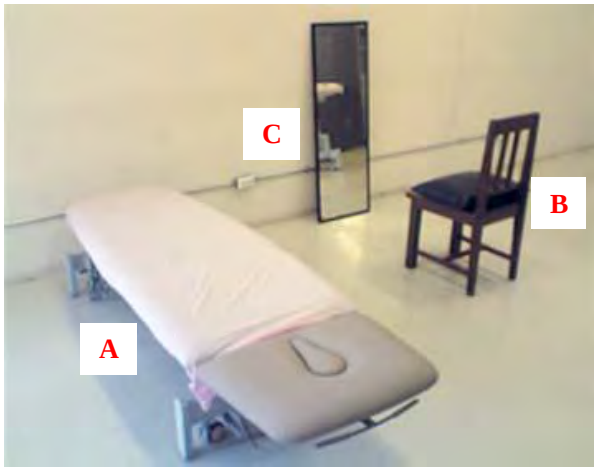

Figure 3.4: The treatment unit.

A = A height-adjustable couch, B = A wooden chair, C = A mirror

For the pain intensity, the participants were asked to indicate their pain at rest and pain on worst movement on the VAS (Appendix AVIII). Then, the participants were asked to sit on the chair in a neutral head position in which an imaginary line from the corner of the eye to the ear was parallel to the floor. A little piece of tissue was placed over participants' nose before applying the CROM on the participants' head. The needles of all three inclinometers indicated zero degree. During the measurements, the participants were not allowed to move their shoulders. A mirror was placed in front of the participants to provide self feedback for avoiding any undesirable movement. The assessor demonstrated all the cervical movements that would be measured (Figure 3.5). The measurement of the cervical ROM was performed in order from flexion, extension, left lateral flexion, right lateral flexion, left rotation, and right rotation. The instructions for the participants to perform the cervical movements were kept uniformly throughout the experiment (Appendix AIX). According to the intra-observer reliability study of this study (Appendix B), the data measured in this order was normally distributed and exhibited no systematic error. The participants were required to perform each cervical movement two times. First repetition was for practicing and the value of the second repetition was recorded (Appendix C). After the pre-treatment measurement, the assessor then left the treatment unit.

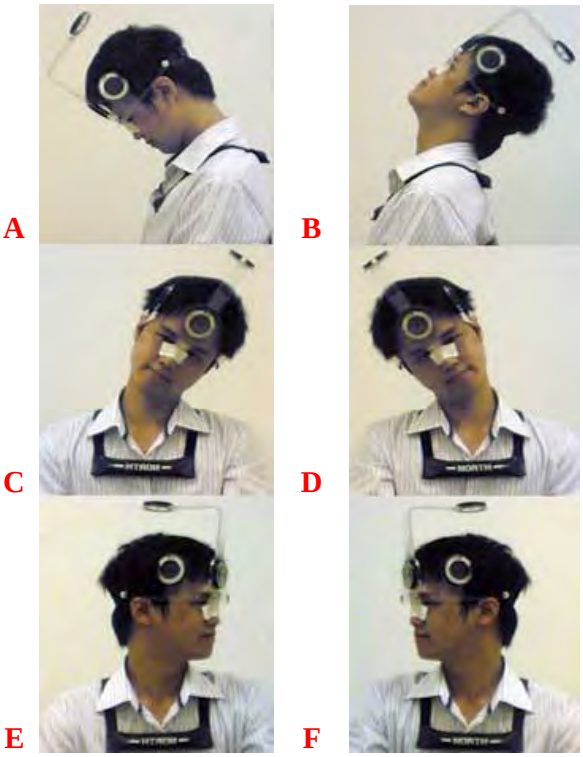

Figure 3.5: Six directions of cervical movements

A = flexion, B = extension, C = left lateral flexion, D = right lateral flexion, E = left rotation, and F = right rotation.

The physical therapist returned to the treatment unit to perform clinical assessment. The participants were asked to lie in prone position on the height-adjustable couch with their forehead resting on their overlapped palms (Figure 3.6). The physical therapist palpated soft tissues of the neck to evaluate for muscle tone, tenderness, and bony alignment. Then the segmental mobility of the cervical spine was assessed by applying oscillatory movement on the spinous process and the zygapophyseal joints in the postero-anterior direction. The resistance and pain response of each segmental level of the cervical spinal were noted. The level(s) that resulted in the reproduction of the participants' symptom during the oscillatory pressure on the spinous process in

the postero-anterior direction were recorded and were considered to be the level(s) for applying the treatment.

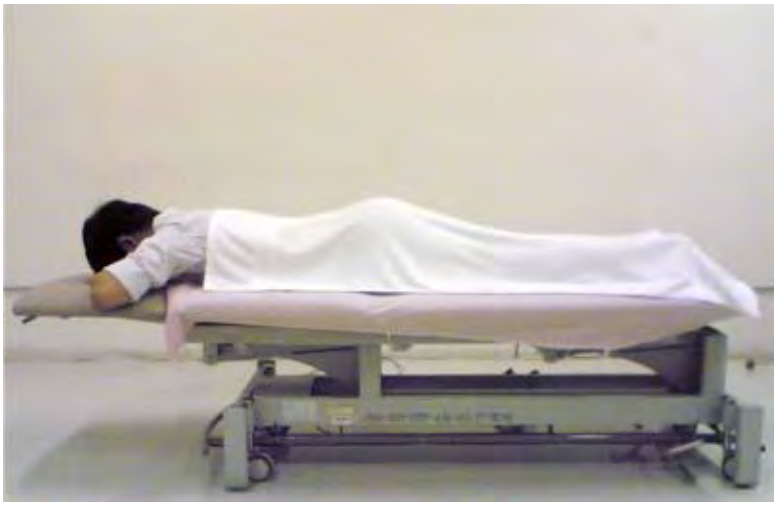

Figure 3.6: The participants' starting position for assessment and treatment.

After the assessment, the physical therapist informed the participants about the treatment that would be given for getting permission to proceed. The central PA mobilization technique was then given as a set of 1-minute oscillation at the level(s) that was considered to be responsible for the symptom. Irrespective of the number of symptomatic segment, a maximum of three sets were performed at each appointment. Grade of treatment was considered from the participants' clinical presentation during assessment. Each set was applied with 30-second rest in between. After completion of the treatment, the physical therapist left the treatment unit.

The assessor returned to the treatment unit to collect "post-treatment" data which consisted of the pain intensity and cervical ROM. The "post-treatment" data were collected in the same manner as the "pre-treatment" data and these data were recorded

in the separate form (Appendix AX). The first appointment of clinical trial ended after the post-treatment measurement and the participants were appointed to return twice a week for a total of eight appointments.

The duration between each appointment was three-four days. At each subsequent appointment, pain at rest, pain on worst movement, and cervical ROM were measured before and after treatment in the same manner as those in the first appointment. At the fifth and the eighth appointments, the Thai version of NDI and the GPE were added to the "pre-treatment" data collection. This was to observe the 2-week and 4-week course effects of the treatment technique on level of disability and GPE.

During the 4-week period of the study, participants were asked to refrain from other interventions or medication which aimed for managing neck pain to avoid any confounding effects on the treatment course. In this study, the treatment was discontinued by the physical therapist if the participants either had any adverse effects which suggested that the cervical mobilization was no longer an appropriate treatment or reported pain at rest and pain on worst movement as zero. Information about adverse effects was obtained by subjective examination in each appointment by the physical therapist. Nevertheless, these participants were asked to continue the appointment(s) for cervical ROM measurement.

3.6 DATA ANALYSIS

Data were analyzed with SPSS, version 11.5 for Windows (SPSS, Chicago, IL). Descriptive statistics were used to describe general demographic and clinical

characteristics. The Kolmogorov-Smirnov test used to examine whether the data of each variable were normally distributed. In the presence of drop-outs, only the available data for each of the outcome measures that excluded those of the drop-out participants were analyzed.

In order to investigate the effects of the central PA mobilization technique on pain and cervical ROM, One-way repeated measures analysis of variance (ANOVA) was performed. The pain at rest, pain on worst movement, and cervical ROM measured at post-treatment of each appointment were compared with those taken at baseline. *Post hoc* Tukey's honestly significant difference test was performed to identify which pairwise comparisons of means were responsible for the significance.

Before investigating the outcome of the level of disability, the scores of NDI obtained at baseline, the fifth, and the final appointments were transformed to percentage score. This allowed the NDI data of all participants to be compared in case of the non responses to any sections of the questionnaire. One-way repeated measures ANOVA was used to compare the NDI scores obtained at baseline, the fifth, and the eighth appointments.

To ascertain the effect of the central PA mobilization technique on the participants' perceived recovery in this study, the GPE scores were dichotomized into "improved" (i.e., completely recovered or much improved) and "unchanged" (i.e., slightly improved, no change, slightly worsened, much worsened, or worse than ever) categories. The percentages of participants in each category were calculated.

For all comparisons, $p < 0.05$ was considered as statistical significance.

CHAPTER IV

RESULTS

4.1 Introduction

This chapter presents the results of the study which include pain intensity, cervical ROM, level of disability, and GPE.

4.2 Results

4.2.1 Demographic data

Recruitment of participants who suffered from central and/or bilateral neck pain was conducted over a 5-month period from September 2007 – January 2008. Eighty-five patients were contacted of which 28 patients enrolled in and became the participants of this study. A total of 18 (three males and 15 females) participants completed the 4-week treatment course. The reasons of the drop-out participants were unavailability and time constraints (n = 5), work-related or study-related jaunt (n = 4), and unknown reason (n = 1). None of the participants reported any adverse effects from the cervical mobilization. They were categorized as chronic mechanical neck pain with the median duration of symptoms of 730 days (interquartile range = 593 – 1593 days). Their means (SDs) of age, height, and weight at baseline were 37.7 (11.0) years, 1.62 (0.09) meters, and 60.0 (8.2) kilograms, respectively. Thirteen participants (72

percent) were found to have three symptomatic segments, two (11 percent) had two symptomatic segments, and three (17 percent) had one symptomatic segment.

4.2.2 Pain intensity and cervical ROM

Raw data of pain intensity and cervical ROM of 28 participants are presented in Appendix D. For 18 participants who completed the 4-week treatment course, their means (SDs) of the pain intensity and on worst movement measured at pre-treatment and post-treatment of each appointment are shown in Table 4.1. The changes in pain intensity at the beginning of the treatment course were relatively greater than those recorded later in the treatment course (Figure 4.1 and 4.2).

Table 4.1: Means of pain intensity at rest and pain on worst movement measured pre-treatment and post-treatment of each appointment for four weeks (n = 18).

Appointment	Pain at rest (mm)			Pain on worst movement (mm)		
	Pre	Post	Differences	Pre	Post	Differences
1	41.1	30.1	11.0	60.8	49.8	11.0
2	31.2	26.7	4.5	47.7	41.7	6.0
3	27.1	19.1	8.0	41.5	29.9	11.6
4	26.8	16.9	9.9	36.8	30.9	5.9
5	15.8	12.9	2.9	24.6	19.1	5.5
6	15.5	12.9	2.6	23.3	16.1	7.2
7	10.6	7.9	2.7	20.0	14.8	5.2
8	7.5	4.9	2.6	13.7	8.2	5.5

Pre = Pre-treatment; Post = Post-treatment; mm = millimeters.

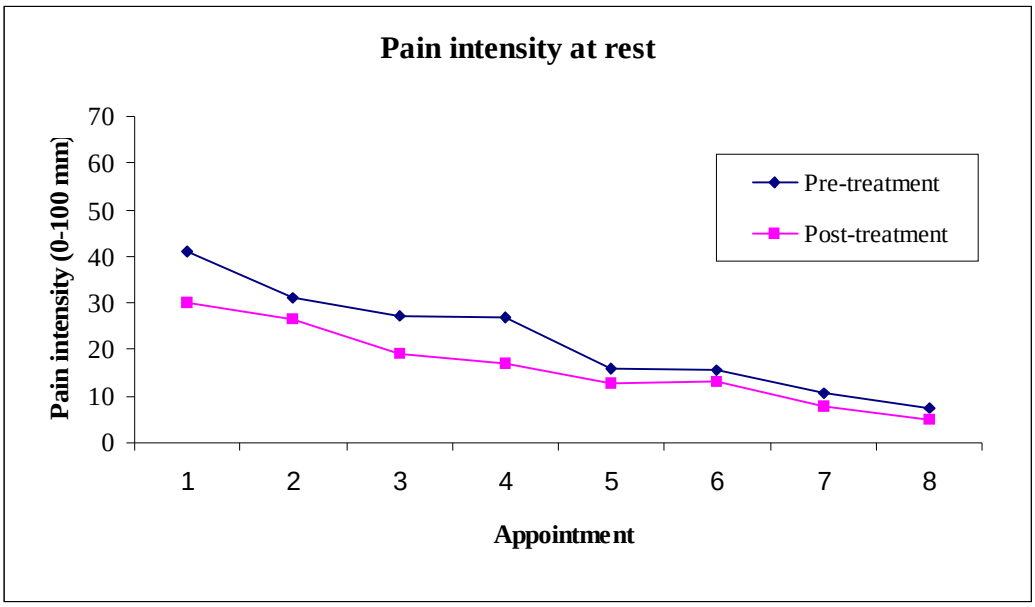

Figure 4.1: Means of pain intensity at rest measured at pre-treatment and post-treatment of each appointment (n = 18).

