Sacroiliac Joint Mobilization Immediate Improved Clinical Features of Non-Specific Low Back Pain with Sacroiliac Joint Dysfunction
ผลทันทีของการขยับเคลื่อนข้อกระเบนเหน็บต่อลักษณะทางคลินิกของผู้ป่วยปวดหลังส่วนล่างแบบไม่เฉพาะเจาะจงซึ่งมีความผิดปกติของข้อกระเบนเหน็บร่วมด้วย

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ABSTRACT

The sacroiliac joint (SIJ) is an important primary source of low back pain (LBP). Sacroiliac joint dysfunction (SIJD) can be found in both symptomatic and asymptomatic adults, resulting in pain and limitation of degrees of lumbar spinal, and SIJ movement. SIJ mobilization is another method of physical therapy treatment supported by studies in several aspects, namely reducing pain and promoting the movement of SIJ. However, no previous study has evaluated the immediate effect of the SIJ mobilization on the lumbar spinal flexibility improvement. The purpose of this study was to investigate the immediate effects of SIJ mobilization on lumbar spinal flexibility, pain perception, and pressure pain threshold (PPT) in patients with non-specific low back pain (NSLBP) associated with SIJD. Sixteen participants (8 males and 8 females with a mean age of 39.3 ± 12.7 years) were randomly assigned into two groups. Experimental group was treated with SIJ mobilization 30 oscillations/ set, 3 sets/ one side (total within 4 minutes). The control group was instructed the same starting position (rest in side lying for 2 minutes/ side) as of the experimental group but just with the sham method. Both groups were immediately pre and post-treatment assessed lumbar spinal flexibility, pain perception level, and pressure pain threshold tested by Modified-modified Schober's test, Visual analog scale (VAS), and algometry. The results from t-test analysis indicated that experimental group had showed increasing of lumbar spinal flexibility significantly (p=0.007; 0.71±0.53) more than control group (p=0.07; 0.12±0.15) with signifi-

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cant difference between groups (p=0.008). Moreover, VAS had a significant decrease (p=0.001; 22.25±9.56) while PPT had a significant increase (p=0.001; 1.81±0.97), with significant difference between groups (p=0.001). In conclusion, the SIJ mobilization increases lumbar spinal flexibility, reduces pain, and improves pain threshold relating to parameters in non-specific low back pain with sacroiliac joint dysfunction patients.

บทคัดย่อ

ข้อกระเบนเหน็บ (Sacroiliac joint: SIJ) เป็นโครงสร้างสำคัญที่เป็นสาเหตุของอาการปวดหลังส่วนล่าง (low back pain; LBP) ความผิดปกติของข้อกระเบนเหน็บ (sacroiliac joint dysfunction; SIJD) พบได้ทั้งในผู้ที่มีอาการและไม่มีอาการปวดหลังส่วนล่าง อาจส่งผลให้เกิดอาการปวด และการจำกัดองศาการเคลื่อนไหวของกระดูกสันหลังบริเวณเอวและข้อกระเบนเหน็บได้ การขยับเคลื่อนข้อกระเบนเหน็บ (SIJ mobilization) เป็นอีกหนึ่งในวิธีการรักษาทางกายภาพบำบัด ซึ่งมีหลักฐานสนับสนุนผลของการศึกษาในหลายแง่มุม ได้แก่ สามารถลดอาการปวดและส่งเสริมการเคลื่อนไหวของข้อกระเบนเหน็บ อย่างไรก็ตามยังไม่มีการศึกษาใดที่ทำการศึกษาผลทันทีของการขยับเคลื่อนข้อกระเบนเหน็บต่อการเพิ่มความยืดหยุ่นของกระดูกสันหลังระดับเอว ของการศึกษาครั้งนี้มีวัตถุประสงค์เพื่อศึกษาผลทันทีของการขยับเคลื่อนข้อกระเบนเหน็บต่อความยืดหยุ่นของกระดูกสันหลังระดับเอว การรับรู้ความรู้สึกเจ็บปวด และระดับกั้นความเจ็บปวดจากแรงกดในผู้ป่วยปวดหลังส่วนล่างแบบไม่เฉพาะเจาะจงซึ่งมีความผิดปกติของข้อกระเบนเหน็บ โดยมีผู้เข้าร่วมวิจัยจำนวน 16 คน (ชาย 8 คน หญิง 8 คน อายุ 39.3 ± 12.7 ปี) โดยแบ่งอาสาสมัครแบบสุ่มเป็น 2 กลุ่ม กลุ่มทดลองได้รับการรักษาโดยการขยับเคลื่อนข้อกระเบนเหน็บทั้งสองข้าง 30 ครั้ง/เซ็ต 3 เซ็ต/ข้าง (ภายในระยะเวลา 4 นาที) ส่วนกลุ่มควบคุมได้รับจัดท่าเริ่มต้น (นอนพักในท่าตะแคงด้านละ 2 นาที) เหมือนกลุ่มทดลองทุกประการ โดยผู้วิจัยใช้มือสัมผัสบริเวณข้อกระเบนเหน็บทั้งสองด้าน แต่มิได้ส่งแรงกระทำแต่อย่างใด ทั้ง 2 กลุ่มจะได้รับการประเมินความยืดหยุ่นของกระดูกสันหลังส่วนเอว (lumbar spinal flexibility) ด้วยวิธีทดสอบ Modified-modified Schober ทดสอบการรับรู้ความรู้สึกเจ็บปวด (pain perception) ด้วยแบบประเมินความเจ็บปวด (visual analog scale: VAS) และทดสอบระดับกั้นความเจ็บปวดจากแรงกด (pressure pain threshold: PPT) ด้วยเครื่อง algometer ก่อนและหลังการทดลองทันที ผลการศึกษาเมื่อวิเคราะห์ข้อมูลด้วยสถิติ t-test พบว่ากลุ่มทดลองมีการเพิ่มขึ้นของความยืดหยุ่นของหลังระดับเอว (p=0.007; 0.71±0.53) มากกว่ากลุ่มควบคุม (p=0.07; 0.12±0.15) อย่างมีนัยสำคัญทางสถิติ (p=0.008) นอกจากนี้กลุ่มทดลองยังมีระดับ VAS ลดลง (p=0.001 ; 22.25±9.56) และค่า PPT เพิ่มขึ้น (p=0.001; 1.81±0.97) แตกต่างจากกลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ (p=0.001) สรุปผลการศึกษา การขยับเคลื่อนข้อกระเบนเหน็บสามารถเพิ่มความยืดหยุ่นโดยรวมของหลังระดับเอว ลดอาการปวดหลัง และเพิ่มระดับกั้นความเจ็บปวดจากแรงกดในผู้ป่วยปวดหลังส่วนล่างแบบไม่เฉพาะเจาะจงซึ่งมีความผิดปกติของข้อกระเบนเหน็บร่วมได้