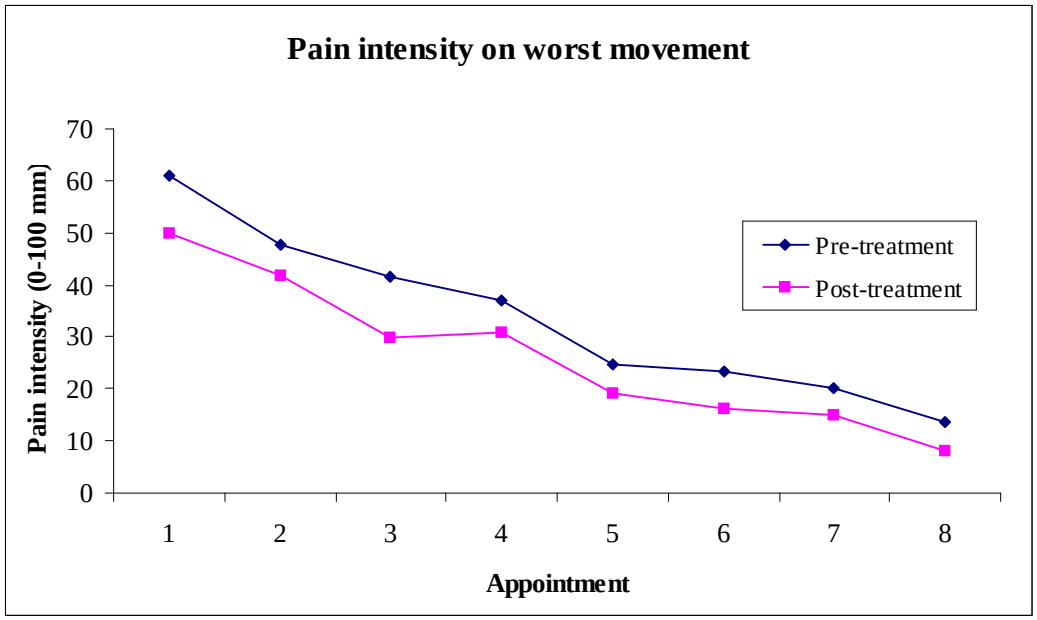

Figure 4.2: Means of pain intensity on worst movement measured at pre-treatment and post-treatment of each appointment (n = 18).

In regard to the comparison to baseline data, the means (SDs) of pain intensity and cervical ROM measured at baseline and post-treatment at each appointment are shown in Table 4.2. One-way repeated measures ANOVA demonstrated that there were significant differences in pain at rest ($p < 0.001$) and pain on worst movement ($p < 0.001$) among appointments (Table 4.3). No significant differences in cervical ROM among appointments were found ($p > 0.05$).

Post hoc analysis was performed. For pain at rest, the differences were found between the data obtained from the third to the eighth appointments and the baseline ($p < 0.05$) (Table 4.4). For pain on worst movement, the differences were found between the data taken from the second to the eighth appointments and the baseline ($p < 0.05$) (Table 4.4).

Table 4.2: Means (Standard deviations) of pain intensity and cervical range of motion (ROM) measured at baseline and post-treatment of each appointment for four weeks (n = 18).

Appointments	Baseline	1	2	3	4	5	6	7	8
Pain intensity (millimeters)									
At rest	41.1 (14.9)	30.1 (18.8)	26.7 (20.1)	19.1 (15.3)	16.9 (17.3)	12.9 (16.3)	12.9 (17.6)	7.9 (14.8)	4.9 (11.5)
On worst movement	60.8 (17.8)	49.8 (19.3)	41.7 (21.5)	29.9 (19.9)	30.9 (20.2)	19.1 (17.1)	16.1 (19.2)	14.7 (15.9)	8.2 (12.6)
Cervical ROM (degrees)									
Flexion	49.1 (10.9)	49.7 (8.7)	50.4 (9.8)	50.2 (7.7)	50.7 (10.0)	51.1 (8.8)	51.4 (8.4)	52.6 (8.9)	51.8 (10.2)
Extension	71.9 (13.4)	68.9 (14.0)	68.2 (14.9)	69.3 (11.9)	67.3 (12.8)	68.8 (13.1)	69.4 (12.4)	70.1 (14.4)	69.8 (14.6)
Left lateral flexion	42.2 (8.5)	42.7 (9.0)	42.9 (9.9)	44.0 (8.7)	43.0 (9.9)	42.7 (10.5)	41.3 (10.3)	42.4 (10.6)	43.7 (10.2)
Right lateral flexion	40.9 (9.2)	41.5 (8.5)	41.7 (9.3)	42.2 (7.9)	41.1 (8.9)	41.4 (9.3)	41.9 (9.5)	41.3 (10.9)	41.2 (9.6)
Left rotation	68.1 (7.0)	68.9 (8.3)	68.7 (7.0)	68.2 (7.3)	69.0 (8.8)	68.3 (6.6)	68.7 (8.5)	68.2 (8.2)	69.6 (7.6)
Right rotation	67.6 (9.1)	66.2 (7.9)	67.2 (8.5)	67.8 (7.2)	67.0 (8.3)	66.1 (9.1)	69.0 (8.5)	67.3 (9.2)	69.3 (7.7)
Worst movement	57.9 (20.0)	56.7 (19.5)	51.2 (15.3)	52.2 (15.8)	52.1 (16.0)	54.3 (15.3)	49.3 (15.2)	48.8 (17.0)	48.6 (15.1)

Table 4.3: Results of one-way repeated analysis of variance for testing the effectiveness of the treatment course on pain intensity and cervical range of motion (n = 18).

	$F_{8,136}$	p-value
Pain		
At rest	24.6	**<0.001****
On worst movement	42.5	**<0.001****
Cervical range of motion		
Flexion	0.88	0.468
Extension	1.00	0.437
Left lateral flexion	0.65	0.599
Right lateral flexion	0.18	0.885
Left rotation	0.27	0.891
Right rotation	1.25	0.296
Worst movement	2.07	0.107

** = $p < 0.001$

Table 4.4: Pairwise mean differences of pain at rest and pain on worst movement between data measured at baseline and post-treatment of each appointment (n = 18).

Pain intensity (millimeters)	**Appointments**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
At rest	10.0	14.4	22.0*	24.2*	28.2*	28.2*	33.2*	36.2*
On worst movement	11.0	19.1*	30.9*	29.9*	41.7*	44.7*	46.1*	52.6*

* = $p < 0.05$

Interestingly, pain at rest and pain on worst movement decreased continuously as shown in Figure 4.3. At baseline, pain at rest and pain on worst movement were 42.5

and 60.4 mm, respectively. After eight appointments, the pain intensity decreased below 10 mm.

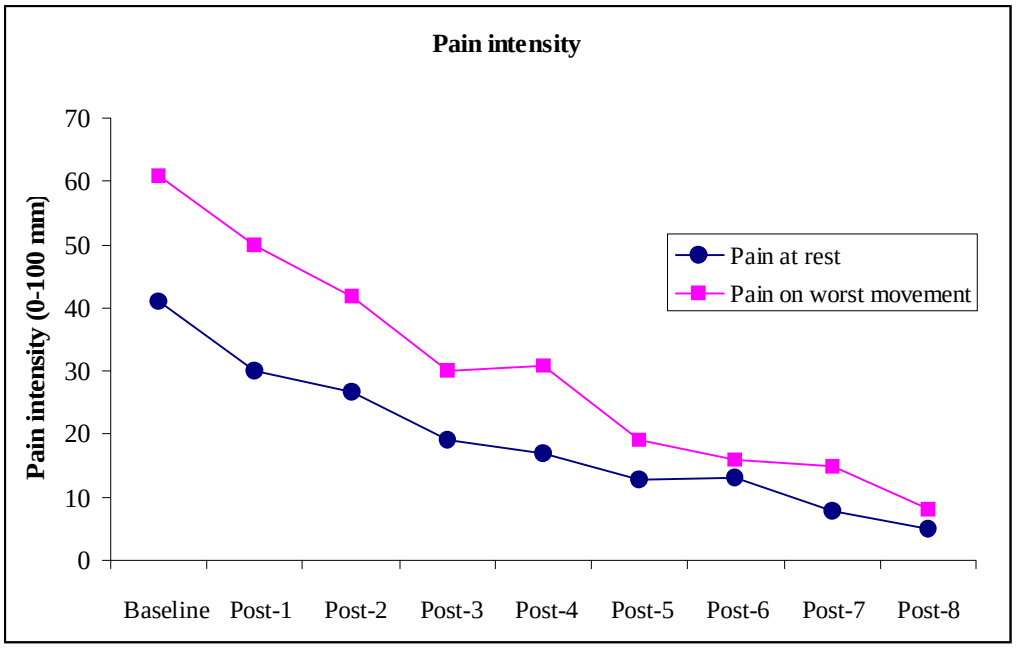

Figure 4.3: Means of pain at rest and pain on worst movement at baseline and post-treatment for each appointment, Post-*a* = post-treatment data recorded at *a* appointment (n = 18).

4.2.3 Neck Disability Index

Raw data of the NDI scores for 28 participants are shown in Appendix D. When the study was completed, the NDI scores assessed at baseline, the fifth, and the eighth appointments were obtained from 18 participants. The data analysis was then performed on these participants.

The means percentage of the NDI scores decreased continuously from baseline of 30.0 percent to 15.9 and 11.4 percent at the second and the fourth weeks of the treatment course (Figure 4.4). One-way repeated measures ANOVA demonstrated significant differences in the NDI scores among appointments ($F_{4,92}$ = 23.5, p < 0.001). *Post hoc* analysis demonstrated significant reduction in the NDI scores from baseline both at the second and the fourth weeks of the treatment course (p < 0.05) (Figure 4.4).

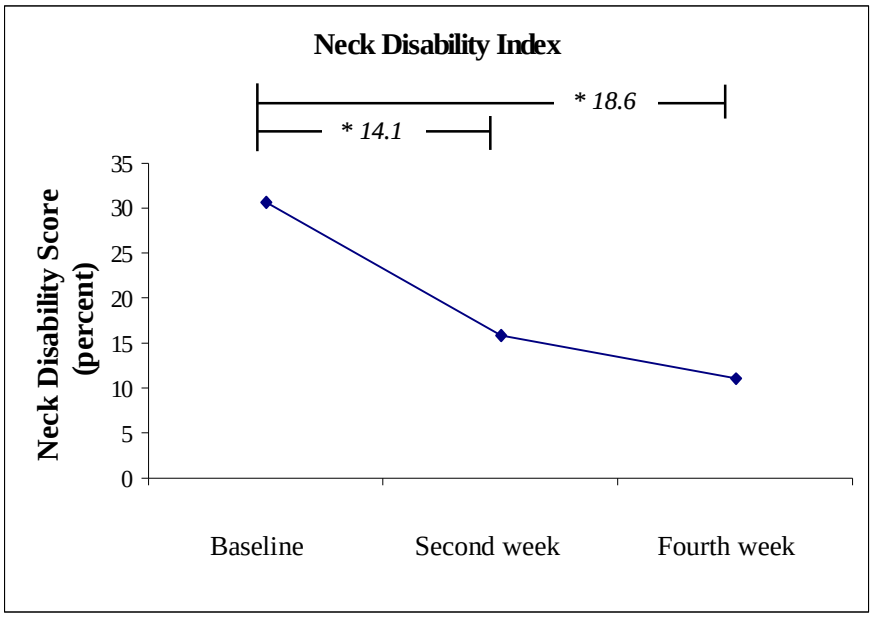

Figure 4.4: Means of the percentage neck disability scores (n = 18). Pairwise mean differences of percentage neck disability scores are shown in italic (* = p < 0.05).

4.2.4 Global Perceived Effect

The raw data of the participants' perceived recovery effect classed into each category are shown in Appendix D. When the study was completed, the data of GPE assessed

at the fifth and the eighth appointments could be obtained from 18 participants. At the fifth appointment of the treatment course, 11 participants out of the total of 18 participants (61.1 percent) reported their GPE as improved. At the completion of the treatment course, 13 participants reported their GPE as improved.

CHAPTER V

DISSCUSSION

5.1 Introduction

To our knowledge, this is the first study investigating the effects of the treatment course of cervical central PA mobilization technique for treating patients presenting with central and/or bilateral neck pain throughout a 4-week treatment course. Pain at rest and pain on worst movement were reduced, level of disability and global perceived effect were improved while the cervical ROM in all directions were not increased. These findings partially support the clinical recommendation for selection of this mobilization technique as the treatment of choice for treating this group of patients.

5.2 Effect of central PA mobilization on pain

In the present study, the application of the central PA mobilization produced the immediate pain reduction at rest of 11.0 mm and pain reduction on worst movement of 11.0 mm within the first appointment. The results were similar to the immediate pain reduction found in previous study following the application of cervical mobilization in the form of muscle energy technique in patients with unilateral neck pain (10.5 mm) (Cassidy et al., 1992). Nevertheless, it differed considerably from the

result of the immediate pain at rest reduction found following the application of cervical mobilization in the form of sustained stretching of the neck in the manipulated position in patients with unilateral neck pain (4.0 mm) (Martinez-Segura et al., 2006). Obviously, the discrepancy in the magnitudes of pain reduction among studies reflects the differences in the therapeutic mechanisms among the mobilization techniques. Both Maitland mobilization and the stretching in the manipulated position aim for treating the joint whereas the muscle energy technique aims to improve muscle property. As the mechanical neck pain is the multi-dimensional problem, either treating muscle or joint should produce good results. The greater pain reduction found following Maitland mobilization and the muscle energy technique might be explained by the number of cervical segment being treated. For these two techniques, more than one symptomatic cervical segment was treated within one session. For the stretching in the manipulated position, the study applied the technique once at one cervical segment (Martinez-Segura et al., 2006). Since the problem of mechanical neck pain usually arises from more than one cervical segment, the greater therapeutic effect would be obtained if more cervical segments were treated. However, within the first appointment, the pain reduction in this study and both two previous studies were not considered as clinical significance as the improvement was less than 20 mm on the VAS (Ostelo and de Vet, 2005).

Because this is the first study reporting pain on worst movement, comparing the result to other studies was not possible. From Table 4.1, the current study demonstrated that the pain at rest and pain on worst movement reduced with same magnitude (11.0 mm). This information is clinically important since all patients always exhibit pain on worst movement and not all patients experience pain at rest. Pain on worst movement

should therefore be included in the reassessment process in the clinical practice and in the outcome measurement. This is in line with the guideline advocated by Maitland (Maitland et al., 2005).

By repeatedly applying the central PA mobilization technique for eight appointments throughout the 4-week period, the cumulative effect on pain reduction was seen. This was illustrated as the continuous decline in the means of both pain at rest and pain on worst movement with continuation of appointments (Figure 4.1). From Figure 4.1, it is likely that the continuous decline in both pain intensities would have been observed if the treatments were continued. Further study should extend the period of the treatment course to provide evidence for supporting this claim.

Although significant reductions in pain at rest (22.0 mm) and pain on worst movement (19.1 mm) were started to be shown after the third and the second appointments, their clinical significances were found after the third appointment of the treatment course (Table 4.3). These results suggest that it would take at least three appointments for the central PA mobilization to demonstrate its effectiveness on pain reduction in these patients.

After eight appointments, the mean reduction of pain at rest was 36 mm which was nearly four times greater than the immediate pain reduction at the first appointment. Similarly, the mean reduction of pain on worst movement was also high. The reduction of 52.6 mm was nearly five times greater than the immediate reduction in pain on worst movement after the first appointment. In comparison with the only available study that assessed the effectiveness of the mobilization technique during an

ongoing treatment course for six weeks, the central PA mobilization technique employed in this present study demonstrated greater pain reduction. After six weeks, the means of pain intensity on average and of the most severe pain were 35 and 45 mm, respectively (Hoving et al., 2002). The treatment dosage could probably be responsible for the superiority of the present study to the previous study. Participants received eight treatments (twice a week for four weeks) in this study while they received six treatments (once a week for six weeks) in the previous study (Hoving et al., 2002). Moreover, within the same treatment duration, the participants in this study were treated more frequently than the previous study.

5.3 Effect of central PA mobilization on cervical ROM

In this study, the application of the central PA mobilization produced neither immediate nor 4-week significant improvement from baseline in cervical ROM. The changes were either increase or decrease in cervical ROM (Table 4.1). These findings were inconsistent with previous studies which demonstrated an increase in cervical ROM in all directions after mobilization (Cassidy et al., 1992; Hoving et al., 2002; Martinez-Segura et al., 2006).

After receiving the muscle energy technique, the immediate improvement from baseline in cervical ROM in all directions was reported to be ranging from 1.3 – 4.2 degrees (Cassidy et al., 1992). Similarly, the immediate significant improvement from baseline in cervical ROM in most directions was reported to be ranging from 0.8 – 1.5 degrees after receiving the sustained stretching of the neck in the manipulated position (Martinez-Segura et al., 2006). However, these studies did not report their

MDC values for determining the significant changes in cervical ROM. The clinical relevance of these results could therefore not be established. In the current study, the immediate changes in cervical ROM in all directions were less than three degrees which was considered to be of clinical meaningful (Appendix D).

No specific trend of the change in cervical ROM in any directions was found with the continuation of the mobilization treatments. The changes were found to fluctuate within the narrow range of four degrees. These insignificant changes might be explained by the proximity of the cervical ROM of the participants recruited in this study to the normal cervical ROM as shown in Appendix AXII (Youdas et al., 1992). No further changes in cervical ROM could therefore be measured. Consequently, it should not be interpreted that the central PA mobilization had no effect on cervical ROM. Prior to making any conclusion, further study in participants with noticeable limitation of cervical ROM is required.

5.4 Effect of central PA mobilization on level of disability

The treatment course of central PA mobilization produced significant improvement from baseline in level of disability at the second and the fourth weeks. At the second week of the treatment course, the NDI scores decreased 14.1 percent from baseline and continued to decrease 4.5 percent more when the treatment course was completed (18.6 percent from baseline). These improvements were clinically significant as the changes were greater than the MDC of 7.4 percent (Luckumnueporn, 2007).

The reduction in the NDI scores of the 4-week treatment course was similar to the reduction of 15.6 percent of the previous study using combined Maitland mobilization techniques (Hoving et al., 2002). With the similar NDI scores at baseline, these results imply that the mobilization technique used in this study is superior to that of the previous study. However, these findings must be interpreted with care as discussed earlier in Section 5.2.

5.5 Effect of central PA mobilization on GPE

The treatment course of central PA mobilization produced significant improvement from baseline in patients' recovery effect at the second (60 percent improved) and the fourth weeks (72.2 percent improved). In general, these findings coincided with the report of an improvement in 68 percent of the participants after six weeks of treatment with combined Maitland mobilization techniques (Hoving et al., 2002). Regarding of the period of treatment, the treatment course of central PA mobilization could be perceived as producing greater recovery than the previous study. However, these data should be interpreted with caution because there are several factors, for example, participants' expectation and motivation that could influence the response of the participants.

5.6 Limitations of this study

Some potential limitations need to be considered when the results of the current study are interpreted. First, all participants in this study were classified as chronic neck pain. Caution is needed to be exercised in order to generalize these results to

participants with acute or sub-acute neck pain. Second, this study limited the number of sets for cervical mobilization performed at each appointment at three sets. As the majority of participants (72 percent) possessed three symptomatic segments, each segment was received only one set of cervical mobilization at each appointment. Although this dosage allowed significant pain reduction to be detected, a greater improvement in pain and cervical ROM might be obtained if more treatment dosages are delivered. Last, previous study reported that the manual forces applied during the cervical mobilization varied widely between therapists (Snodgrass et al., 2007). The treatment effects of the cervical mobilization may therefore vary between therapists. The outcomes from the treatment applied by experienced therapists and general therapists may be different. However, no study has compared the effectiveness between experienced therapists and general therapists. Further study should be conducted to compare the effects of the treatment delivered by multiple therapists.

CHAPTER VI

CONCLUSION

This study has implication for the treatment of the mechanical neck pain. The results indicate that the central PA mobilization technique is effective in decreasing pain and disability while improving GPE. However, it is not effective in improving cervical ROM. In patients suffering from mild to moderate central and/or bilateral neck pain, the application of the central PA mobilization technique provides clinical effects after four appointments. Moreover, the clinical effects on pain and disability are cumulative with the subsequent application of the mobilization.

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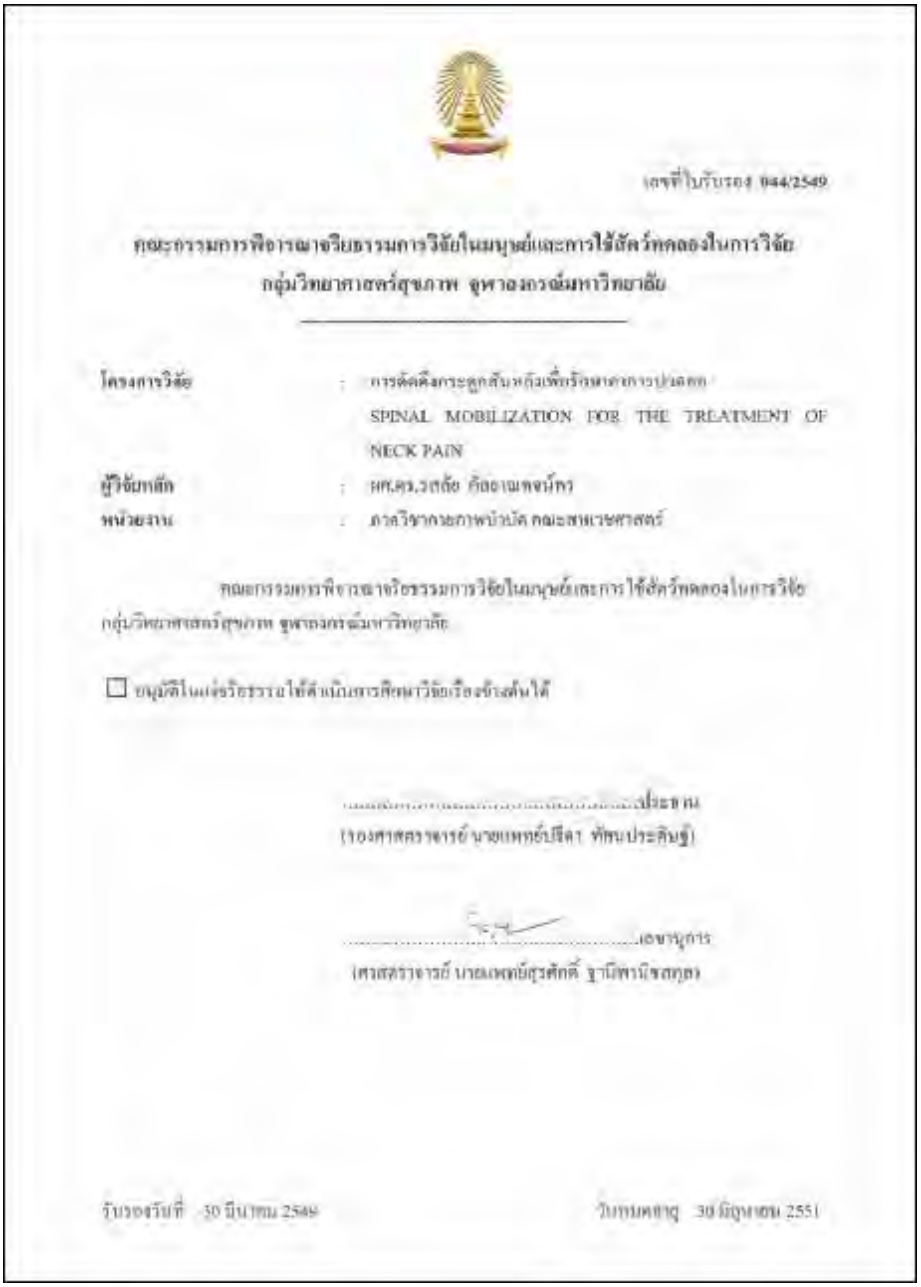
APPENDICES

APPENDIX A

A I Ethical approval for the study



เลขที่ใบรับรอง 044/2549

คณะกรรมการพิจารณาจริยธรรมการวิจัยในมนุษย์และการใช้สัตว์ทดลองในการวิจัย
กลุ่มวิทยาศาสตร์สุขภาพ จุฬาลงกรณ์มหาวิทยาลัย

โครงการวิจัย : การดัดดึงกระดูกสันหลังเพื่อรักษาอาการปวดคอ
SPINAL MOBILIZATION FOR THE TREATMENT OF NECK PAIN

ผู้วิจัยหลัก : ผศ.ดร.วสันต์ ศิลาเดชพันธ์กร

หน่วยงาน : ภาควิชากายภาพบำบัด คณะสหเวชศาสตร์

คณะกรรมการพิจารณาจริยธรรมการวิจัยในมนุษย์และการใช้สัตว์ทดลองในการวิจัย กลุ่มวิทยาศาสตร์สุขภาพ จุฬาลงกรณ์มหาวิทยาลัย

☐ อนุมัติในหลักจริยธรรมให้ดำเนินการศึกษาวิจัยเรื่องข้างต้นได้

.....ประธาน
(รองศาสตราจารย์ นายแพทย์ปรีดา ทัพนประสิทธิ์)

.....เลขานุการ
(ศาสตราจารย์ นายแพทย์สุรศักดิ์ ฐานิตพานิชสกุล)

รับรองวันที่ 30 มีนาคม 2549 วันหมดอายุ 30 มิถุนายน 2551

A II Participant Information Sheet

1.ชื่อโครงการวิจัย

(ภาษาไทย) ผลของโปรแกรมการรักษาหนึ่งเดือนของการดัดดึงแบบการขยับข้อต่อตรงกลางจากด้านหลังไปด้านหน้าที่มีต่อความเจ็บปวด และช่วงการเคลื่อนไหวของกระดูกสันหลังส่วนคอในการรักษาผู้ป่วยที่มีอาการปวดคอบริเวณแนวกลางและ/หรือทั้งสองด้านของคอ

(ภาษาอังกฤษ) Effect of a one-month course of central postero-anterior mobilization on pain and cervical range of motion for treating patients with central and/or bilateral neck pain

2.ชื่อผู้วิจัย นายประพัฒณ์ สิริประภาพร ตำแหน่ง นิสิตปริญญาโท

3.สถานที่ปฏิบัติงาน ภาควิชากายภาพบำบัด คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย

โทรศัพท์ที่บ้าน 0-2611-5750 โทรศัพท์เคลื่อนที่ 08-9683-6475

E-mail: New-Bluesky@hotmail.com

4.รายละเอียดโครงการ

4.1 วัตถุประสงค์ของโครงการ – โครงการวิจัยนี้เพื่อศึกษาผลของการรักษาผู้ป่วยที่มีอาการปวดคอบริเวณแนวกลาง และ/หรือ ทั้งสองด้านของคอโดยโปรแกรมการรักษาหนึ่งเดือนด้วยวิธีการขยับข้อต่อตรงกลางจากด้านหลังไปด้านหน้า

4.2 การทำวิจัย – จะประกอบไปด้วยการวัดระดับความเจ็บปวด, องศาการเคลื่อนไหวของคอ, ระดับการจำกัดการทำกิจกรรมจากการปวดคอ, และระดับการรับรู้การดีขึ้นหรือแย่ลงโดยรวม โดยจะวัดเทียบผลก่อนและหลังการรักษา การรักษาจะเป็นโปรแกรมต่อเนื่องนาน 4 สัปดาห์ สัปดาห์ละ 2 ครั้ง ระยะเวลารวมประมาณ 1 เดือน ในแต่ละครั้งจะใช้เวลาประมาณ 45 นาที - 1 ชั่วโมง

4.3 ขั้นตอนในการทำวิจัย – เริ่มจากนักกายภาพบำบัดซักประวัติของผู้มีความประสงค์จะเข้าร่วมงานวิจัย จากนั้นผู้เข้าร่วมงานวิจัยลงนามในใบยินยอมเข้าร่วมการวิจัย กรอกข้อมูลประวัติและรายละเอียดต่างๆ จากนั้นผู้ทำการวัดจะทำการเก็บข้อมูลก่อนการรักษา คือ ระดับความเจ็บปวด, ระดับการจำกัดการทำกิจกรรมจากการปวดคอโดยตอบลงในแบบสอบถาม, และองศาการเคลื่อนไหวของคอโดยทำการวัด ผู้เข้าร่วมการวิจัยจะนั่งสวมเครื่องมือวัดหน้ากระจกและเคลื่อนไหวคอในทิศทางต่างๆรวม 6 ท่า ประกอบไปด้วย ก้มคอ, เงยคอ, เอียงคอไปด้านซ้ายและขวา, และหมุนคอไปด้านซ้ายและขวา ผู้ทำการวัดจะสาธิตท่าทั้ง 6 ให้ดูก่อน จากนั้นจะทำการวัดจริง หลังจากการวัดนักกายภาพบำบัดจะทำการตรวจร่างกาย และทำการรักษา โดยจะให้การรักษาด้วยการดัดดึงข้อต่อเป็นจำนวน 3 เซตลงบนข้อต่อที่เป็นสาเหตุให้เกิดอาการของผู้เข้าร่วมงานวิจัย เมื่อทำการรักษาเสร็จแล้ว ผู้ทำการวัดจะทำการวัดระดับความเจ็บปวดและองศาการ

เคลื่อนไหวของคออีกครั้งหนึ่ง การรักษาในครั้งแรกสิ้นสุด นักกายภาพบำบัดจะทำการนัดหมายผู้เข้าร่วมงานวิจัยเพื่อเข้ารับการรักษาต่อไปจนกว่าจะสิ้นสุดโปรแกรมการรักษา 8 ครั้ง

4.4 ผู้เข้าร่วมงานวิจัยไม่มีความรับผิดชอบใดๆกับงานวิจัยนี้

4.5 ผู้เข้าร่วมงานวิจัยอาจจะมีอาการปวดระบมที่บริเวณที่ได้รับการรักษาได้เล็กน้อย ซึ่งถือว่าเป็นเรื่องปกติสำหรับผู้ที่ไม่เคยได้รับการรักษาด้วยวิธีการดังกล่าว โดยอาการดังกล่าวอาจจะเกิดขึ้นทันทีหลังจากเสร็จสิ้นขั้นตอนในการวิจัย หรือหลังจากนั้นประมาณ 1-2 วัน โดยอาการจะค่อยๆหายไปในระยะเวลาไม่เกิน 1 สัปดาห์

4.6 ผู้เข้าร่วมงานวิจัยอาจไม่ได้รับประโยชน์จากการวิจัยครั้งนี้โดยตรง แต่ผลจากการวิจัยนี้ทำให้เกิดความก้าวหน้าทางวิชาการ ในการรักษาอาการปวดคอต่อไปในอนาคต

4.7 การเข้าร่วมโครงการวิจัยทำโดยสมัครใจ และผู้เข้าร่วมงานวิจัยอาจปฏิเสธที่จะเข้าร่วม หรือถอนตัวออกจากการวิจัยได้ทุกขณะ โดยไม่ต้องได้รับโทษหรือสูญเสียประโยชน์ซึ่งพึงได้รับ

4.8 ผู้กำกับและดูแลการวิจัย ผู้ตรวจสอบ และคณะกรรมการพิจารณาจริยธรรม สามารถเข้าไปตรวจสอบบันทึกข้อมูลทางการแพทย์ของผู้เข้าร่วมงานวิจัย เพื่อเป็นการยืนยันถึงขั้นตอนในการวิจัยทางคลินิก และข้อมูลอื่นๆ โดยไม่ล่วงละเมิดเอกสิทธิ์ในการปิดบังข้อมูลของผู้เข้าร่วมการวิจัย ตามกรอบที่กฎหมาย และกฎระเบียบได้อนุญาต นอกจากนี้โดยการเซ็นให้ความยินยอม ผู้เข้าร่วมการวิจัยมีสิทธิ์ตรวจสอบและมีสิทธิที่จะได้รับข้อมูลเช่นกัน

4.9 ข้อมูลที่อาจนำไปสู่การเปิดเผยตัวของผู้เข้าร่วมการวิจัยจะได้รับการปกปิด ยกเว้นว่าได้รับความยินยอม โดยกฎระเบียบและกฎหมายที่เกี่ยวข้องเท่านั้น จึงจะเปิดเผยข้อมูลแก่สาธารณชนได้ ในกรณีที่ผลการวิจัยได้รับการตีพิมพ์ ชื่อและที่อยู่ของผู้เข้าร่วมการวิจัยจะต้องได้รับการปกปิดอยู่เสมอ

4.10 ผู้เข้าร่วมการวิจัยสามารถติดต่อแจ้งข้อมูลเพิ่มเติมที่เกี่ยวข้องกับการวิจัย สิทธิของผู้เข้าร่วมการวิจัย และในกรณีที่เกิดอันตรายที่เกี่ยวข้องกับการวิจัย ได้ตามชื่อ ที่อยู่ และเบอร์โทรศัพท์ ดังกล่าวไว้ข้างต้น

4.11 ระยะเวลาที่คาดว่าผู้เข้าร่วมการวิจัยจะทำการเข้าร่วมประมาณ 45 นาที

A III Informed Consent Form

ใบยินยอมของประชากรตัวอย่างหรือผู้มีส่วนร่วมในการวิจัย (Informed Consent Form)

ชื่อโครงการวิจัย การดัดดึงกระดูกสันหลังเพื่อรักษาอาการปวดคอ

ข้าพเจ้าได้รับทราบจากผู้วิจัย ชื่อ ผศ.ดร. รสลัย กัลยาณพจน์พร
นายประพัฒณ์ สิริประภาพร
นางสาวมลทิชา สกุณา
ที่อยู่ ภาควิชากายภาพบำบัด คณะสหเวชศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ซึ่งได้ลงนามด้านท้ายของหนังสือนี้ ถึงวัตถุประสงค์ ลักษณะ และแนวทางการศึกษาวิจัย รวมทั้งทราบถึงผลดี ผลข้างเคียง และความเสี่ยงที่อาจเกิดขึ้น ข้าพเจ้าได้ซักถาม ทำความเข้าใจเกี่ยวกับการศึกษาดังกล่าวนี้ เป็นที่เรียบร้อยแล้ว

- ข้าพเจ้ายินดีเข้าร่วมการศึกษาวิจัยครั้งนี้โดยสมัครใจ และอาจถอนตัวจากการเข้าร่วมศึกษานี้เมื่อใดก็ได้ โดยไม่จำเป็นต้องแจ้งเหตุผล
- ข้าพเจ้าได้รับทราบจากผู้ทำการวิจัยว่า หากข้าพเจ้าได้รับความผิดปกติเนื่องจากการศึกษาทดลอง ข้าพเจ้าจะได้รับความคุ้มครองตามกฎหมาย และจะแจ้งผู้ทำการวิจัยทันที ในกรณีที่มิได้แจ้งให้ผู้ทำการวิจัยทราบในทันทีถึงความผิดปรกติที่เกิดขึ้นได้ จะถือว่าข้าพเจ้าทำให้การคุ้มครองความปลอดภัยเป็นโมฆะ (ตามที่กฎหมายกำหนด)
- ข้าพเจ้ายินดีให้ข้อมูลของข้าพเจ้าแก่คณะผู้วิจัย เพื่อเป็นประโยชน์ในการศึกษาวิจัยครั้งนี้
- ข้าพเจ้าเข้าใจและตระหนักว่า ผู้วิจัยจะเก็บข้อมูลเฉพาะเกี่ยวกับข้าพเจ้าเป็นความลับ และจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย (หรือข้าพเจ้าอนุญาตให้ผู้วิจัยเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่างๆ ที่เกี่ยวข้องตามที่ผู้วิจัยเห็นสมควร)
- ข้าพเจ้ายืนยันว่า ข้าพเจ้ามีอายุ 20 ปีบริบูรณ์ หรือมากกว่า
- ข้าพเจ้ายินดีเข้าร่วมการศึกษานี้ ภายใต้เงื่อนไขที่ได้ระบุไว้แล้วในข้างต้น

ลงนามประชากรตัวอย่าง ....
หรือผู้มีส่วนร่วมในการวิจัย ( ) สถานที่ / วันที่

ลงนามผู้วิจัยหลัก ....
(นายประพัฒณ์ สิริประภาพร) สถานที่ / วันที่

ลงนามพยาน ....
( ) สถานที่ / วันที่

เบอร์โทรศัพท์สำหรับติดต่อ .....

A IV Visual Analogue Scale (VAS) (Thai)

กรุณาทำเครื่องหมาย Ⅰ ลงบนเส้นด้านล่าง เพื่อแสดงระดับความเจ็บปวดของคุณ

ไม่มีอาการ
เจ็บปวดเลย

เจ็บปวดมากที่สุด
เท่าที่จินตนาการได้

A V Neck Disability Index (NDI) (Thai)

ดัชนีชี้วัดการจำกัดการทำกิจกรรมจากอาการปวดคอ

คำชี้แจง: แบบสอบถามนี้ถูกออกแบบขึ้นเพื่อให้ข้อมูลกับผู้รักษาว่าอาการปวดคอมีผลต่อการทำกิจวัตรประจำวันของคุณอย่างไร กรุณาตอบแบบสอบถามทุกข้อ หากมีตัวเลือกที่ตรงกับคุณมากกว่าหนึ่งข้อ
โปรดทำเครื่องหมายหน้าตัวเลือกที่บรรยายลักษณะใกล้เคียงกับคุณมากที่สุดเพียงข้อเดียว

1. **ระดับความเจ็บปวด**
   - ในขณะนี้ ฉันไม่มีอาการปวดเลย
   - ในขณะนี้ ฉันมีอาการปวดเล็กน้อย
   - ในขณะนี้ ฉันมีอาการปวดปานกลาง
   - ในขณะนี้ ฉันมีอาการปวดค่อนข้างรุนแรง
   - ในขณะนี้ ฉันมีอาการปวดรุนแรงมาก
   - ในขณะนี้ ฉันมีอาการปวดมากที่สุดเท่าที่จะจินตนาการได้

2. **การดูแลตัวเอง (เช่น การอาบน้ำ การแต่งตัว เป็นต้น)**
   - ฉันสามารถดูแลตัวเองได้ตามปกติ โดยไม่มีอาการปวดเพิ่มขึ้น
   - ฉันสามารถดูแลตัวเองได้ตามปกติ แต่มีอาการปวดเพิ่มขึ้น
   - ในขณะที่ดูแลตัวเองฉันมีอาการปวด ฉันต้องทำช้าๆ ด้วยความระมัดระวัง
   - ฉันสามารถดูแลตัวเองได้เป็นส่วนใหญ่ แต่ต้องการความช่วยเหลือบ้าง
   - ฉันต้องการความช่วยเหลือในทุกๆวัน ในการดูแลตัวเองเกือบทุกอย่าง
   - ฉันไม่สามารถแต่งตัวเองได้ ฉันอาบน้ำด้วยความลำบากและนอนอยู่บนเตียงเป็นส่วนใหญ่

3. **การยกของ**
   - ฉันสามารถยกของหนักได้ โดยไม่มีอาการปวดเพิ่มขึ้น
   - ฉันสามารถยกของหนักได้ แต่จะทำให้อาการปวดเพิ่มขึ้น
   - ฉันไม่สามารถยกของหนักขึ้นจากพื้นได้เนื่องจากมีอาการปวด แต่ฉันสามารถยกของนั้นได้ ถ้ามันอยู่ในตำแหน่งที่สามารถยกได้สะดวก เช่น บนโต๊ะ
   - ฉันไม่สามารถยกของหนักขึ้นจากพื้นได้เนื่องจากอาการปวด แต่ฉันสามารถยกของที่มีน้ำหนักเบาถึงปานกลางได้ ถ้ามันอยู่ในตำแหน่งที่สามารถยกได้สะดวก
   - ฉันสามารถยกของที่เบาๆ ได้
   - ฉันไม่สามารถยกหรือถือของได้เลย

4. **การอ่านหนังสือ**

* ฉันสามารถอ่านได้มากเท่าที่ต้องการ โดยไม่มีอาการปวดคอ
* ฉันสามารถอ่านได้มากเท่าที่ต้องการ แต่มีอาการปวดคอเล็กน้อย
* ฉันสามารถอ่านได้มากเท่าที่ต้องการ แต่มีอาการปวดคอปานกลาง
* ฉันไม่สามารถอ่านได้มากเท่าที่ต้องการ เนื่องจากมีอาการปวดคอปานกลาง
* ฉันไม่สามารถอ่านได้มากเท่าที่ต้องการ เนื่องจากมีอาการปวดคอรุนแรง
* ฉันไม่สามารถอ่านได้เลย

5. **ปวดศีรษะ**

* ฉันไม่มีอาการปวดศีรษะใดๆ
* ฉันมีอาการปวดศีรษะเล็กน้อย แต่ไม่บ่อย
* ฉันมีอาการปวดศีรษะปานกลาง แต่ไม่บ่อย
* ฉันมีอาการปวดศีรษะปานกลาง บ่อยๆ
* ฉันมีอาการปวดศีรษะรุนแรง บ่อยๆ
* ฉันมีอาการปวดศีรษะเกือบตลอดเวลา

6. **การมีสมาธิ หรือความจดจ่อในการทำงาน**

* ฉันมีสมาธิเต็มที่ตามที่ต้องการโดยไม่ลำบาก
* ฉันมีสมาธิเต็มที่ตามที่ต้องการโดยมีความลำบากเล็กน้อย
* ฉันมีความลำบากปานกลาง เมื่อฉันต้องการมีสมาธิ
* ฉันมีความลำบากมาก เมื่อฉันต้องการมีสมาธิ
* ฉันมีความลำบากอย่างยิ่งยวด เมื่อฉันต้องการมีสมาธิ
* ฉันไม่มีสมาธิเลย

7. **การทำงาน หรือการประกอบอาชีพ**

* ฉันสามารถทำงานได้มากเท่าที่ต้องการ
* ฉันสามารถทำงานประจำได้ตามปกติ แต่ไม่สามารถทำเพิ่มได้
* ฉันสามารถทำงานประจำได้เป็นส่วนมาก แต่ไม่สามารถทำเพิ่มได้อีก
* ฉันไม่สามารถทำงานประจำตามปกติได้
* ฉันแทบจะไม่สามารถทำงานใดๆได้
* ฉันไม่สามารถทำงานใดๆได้เลย

8. **การขับรถ (ตอบเฉพาะผู้ที่ขับรถอยู่เป็นประจำ)**

* ฉันสามารถขับรถได้โดยไม่มีอาการปวดคอ
* ฉันสามารถขับรถได้นานเท่าที่ต้องการ แต่มีอาการปวดคอเล็กน้อย
* ฉันสามารถขับรถได้นานเท่าที่ต้องการ แต่มีอาการปวดคอปานกลาง
* ฉันไม่สามารถขับรถได้นานเท่าที่ต้องการ เนื่องจากมีอาการปวดคอปานกลาง
* ฉันเกือบจะขับรถไม่ได้ เนื่องจากมีอาการปวดคอรุนแรง
* ฉันไม่สามารถขับรถได้เลย

9. **การนอนหลับ**

* ฉันไม่มีปัญหาในการนอนหลับ
* การนอนหลับของฉันถูกรบกวน จากอาการปวดคอ เล็กน้อย (นอนไม่หลับ น้อยกว่า 1 ชั่วโมง)
* การนอนหลับของฉันถูกรบกวน จากอาการปวดคอ ไม่มาก (นอนไม่หลับ 1-2 ชั่วโมง)
* การนอนหลับของฉันถูกรบกวน จากอาการปวดคอ ปานกลาง (นอนไม่หลับ 2-3 ชั่วโมง)
* การนอนหลับของฉันถูกรบกวน จากอาการปวดคอ อย่างมาก (นอนไม่หลับ 3-5 ชั่วโมง)
* การนอนหลับของฉันถูกรบกวน จากอาการปวดคอ ตลอดคืน (นอนไม่หลับ 5-7 ชั่วโมง)

10. **กิจกรรมยามว่าง**

* ฉันสามารถทำกิจกรรมยามว่างได้ โดยไม่มีอาการปวดคอ
* ฉันสามารถทำกิจกรรมยามว่างได้ โดยมีอาการปวดคอเล็กน้อย
* ฉันสามารถทำกิจกรรมยามว่างได้เป็นส่วนมากแต่ไม่ทั้งหมด เนื่องจากมีอาการปวดคอ
* ฉันสามารถทำกิจกรรมยามว่างได้เล็กน้อย เนื่องจากมีอาการปวดคอ
* ฉันเกือบจะไม่สามารถทำกิจกรรมยามว่างใดๆได้ เนื่องจากมีอาการปวดคอ
* ฉันไม่สามารถทำกิจกรรมยามว่างใดๆได้เลย

I I I I I I I I I I

A VI Global Perceived Effect (GPE) (Thai)

กรุณาเลือกตัวเลขที่ระบุระดับ**อาการโดยรวม**ของคุณภายหลังจากการเข้าโปรแกรมการรักษา
(Global perceived effect)

1	อาการหายไปจนเป็นปกติ (Completely recovered)
2	อาการดีขึ้นมาก (Much improved)
3	อาการดีขึ้นเล็กน้อย(Slightly improved)
4	อาการคงที่ไม่เปลี่ยนแปลง (No change)
5	อาการแย่ลงเล็กน้อย (Slightly worsened)
6	อาการแย่ลงมาก (Much worsened)
7	อาการแย่ลงมากแบบที่ไม่เคยเป็นมาก่อน (Worse than ever)

A VII Participant's profile

Patient's profile

1. ชื่อ (นาย, นาง, นางสาว) …… นามสกุล ……
2. อายุ ..... ปี น้ำหนัก ..... กิโลกรัม ส่วนสูง ..... เซนติเมตร
3. อาชีพ .....
4. ระยะเวลาที่เคยมีอาการปวดทั้งหมด ..... ปี ..... เดือน ..... วัน
5. คุณมีสภาวะต่อไปนี้หรือไม่

ก.	ตั้งครรภ์	* ไม่มี	* มี .....
ข.	มีไข้	* ไม่มี	* มี .....
ค.	กระดูกพรุน	* ไม่มี	* มี .....
ง.	อุบัติเหตุบริเวณคอ	* ไม่มี	* มี .....
จ.	กระดูกหักบริเวณคอ	* ไม่มี	* มี .....
ฉ.	ประวัติการผ่าตัดบริเวณคอ	* ไม่มี	* มี .....
ช.	Cervical instability	* ไม่มี	* มี .....
ซ.	Rheumatoid arthritis	* ไม่มี	* มี .....
ฌ.	Ankylosing spondylitis	* ไม่มี	* มี .....
ญ.	Migraine	* ไม่มี	* มี .....
ฎ.	มีประวัติเนื้องอก	* ไม่มี	* มี .....
ฏ.	VBI	* ไม่มี	* มี

   * Dizziness * Diplopia * Dysarthria * Dysphagia
   * Tinnitus * Drop attack

6. คุณเคยได้รับการวินิจฉัยจากบุคลากรทางการแพทย์ด้วยโรคใดหรือไม่
   * ไม่เคย
   * เคย ระบุ.....
7. คุณเคยได้รับการถ่ายรังสี หรือการตรวจ MRI หรือ CT scan หรือไม่
   * ไม่เคย
   * เคย เมื่อวันที่ ..... ผล.....

8. คุณกำลังรับประทาน หรือใช้ยาใดหรือไม่
   * ไม่ใช้
   * ใช้ ระบุ .....
9. ภายใน 6 เดือนนี้ คุณเคยมีอาการปวดคอที่ต้องการการรักษา และต้องลาหยุดงานหรือไม่
   * ไม่เคย
   * เคย ระบุ .....
10. ใน**ขณะนี้**คุณมีอาการปวดคอหรือไม่
    * ไม่มี
    * มี โดยมีอาการปวดคอ**ครั้งนี้**ติดต่อกันเป็นเวลานาน ..... ปี ..... เดือน ..... วัน
11. กิจกรรมใดทำให้อาการปวดคอเพิ่มขึ้น

    .....
12. กิจกรรมใดทำให้อาการปวดคอลดลง

    .....
13. คุณได้ทำการรักษาอย่างไรบ้าง
    * ไม่ได้ทำการรักษา
    * พบแพทย์ และได้รับการรักษาด้วย .....

    .....
    * พบนักกายภาพบำบัด และได้รับการรักษาด้วย .....

    .....
14. คุณคิดว่า อาการปวดคอนี้มีสาเหตุจากอะไร

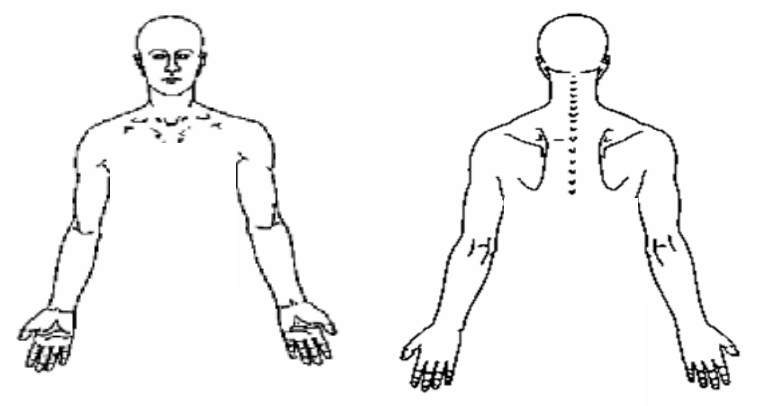
    .....

I I I I I I I I I

A VIII Before treatment form

Before treatment

1. กรุณาระบุบริเวณ และลักษณะอาการในขณะนี้บนแผนภูมิ



2. กรุณาทำเครื่องหมาย I ลงบนเส้นด้านล่าง เพื่อแสดงระดับความเจ็บปวดของคุณ

ก. ระดับความเจ็บปวดในขณะนี้

ไม่มีอาการเจ็บปวดเลย — เจ็บปวดมากที่สุดเท่าที่จินตนาการได้

ข. ระดับความเจ็บปวดเมื่อทำการเคลื่อนไหวคอในทิศทางที่ก่อให้เกิดความเจ็บปวดมากที่สุด

ไม่มีอาการเจ็บปวดเลย — เจ็บปวดมากที่สุดเท่าที่จินตนาการได้

3. ช่วงการเคลื่อนไหวของคอก่อนการรักษา

Motion	ROM (degrees)	Worst movement
Flexion		
Extension		
Left lateral flexion		
Right lateral flexion		
Left rotation		
Right rotation		

A IX Instruction for cervical range of motion (ROM) measurement

ผู้ทำการวัดเริ่มกระบวนการวัดองศาการเคลื่อนไหวของกระดูกสันหลังส่วนคอ โดยอธิบายให้ผู้เข้าร่วมงานวิจัยทราบขั้นตอนพร้อมทั้งแสดงภาพตัวอย่างการเคลื่อนไหวในท่าต่างๆไปพร้อมๆกัน ดังนี้

“ในการวัดองศาการเคลื่อนไหว ดิฉันจะสวมเครื่องมือที่เห็นอยู่เข้ากับศีรษะและคอ โดยจะให้คุณนั่งตัวตรงตามองตรงไปที่กระจกด้านหน้าไม่หันซ้ายหันขวา ไม่ก้มตาหรือเอียงศีรษะไปข้างใดข้างหนึ่ง แล้วทำท่าต่างๆที่เห็นอยู่นี้ ในแต่ละท่าจะให้ซ้อมทำการเคลื่อนไหวก่อนหนึ่งครั้ง และจะวัดจริงสองครั้ง เวลาเคลื่อนไหวเคลื่อนไหวไปให้สุดช่วงการเคลื่อนไหวเท่าที่ทำได้แล้วให้หยุด รอจนกว่าดิฉันจะบอกให้กลับมายังจุดเริ่มต้นนะคะ”

จากนั้นผู้ทำการวัดสาธิตท่าทางที่จะทำการวัดทั้งหกท่า พร้อมสิ่งที่ควรระวังดังนี้

“เริ่มแรกดิฉันจะให้ก้มคอลงตามองพื้น ก้มลงไปให้มากที่สุดเท่าที่จะทำได้ปล่อยคอสบายๆไม่ต้องเกร็ง ก้มลงเฉพาะส่วนคอ หลังพิงพนักเก้าอี้ไว้ไม่ก้มตาม ท่าที่สองจะให้เงยคอขึ้นตามองเพดาน เงยขึ้นไปให้ได้มากที่สุดเท่าที่จะทำได้ไม่แอ่นหน้าอก ท่าที่สามคือเอียงคอไปด้านซ้าย ให้เอียงคอไปด้านซ้ายให้ได้มากที่สุดเท่าที่จะทำได้ ไหล่ขวาไม่ต้องยกตาม ท่าที่สี่คือเอียงคอไปด้านขวา ให้เอียงคอไปด้านขวาให้ได้มากที่สุดเท่าที่จะทำได้ ไหล่ซ้ายไม่ต้องยกตาม ท่าต่อไปคือหันคอไปด้านซ้าย ให้หันคอไปด้านซ้ายให้ได้มากที่สุดเท่าที่จะทำได้ หันไปเฉพาะส่วนคอไหล่ขวาพิงพนักไว้ไม่เคลื่อนไหวลำตัว และท่าสุดท้ายคือหันคอไปด้านขวา ให้หันคอไปด้านขวาให้ได้มากที่สุดเท่าที่จะทำได้ หันไปเฉพาะส่วนคอไหล่ซ้ายพิงพนักไว้ไม่เคลื่อนไหวลำตัวนะคะ”

จากนั้นให้ผู้เข้าร่วมงานวิจัยนั่งตัวตรงบนเก้าอี้ไม้ หลังส่วนล่างชิดพนักพิง สวมเครื่องมือและจัดท่าเริ่มต้นให้

1. Flexion จากท่าเริ่มต้นให้ผู้วัดออกคำสั่งดังนี้ “ก้มคอลงตามองพื้นนะคะ ก้มลงไปให้ได้มากที่สุดเท่าที่จะทำได้ปล่อยคอสบายๆไม่ต้องเกร็งค่ะ หลังพิงพนักเก้าอี้ไว้ไม่ก้มตาม นิ่งๆนะคะ เงยหน้ากลับค่ะ” เมื่อผู้เข้าร่วมงานวิจัยทำได้ถูกต้องแล้วจึงทำการวัดเพื่อเก็บข้อมูลจริงอีกสองครั้ง โดยใช้คำสั่งเดิมซ้ำ

2. Extension จากท่าเริ่มต้นให้ผู้วัดออกคำสั่งดังนี้ “เงยคอขึ้นตามองเพดานนะคะ เงยขึ้นไปให้ได้มากที่สุดเท่าที่จะทำได้ไม่แอ่นหน้าอก นิ่งๆนะคะ ก้มคอกลับค่ะ” เมื่อผู้เข้าร่วมงานวิจัยทำได้ถูกต้องแล้วจึงทำการวัดเพื่อเก็บข้อมูลจริงอีกสองครั้ง โดยใช้คำสั่งเดิมซ้ำ

3. Left lateral flexion จากท่าเริ่มต้นให้ผู้วัดออกคำสั่งดังนี้ “เอียงคอไปด้านซ้ายนะคะ เอียงไปให้ได้มากที่สุดเท่าที่จะทำได้ไหล่ขวาไม่ต้องยก นิ่งๆนะคะ เอียงคอกลับค่ะ”

4. Right lateral flexion จากท่าเริ่มต้นให้ผู้ทำการวัดออกคำสั่งดังนี้“เอียงคอไปด้านขวานะคะ เอียงไปให้ได้มากที่สุดเท่าที่จะทำได้ไหล่ซ้ายไม่ต้องยก นิ่งๆนะคะ เอียงคอกลับค่ะ”

5. Left rotation จากท่าเริ่มต้นให้ผู้ทำการวัดออกคำสั่งดังนี้ “หันคอไปด้านซ้ายนะคะ หันไปให้ได้มากที่สุดเท่าที่จะทำได้ไหล่ขวาพิงพนักไว้ไม่เคลื่อนไหวลำตัวนะคะ นิ่งๆนะคะ หันคอกลับค่ะ”

6. Right rotation จากท่าเริ่มต้นให้ผู้ทำการวัดออกคำสั่งดังนี้ “หันคอไปด้านขวานะคะ หันไปให้ได้มากที่สุดเท่าที่จะทำได้ไหล่ซ้ายพิงพนักไว้ไม่เคลื่อนไหวลำตัวนะคะ นิ่งๆนะคะ หันคอกลับค่ะ”

ในแต่ละท่าจะให้ผู้เข้าร่วมงานวิจัยทำหนึ่งครั้งเพื่อเป็นการซ้อมก่อน เมื่อผู้เข้าร่วมงานวิจัยสามารถทำท่าได้ถูกต้องแล้ว จะทำการออกคำสั่งให้ทำซ้ำอีกสองครั้งเพื่อเก็บข้อมูลจริง

A X After treatment form

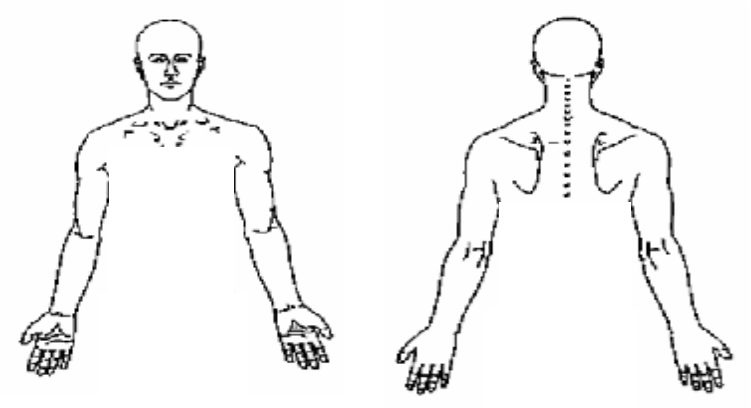
After treatment

Cervical level …… Grade ……. Set …… * Stiffness * Pain

Cervical level …… Grade ……. Set …… * Stiffness * Pain

Cervical level …… Grade ……. Set …… * Stiffness * Pain

1. กรุณาระบุบริเวณ และลักษณะอาการในขณะนี้บนแผนภูมิ



2. กรุณาระบุระดับความเจ็บปวดของคุณ

ค. ระดับความเจ็บปวดในขณะนี้ ……

ง. ระดับความเจ็บปวดในทิศทางที่ก่อให้เกิดความเจ็บปวดมากที่สุด ……

3. ช่วงการเคลื่อนไหวของคอหลังการรักษา

Motion	ROM (degrees)	Worst movement
Flexion		
Extension		
Left lateral flexion		
Right lateral flexion		
Left rotation		
Right rotation		

A XI Data collection form for intra-observer reliability study

การทดลองวัดความน่าเชื่อถือในการวัด

ช่วงการเคลื่อนไหวของกระดูกสันหลังระดับคอด้วย

Cervical Range of Motion Instrument

ID …… Date …….. / …….. / 2007

ชื่อ (นาย, นาง, นางสาว) ..... นามสกุล .....

อายุ ..... ปี น้ำหนัก ..... กิโลกรัม ส่วนสูง ..... เซนติเมตร

Motion	ROM (degrees) First repetition	ROM (degrees) Second repetition
Flexion		
Extension		
Left lateral flexion		
Right lateral flexion		
Left rotation		
Right rotation		

A XII Normal cervical range of motion

Cervical movement	Cervical range of motion (degrees)	
	30 – 39 year	40 – 49 year
Flexion	47.3	49.5
Extension	68 - 78	62 - 77
Left lateral flexion	41 - 43	35 - 41
Right lateral flexion	43 - 47	38 - 43
Left rotation	65 - 66	62 - 64
Right rotation	67 - 72	65 - 70

APPENDIX B

PILOT STUDY

B I Introduction

CROM is an instrument specifically designed for measuring cervical ROM. Its validity and reliability have been well established as presented in Section 3.4.2. However, as reliability is population specific, it is recommended that each study should also establish its own reliability. Therefore, the aim of this pilot study was to determine the intra-observer reliability of the CROM for measuring cervical ROM in participants with central and/or bilateral neck pain.

B II Study design

A test-retest research design was used to evaluate the intra-observer reliability of the CROM for all cervical movements. Ethical approval was granted by the Ethical Review Committee for Research Involving Human Subjects and/or Use of Animal in Research, Health Science Group of Faculties, Colleges and Institutes, Chulalongkorn University, Thailand (Appendix AI). Informed consent was obtained from each participant prior to entry into this study (Appendix AIII).

B III Participants

Ten participants with central and/or bilateral neck pain were recruited into this study. The inclusion and the exclusion criteria were the same as those described in Section 3.3.1.

B IV Materials

This study used the same instruments for measuring cervical ROM as described in Section 3.4.

B V Procedure

All participants were required to have their cervical ROM measured in two sessions with 5-minute rest in between. The measurement procedure described in Section 3.5 was followed. In brief, all participants were measured in sitting by the same assessor who carried out the measurement in the main study. The participants were instructed to perform two repetitions of cervical movements in each direction in the following order: flexion, extension, left lateral flexion, right lateral flexion, left rotation, and right rotation and both data were recorded. Next, the CROM was removed and the participants were asked to move around in the laboratory. After five minutes, the participants returned to sit in the same position and the CROM was reset on their head. The same procedure was then followed. To blind the assessor from previous data recorded from the first session, the data from the second session were recorded

on the separate sheet (Appendix AXI). For each cervical movement, four data were therefore obtained.

B VI Data analysis

Data for each cervical movement were analyzed with SPSS software package for Windows. One-way repeated measures ANOVA was performed to examine whether there were any significant differences in cervical ROM among the four values obtained from those two sessions of the measurement. For all comparisons, $p < 0.05$ were considered as statistical significance.

When there were no statistically significant differences among the four values, the data recorded from both sessions were paired. One was the paired between the first repetition data from both sessions and the other was between the second repetition data from both sessions. Two pairs of data were then obtained and tested with the intraclass correlation coefficient ($ICC_{(2,1)}$). This was to examine the reliability of the cervical ROM measured on each repetition between sessions. The ICC values were considered as no reliability with the values less than 0.25, fair reliability with the values from 0.25 – 0.50, good reliability with the values from 0.51 – 0.75, and substantial or high reliability with the values greater than 0.75 (Portney and Watkins, 2000). The pair which showed the higher ICC values would then be used for further calculation of standard error of measurement (SEM) and MDC. SEM is defined as an amount that cervical ROM could vary when it was tested multiple times (Scherer and Wilson, 2007). It is calculated as $SD\sqrt{(1-r)}$ where SD is a standard deviation of the sets of cervical ROM and r is a reliability coefficient of the ICC (Leggin et al., 2003).

In order to establish the magnitude of the change in cervical ROM that represents the true change, the MDC was calculated (Scherer and Wilson, 2007). It is an amount that exceeds the measurement error which is calculated as [1.96 × SEM × √2] (Leggin et al., 2003).

B VII Results

Ten participants (one male and nine females; 21 – 60 years old; mean 40.3; SD 11.3) participated in this study. Their means (SDs) height and weight were 1.58 (7.6) meters and 57.0 (4.8) kilograms, respectively. One-way repeated measures ANOVA demonstrated no significant differences in cervical ROM among the four values obtained from the two sessions of the measurement ($p < 0.05$) (Table BI). The $ICC_{(2,1)}$ values calculated from the first repetition data of each session ranged from 0.88 – 0.97 while the values calculated from the second repetition data of each session ranged from 0.89 – 0.98. The MDC values were then calculated from the ICC values of the second repetition data and demonstrated the range of 0.78 – 2.12 degrees (Table BI).

Table BI: The intraclass correlation coefficient ($ICC_{(2,1)}$) values and minimal detectable change (MDC) of the cervical range of motion from the second repetition data (n = 10).

Movement	ICC	SEM	MDC (degrees)	*p*-value
Flexion	0.96	0.35	0.96	0.598
Extension	0.97	0.46	1.28	0.476
Left lateral flexion	0.94	0.60	1.67	0.694
Right lateral flexion	0.96	0.33	0.91	0.473
Left rotation	0.98	0.28	0.78	0.870
Right rotation	0.89	0.77	2.12	0.083

B VIII Discussion

The intra-observer reliability of the cervical ROM measurement in this study was high with the ICCs in all directions over 0.89. This current results were consistent with the results of previous studies conducting in asymptomatic subjects with ICCs ranging from 0.92 – 0.96 (Hole et al., 1995) and Pearson's *r* correlation ranging from 0.62 – 0.91 (Capuano-Pucci et al., 1991). The results of this current study suggest that the measurement protocol for cervical ROM with CROM and the assessor of this study are reliable. Although there were slightly higher ICC values of the data recorded from the second repetition in comparison with those data recorded from the first repetition, the cervical ROM measurement obtained from both repetitions could be used. In this study, the first repetition could be performed as a practice repetition whereas the second repetition data could be recorded for further analysis. In addition, the nonsignificant differences among the cervical ROM values obtained between sessions suggest that the order of the cervical movement has no effect on the results.

The high intra-observer reliability also reflects through the small MDC values of less than three degrees for all six directions of the cervical ROM measurement. This indicates that the changes in excess of three degrees are required to confidently state that an intervention has had an influence on the cervical ROM.

B IX Conclusion

CROM was a feasible instrument for assessing the cervical ROM in patients with central and/or bilateral neck pain. The intra-observer reliability of the cervical ROM measurement in this study was high. The data of cervical ROM obtained on the second repetition could be used for investigating any intervention effects. In this study, the changes in cervical ROM over three degrees would therefore be considered to be meaningful.

B X References

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APPENDIX C

DATA OF PILOT STUDY

Table CI Demographic data of participants (*n* = 10)

Participants	Sex	Age (year)	Height (meter)	Weight (kilogram
1	Female	60	152	50
2	Female	46	151	47
3	Female	33	162	55
4	Female	39	160	60
5	Female	46	154	63
6	Male	21	175	58
7	Female	36	161	59
8	Female	32	162	58
9	Female	37	150	56
10	Female	53	159	62

Table CII Cervical flexion and extension ROM (*n* = 10)

	Cervical flexion (degree)				**Cervical Extension (degree)**			
Participants	**First Session**		**Second Session**		**First Session**		**Second Session**	
	1	**2**	**1**	**2**	**1**	**2**	**1**	**2**
1	44	44	42	42	44	44	46	46
2	52	52	52	52	88	88	88	88
3	58	58	56	56	74	76	74	74
4	48	46	48	46	68	68	62	64
5	46	48	48	48	64	64	62	64
6	58	58	56	58	74	74	76	76
7	44	44	42	42	70	70	72	72
8	50	50	50	50	72	72	68	68
9	36	36	38	40	62	62	60	62
10	50	50	48	50	60	58	60	62

Table CIII Cervical left and right lateral flexion ROM (*n* = 10)

Participants	Cervical Lt. lateral flexion (degree)				Cervical Rt. lateral flexion (degree)			
	First Session		Second Session		First Session		Second Session	
	1	2	1	2	1	2	1	2
1	30	30	30	30	32	32	30	32
2	42	42	44	44	40	40	40	42
3	52	52	50	50	52	52	54	54
4	42	42	40	40	38	38	38	40
5	42	42	38	38	32	32	30	30
6	40	40	42	42	40	40	40	42
7	52	52	56	56	42	42	42	42
8	40	40	38	38	42	42	42	42
9	40	40	40	40	38	38	40	40
10	46	48	46	46	44	42	42	40

Table CIV Cervical left and right rotation ROM (*n* = 10)

Participants	Cervical Lt. rotation (degree)				Cervical Rt. rotation (degree)			
	First Session		Second Session		First Session		Second Session	
	1	2	1	2	1	2	1	2
1	62	60	60	60	64	66	66	68
2	88	88	88	88	70	72	74	74
3	82	82	80	80	72	72	76	76
4	60	60	64	64	62	62	64	66
5	60	60	62	62	66	66	68	66
6	62	62	64	64	60	58	60	60
7	62	62	62	62	62	62	62	62
8	60	64	60	64	64	64	60	60
9	64	64	64	62	68	68	70	70
10	72	72	70	70	68	68	70	70

APPENDIX D

DATA OF MAIN STUDY

Table DI Demographic data of participants (*n* = 28)

Participants	Sex	Age (year)	Height (centimeter)	Weight (kilogram)
1	Female	47	160	70
2	Female	42	166	76
3	Male	36	170	69
4	Female	39	156	62
5	Female	20	165	50
6	Female	33	155	50
7	Male	56	165	64
8	Female	22	166	64
9	Male	21	175	58
10	Male	28	190	68
11	Male	53	167	57
12	Male	36	170	69
13	Male	35	165	63
14	Female	33	162	55
15	Female	58	152	63
16	Female	36	161	59
17	Female	23	160	52
18	Female	24	160	68
19	Female	27	163	50
20	Female	37	150	56
21	Female	54	153	60
22	Female	51	158	50
23	Female	45	163	65
24	Female	42	149	48
25	Female	38	152	44
26	Female	36	152	60
27	Female	41	162	51
28	Female	50	165	50

Table DII Pain at rest (millimeters) (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	76	67														
2	35	15	49	40												
3	22	16	64	39	33	17										
4	38	33	32	30	28	21										
5	35	34	27	25	22	21	19	17								
6	48	42	45	43	56	50	46	42								
7	65	65	63	59	59	56	70	68	64	61						
8	40	35	45	39	0	0	0	0	0	0						
9	22	18	21	18	20	17	19	16	22	19						
10	68	42	42	34	29	26	36	27	28	25	26	24				
11	43	10	40	22	19	4	0	0	5	0	2	0	2	0	7	0
12	31	22	0	0	5	0	7	4	6	2	3	1	2	2	3	2
13	29	6	16	9	4	4	45	30	6	0	0	0	0	0	0	0
14	51	50	30	29	49	9	51	26	2	1	0	0	0	0	0	0
15	53	52	48	54	56	43	50	47	46	44	57	46	0	0	3	1
16	67	69	74	60	42	42	47	35	30	27	28	28	0	0	0	0
17	29	15	25	16	24	12	19	8	7	4	16	7	16	4	12	9
18	28	25	25	24	6	8	16	0	13	11	0	0	23	18	0	0
19	28	19	0	0	0	0	2	0	0	0	2	5	8	1	0	0
20	22	18	18	16	22	18	9	8	14	12	14	13	13	12	12	10
21	59	54	55	47	44	42	28	0	26	25	37	36	31	24	11	9
22	36	0	0	0	35	7	26	5	18	2	8	1	2	0	24	5
23	71	41	69	67	43	41	67	55	56	56	57	57	60	60	52	49
24	47	38	34	30	23	21	25	21	19	18	18	13	9	7	0	0
25	25	21	21	14	13	9	10	7	0	0	4	1	0	0	0	0
26	34	30	27	27	23	21	10	9	0	0	0	0	0	0	0	0
27	52	46	38	36	45	32	31	14	13	11	8	6	8	4	3	1
28	35	25	42	29	35	30	40	36	24	19	25	19	16	11	8	3

Pre = Pre-treatment, Post = Post-treatment

Table DIII Pain on worst movement (millimeters) (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	77	69														
2	80	47	60	55												
3	41	23	82	52	43	25										
4	51	39	24	22	24	16										
5	51	48	32	31	30	28	24	22								
6	54	48	58	55	61	57	53	49								
7	83	83	77	72	71	67	74	69	62	57						
8	49	44	65	55	36	23	16	16	17	16						
9	33	30	36	34	33	31	29	26	34	29						
10	76	53	66	54	48	43	45	31	40	35	31	26				
11	69	67	64	38	37	13	15	4	19	5	19	1	15	2	18	1
12	59	37	12	12	32	0	37	34	18	10	12	6	15	13	10	8
13	66	18	46	30	27	24	50	50	14	2	7	4	2	0	1	0
14	63	56	48	60	58	6	49	48	18	2	0	0	0	0	0	0
15	64	69	61	63	65	58	60	55	47	42	61	54	38	35	19	12
16	89	54	68	65	58	58	73	58	50	28	29	16	12	5	8	8
17	43	23	30	26	26	15	15	8	6	6	24	9	24	7	18	4
18	49	46	45	31	23	22	27	3	12	11	0	0	25	19	13	8
19	46	48	21	13	5	0	5	4	6	8	6	10	14	4	1	0
20	26	22	23	16	26	18	17	16	18	16	19	19	16	15	15	12
21	77	58	70	63	57	50	44	44	38	32	44	1	36	32	12	9
22	64	39	39	21	66	52	43	24	26	19	32	25	28	16	35	13
23	94	87	79	78	57	54	69	67	69	69	70	70	66	62	58	55
24	73	64	59	55	47	44	44	38	22	21	21	16	13	10	1	0
25	31	28	21	19	18	15	13	12	8	7	7	2	4	2	3	1
26	55	55	54	52	37	35	25	25	8	8	8	4	1	0	0	0
27	72	75	69	67	69	42	39	32	30	28	27	24	26	23	19	12
28	55	50	50	42	39	33	38	35	33	29	33	28	25	21	16	5

Pre = Pre-treatment, Post = Post-treatment

Table DIV Cervical flexion ROM (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	56	54														
2	38	48	50	54												
3	52	50	60	60	60	62										
4	36	30	34	32	40	48										
5	60	60	64	68	62	60	62	60								
6	52	42	50	38	48	48	46	58								
7	44	46	44	44	46	44	44	42	42	46						
8	54	50	60	60	56	50	50	48	52	60						
9	58	58	60	60	66	60	70	72	62	66						
10	50	48	48	44	44	44	50	46	48	48	52	48				
11	56	54	44	52	48	50	46	40	42	44	44	52	54	50	48	50
12	54	60	64	60	62	62	56	64	64	62	58	62	64	70	60	60
13	70	60	66	66	64	56	62	72	70	66	64	66	64	64	68	68
14	60	60	62	62	68	58	56	60	64	68	64	64	70	66	64	66
15	46	48	54	50	50	52	52	56	52	50	50	52	56	56	54	60
16	50	54	46	52	44	44	42	40	40	50	46	46	50	50	54	40
17	52	50	64	66	58	56	60	56	60	56	50	48	54	54	56	50
18	58	54	52	46	56	56	51	46	48	42	50	48	48	46	46	46
19	50	46	44	42	40	40	40	34	36	40	40	34	38	36	44	34
20	30	28	40	36	38	38	40	42	50	44	46	52	42	42	38	36
21	34	42	40	42	34	38	42	40	44	38	44	42	40	44	40	40
22	48	44	50	50	42	44	48	48	50	50	50	50	50	50	48	46
23	34	42	38	38	40	48	34	48	40	40	46	46	42	44	42	50
24	34	42	44	42	46	46	48	48	50	54	46	46	50	50	52	54
25	46	50	54	46	50	50	50	54	50	52	50	50	68	50	50	50
26	48	46	42	44	46	52	50	48	44	52	44	46	52	54	50	58
27	64	64	62	66	64	64	64	64	50	56	60	62	58	60	62	62
28	50	50	42	48	44	50	52	52	50	56	60	60	58	60	56	62

Pre = Pre-treatment, Post = Post-treatment

Table DV Cervical extension ROM (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	70	66														
2	72	78	64	70												
3	54	68	70	72	62	68										
4	68	68	64	56	68	66										
5	50	48	50	46	50	52	50	50								
6	86	76	76	68	78	80	74	74								
7	70	64	62	66	60	62	70	66	62	66						
8	82	68	66	64	70	62	68	62	64	64						
9	74	76	78	78	64	74	70	74	72	76						
10	92	92	84	88	88	92	82	90	90	90	88	94				
11	58	54	60	60	58	60	54	54	56	52	48	52	50	48	52	50
12	80	80	80	76	74	76	74	76	74	70	80	82	80	80	80	82
13	72	70	70	74	70	70	74	70	76	72	76	66	76	76	72	72
14	82	74	82	88	76	84	74	76	78	78	84	86	88	86	92	86
15	58	54	48	56	52	54	50	52	54	60	50	58	56	56	56	54
16	74	82	70	70	70	62	74	80	86	86	72	82	78	80	80	86
17	72	58	66	76	76	72	70	60	66	60	68	60	66	70	64	64
18	62	58	56	50	60	58	62	66	62	60	60	60	56	60	58	56
19	88	80	82	78	90	90	84	74	82	86	80	76	82	86	78	80
20	72	62	62	56	60	62	62	60	70	74	70	64	72	64	62	62
21	78	70	72	74	70	70	68	70	64	68	64	70	70	68	70	72
22	86	82	76	74	70	70	72	70	70	76	74	72	76	70	70	74
23	38	50	46	40	58	66	48	50	42	42	50	48	42	46	40	46
24	76	78	74	80	70	70	62	62	70	66	64	68	64	70	68	70
25	80	86	80	82	80	82	84	84	80	80	82	84	84	84	80	82
26	62	50	52	46	60	60	64	58	64	68	62	64	68	70	70	72
27	62	56	54	56	50	50	52	52	50	50	60	64	50	50	50	50
28	94	96	90	92	90	92	96	98	92	90	94	94	96	98	98	98

Pre = Pre-treatment, Post = Post-treatment

Table DVI Cervical left lateral flexion ROM (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	52	40														
2	40	44	36	42												
3	50	54	58	66	54	60										
4	38	32	36	34	42	34										
5	38	40	38	36	40	40	40	44								
6	42	36	46	40	40	42	40	40								
7	40	38	40	42	46	42	44	42	38	34						
8	38	34	34	36	34	38	36	36	38	38						
9	40	44	46	52	42	48	52	52	46	50						
10	42	40	38	40	44	44	50	48	40	44	42	44				
11	44	46	48	48	38	38	40	36	40	32	30	26	36	32	30	32
12	50	50	50	54	58	56	54	54	52	48	50	52	54	52	60	58
13	40	46	50	54	52	50	52	52	58	60	34	50	60	52	54	56
14	54	54	52	56	60	56	50	56	60	60	58	60	60	62	58	62
15	28	26	26	30	32	30	26	30	30	32	28	32	26	32	28	38
16	60	62	60	60	52	54	60	60	58	60	60	58	58	52	44	50
17	40	42	50	50	46	44	42	42	44	40	46	40	40	36	42	42
18	48	44	42	36	48	46	42	44	40	40	44	40	40	40	40	36
19	44	38	48	40	48	40	36	34	38	40	38	36	36	38	40	36
20	34	38	34	36	38	46	40	40	34	40	40	40	42	44	40	40
21	40	40	42	46	40	42	44	48	40	40	44	40	50	50	48	48
22	50	48	44	44	42	40	40	48	44	44	44	36	42	44	44	46
23	40	40	32	30	32	40	36	34	34	32	36	30	30	30	34	32
24	32	40	34	38	34	36	32	38	34	34	40	36	34	36	34	36
25	40	42	40	38	40	42	38	38	40	40	44	40	40	40	42	42
26	44	44	46	40	50	54	48	46	50	52	46	48	50	50	50	50
27	28	22	22	24	22	26	22	22	24	24	22	26	20	20	24	26
28	44	46	42	48	44	52	48	52	50	50	50	54	50	54	56	56

Pre = Pre-treatment, Post = Post-treatment

Table DVII Cervical right lateral flexion ROM (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	44	32														
2	38	42	40	38												
3	42	50	46	54	48	50										
4	38	40	36	28	40	34										
5	30	34	34	38	38	38	34	38								
6	36	32	36	34	32	34	34	34								
7	28	38	34	32	30	24	30	28	30	28						
8	44	42	40	42	42	42	46	42	40	46						
9	40	44	42	46	40	42	50	50	44	48						
10	42	40	44	46	42	48	46	46	46	44	48	44				
11	42	42	42	48	40	38	40	34	32	28	28	26	32	32	30	28
12	50	52	48	48	52	54	50	54	46	48	54	50	52	50	58	52
13	32	42	48	46	48	48	52	48	52	52	48	48	50	50	50	52
14	56	56	52	58	58	58	54	56	58	60	58	62	62	66	60	56
15	26	24	24	24	26	32	26	30	28	32	24	28	28	28	24	32
16	48	48	42	50	42	40	40	40	42	40	38	42	40	40	34	36
17	38	38	42	44	38	42	38	38	38	38	36	40	38	38	32	36
18	40	42	38	36	40	36	34	36	38	36	40	38	30	32	30	34
19	44	44	40	38	40	42	40	36	36	38	38	38	36	38	38	40
20	38	34	38	40	40	46	44	40	42	46	42	42	42	46	40	38
21	44	40	42	44	44	46	44	50	48	48	46	50	50	50	50	50
22	56	50	44	44	42	42	38	42	42	38	44	44	44	40	44	44
23	34	34	34	30	32	40	30	36	34	36	36	38	30	32	32	36
24	28	38	34	34	34	30	32	28	28	30	30	32	32	32	34	34
25	40	40	40	44	40	40	44	48	44	44	40	44	38	40	38	40
26	40	42	38	40	48	48	42	42	48	50	46	46	52	50	48	52
27	28	28	30	26	28	28	28	28	26	28	30	30	24	24	26	26
28	52	54	56	56	46	50	50	54	52	54	56	56	54	56	60	56

Pre = Pre-treatment, Post = Post-treatment

Table DVIII Cervical left rotation ROM (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	70	72														
2	58	68	68	68												
3	70	70	74	80	72	74										
4	60	58	60	60	62	60										
5	70	70	64	60	70	62	64	66								
6	62	60	60	48	50	50	52	58								
7	60	60	60	56	60	60	66	60	66	60						
8	60	60	64	70	60	70	74	70	74	70						
9	62	64	68	70	66	70	62	68	66	74						
10	74	64	72	68	74	70	70	68	70	64	68	66				
11	72	82	74	76	70	70	70	72	72	70	68	66	72	68	68	70
12	62	66	64	66	70	70	70	70	70	66	72	72	70	70	80	74
13	72	76	80	76	76	76	82	78	82	76	74	78	80	80	74	74
14	78	80	78	78	84	82	80	82	78	76	76	86	82	78	84	80
15	60	60	58	58	60	62	60	60	62	62	58	60	60	62	60	60
16	70	70	70	70	62	60	70	68	70	70	66	66	64	72	62	66
17	66	58	68	68	60	62	64	60	64	58	64	58	52	56	68	60
18	56	60	60	62	62	64	60	60	56	60	60	60	60	56	60	60
19	68	72	0	66	64	70	60	60	68	64	70	66	66	62	66	72
20	60	60	60	58	62	62	62	60	62	64	64	66	62	64	68	64
21	74	72	78	76	78	80	82	80	80	80	72	80	78	78	80	80
22	76	76	72	70	70	64	70	72	72	70	64	70	66	68	68	70
23	70	70	62	66	62	68	70	70	70	66	64	62	68	64	68	64
24	68	76	76	72	70	68	64	62	64	70	68	70	70	68	68	78
25	56	60	66	60	60	56	62	54	54	64	58	60	58	60	58	64
26	66	62	70	64	60	68	80	80	70	72	66	70	80	78	74	70
27	74	60	62	68	60	66	66	74	66	62	60	62	62	62	60	62
28	78	80	82	82	80	80	80	80	80	80	82	84	80	82	82	84

Pre = Pre-treatment, Post = Post-treatment

Table DIX Cervical right rotation ROM (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	64	64														
2	72	78	70	70												
3	74	72	72	70	80	76										
4	56	54	50	46	60	62										
5	62	60	66	68	62	62	66	62								
6	50	40	46	50	44	40	52	50								
7	60	60	62	60	60	58	62	60	60	60						
8	58	54	66	60	60	68	70	68	64	70						
9	58	62	60	60	60	60	62	62	60	58						
10	72	72	62	68	68	70	66	64	70	70	70	66				
11	80	76	72	72	70	70	72	72	64	66	70	70	72	68	70	74
12	70	70	68	66	70	68	70	72	68	70	72	72	74	72	76	72
13	80	74	76	74	82	78	80	80	78	84	84	80	82	80	84	82
14	80	72	76	76	76	72	76	72	70	72	72	76	76	80	74	74
15	54	50	56	52	54	58	56	60	62	58	58	58	60	58	60	62
16	60	62	60	60	62	60	60	60	60	60	60	60	60	62	66	64
17	70	60	70	66	60	74	70	64	62	56	70	68	56	58	64	60
18	60	58	64	70	64	64	58	56	62	60	60	64	54	58	60	60
19	62	60	56	60	62	60	56	54	52	60	52	56	54	52	60	58
20	50	60	50	58	58	60	60	60	54	64	60	70	64	62	68	68
21	74	76	72	78	74	74	70	76	76	74	76	76	78	78	70	76
22	70	74	72	76	64	76	64	70	68	62	70	70	70	66	64	70
23	78	74	72	68	70	70	72	74	76	72	76	76	70	72	72	76
24	64	70	68	72	72	70	70	70	66	68	62	60	66	62	68	76
25	62	58	60	60	62	60	60	62	56	56	60	60	58	64	58	62
26	72	70	70	72	72	76	76	74	76	78	78	82	80	80	78	74
27	60	58	54	52	60	56	60	54	50	56	60	62	58	60	60	60
28	70	70	78	78	70	74	76	76	78	83	84	82	80	80	80	80

Pre = Pre-treatment, Post = Post-treatment

Table DX Cervical ROM on worst movement (*n* = 28)

Participants	Appointment 1		Appointment 2		Appointment 3		Appointment 4		Appointment 5		Appointment 6		Appointment 7		Appointment 8	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	64	60														
2	40	44	36	42												
3	42	50	46	54	48	50										
4	36	30	50	46	40	34										
5	50	48	50	46	50	52	50	50								
6	50	40	46	40	32	34	74	74								
7	44	46	40	42	60	58	70	66	30	28						
8	38	34	40	42	42	42	46	42	40	46						
9	58	62	78	78	64	74	70	74	72	76						
10	74	64	44	46	42	48	46	46	46	44	48	44				
11	58	54	60	60	58	60	54	54	56	52	48	52	50	48	52	52
12	70	70	68	66	70	68	70	72	68	70	76	72	74	72	76	72
13	72	70	50	54	70	70	74	70	76	72	76	66	76	76	72	72
14	60	60	62	62	76	84	50	56	64	68	-	-	-	-	-	-
15	28	26	24	24	26	32	26	30	62	62	24	28	28	28	28	28
16	60	62	70	70	52	54	74	80	58	60	38	42	40	40	34	36
17	72	58	66	76	38	42	70	60	58	38	36	40	66	70	64	60
18	48	44	52	46	56	56	52	46	48	42	50	48	40	40	46	46
19	50	46	48	40	40	40	40	34	36	40	40	34	38	36	44	34
20	72	62	62	56	38	46	62	60	62	64	42	42	42	44	40	40
21	34	42	42	46	34	38	44	48	64	68	64	70	40	44	50	50
22	86	82	76	74	70	70	72	70	70	76	74	72	76	70	70	74
23	38	50	46	40	58	66	48	50	42	42	50	48	42	46	40	46
24	32	40	34	38	34	36	32	28	34	34	40	36	32	32	40	46
25	80	86	40	44	40	40	44	48	44	44	40	44	38	40	38	40
26	62	50	52	46	60	60	64	58	64	68	62	64	68	70	-	-
27	28	22	22	24	22	26	22	22	24	24	22	24	20	20	26	26
28	92	96	56	56	44	52	48	52	52	54	56	56	58	54	60	56

Pre = Pre-treatment, Post = Post-treatment

Table DXI Neck Disability Index (percentage) and Global Perceived Effects (*n* = 28)

Participants	NDI I	NDI II	NDI III	GPE I	GPE II
1	35.5	-	-	-	-
2	30	-	-	-	-
3	12	-	-	-	-
4	30	-	-	-	-
5	24.4	-	-	-	-
6	26.6	-	-	-	-
7	38	24	-	3	-
8	22.2	13.3	-	2	-
9	20	12	-	3	-
10	38	20	-	2	-
11	14	4	6	2	2
12	20	35.6	28.9	5	3
13	30	10	8	2	2
14	36	8	0	2	1
15	34	22	20	3	2
16	34	14	8	2	2
17	26.7	8.9	11.1	2	3
18	6.7	4.4	2.2	2	2
19	12	8	4	2	2
20	11.1	13.3	8.9	3	3
21	48.9	13.3	8.9	2	2
22	24.4	31.1	26	5	4
23	62	40	32	3	3
24	24.4	8.9	2.2	2	2
25	16	12	4	3	2
26	40	13.3	8.9	2	2
27	51.1	17.8	13.3	2	1
28	48	22	12	3	2

BIOGRAPHY

Mister Prapat Siriprapaporn was born on February 9, 1983 in Bangkok, Thailand. He graduated his high school from Debsirin School in 2001 and received his Bachelor degree of Science (Physical Therapy) in 2005 from the Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Bangkok, Thailand. He has enrolled in graduate program for Master degree of Musculoskeletal Physical Therapy Science at Chulalongkorn University since 2006