Key Words : Sacroiliac joint mobilization, Lumbar spinal flexibility
คำสำคัญ : การขยับเคลื่อนข้อกระเบนเหน็บ ความยืดหยุ่นของหลังส่วนล่าง

Introduction

Low back pain (LBP) is one of the most common musculoskeletal problems in modern society, to which a reported lifetime prevails up to 90% in working age group [1]. The cause of LBP is usually found in lesion of the discs or the facet joints at the L4-L5 and L5-S1 levels but almost 50% of the LBP patients are without discogenic pain into the lower limbs. Clearly, the cause is neither the disc nor the facet joints [2]. Interestingly, some recent research papers have suggested that the sacroiliac joint (SIJ) is an important primary source of LBP [3-5]. The SIJ pain is divided into two types- *true SIJ pain* and *sacroiliac joint dysfunction (SIJD)*. True SIJ pain arising for well-established pathological reasons may necessitate medical treatment. For instance, SIJ infection, trauma, inflammatory conditions, degenerative diseases, metabolic conditions and tumor are characterized by non-specific, diffuse, and poorly localized pain [8]. SIJD is not associated with morphological and radiological abnormality. It can be found in both symptomatic and asymptomatic adults [6]. Prevalence of SIJD varies considerably anywhere between 10%-53% of the patients with LBP [6] and about 20% of asymptomatic adults [7]. Their symptoms are commonly observed in clinical practice, for example, pain in the region of the SIJ, the reproduction of pain by physical provocation stress tests, and the elimination of the pain by intra-articular injection. Moreover, SIJD can develop in any problem that places significant biomechanical stress through the lumbar spine and pelvis. It brings about ineffective stress absorption and leads to compensatory patterns above and below which results in an abnormal transmission load and LBP [9].

SIJ mobilization is another method of physical therapy. The advantages of the SIJ mobilization are reported in many aspects, such as decrease of LBP [6], restoring balance in joint kinematics (promoting balance in anterior and posterior tilt of the innominates), restoring pelvic symmetry, correcting the SIJ dysfunction, restoring muscle length, and increasing muscle strength in lumbopelvic and lower limb musculature [10]. To date, a few studies had evaluated the effects of SIJ mobilization on surrounding muscle length and strength. However, no study had evaluated the immediate effect of the SIJ mobilization on the lumbar spinal flexibility improvement.

As of the author opinion, the connective tissues might be shortened and tightened as the result of altered position of SIJ articulation. Moreover, based on the anatomical characteristics of the SIJ function it would link with the lumbar spine and the hip (lumbopelvic rhythm) and many muscles across the SIJ. Also SIJ mobilization would decrease lumbar spinal stress by restoring normal function of innominates, promote pelvic symmetry, correct the SIJD, and relax surrounding muscles of the SIJ. The purpose of this study was to evaluate immediate effects of SIJ mobilization on lumbar spinal flexibility, pain perception, and pressure pain

threshold (PPT) when compared with the control group in patients with non-specific low back pain (NSLBP) associated with SIJD. The benefits of the study provide immediate effects of the SIJ mobilization resulting in decreasing pain intensity and increasing lumbar spinal movement and claiming the SIJ mobilization as a treatment procedure in non-specific low back pain patients with sacroiliac joint dysfunction.

Materials and Methods

This study was a stratified randomized controlled trial research to determine immediate effects of sacroiliac joint (SIJ) mobilization on lumbar spinal flexibility, pain perception, and pressure pain threshold (PPT) of the erector spinae and gluteus maximus muscles in non-specific low back pain (NSLBP) patients with sacroiliac joint dysfunction (SIJD). It had been conducted at the Rehabilitation Medicine department Srinagarind hospital, Khon Kaen University, Thailand.

1. Participants

1.1 Inclusion criteria

- Low back pain (LBP) outpatients at the department of Rehabilitation Medicine of ages ranged between 20 to 60 years

- Being diagnosed as NSLBP with SIJD more than 3 months

- Participants were recorded their initial pain on the pain intensity with visual analogue scale (VAS) in excess of 30 mm (moderate baseline pain)

- The SIJD symptoms were diagnosed using the validity three or more SIJ positive provocation tests obtaining discriminative power for diagnosing SIJD with a mean of 76.4% on specificity, and 85% on sensitivity [11] being found out of these six testings: thigh thrust test, anterior distraction test, side lying iliac compression test, prone sacral thrust test, Gaenslen's test, and the drop (Active hip flexion) test [12, 13]

- Normal BMI (18.5-24.99 kg/m2) [14]

1.2 Exclusion criteria

- Non-mechanical back pain (e.g., spinal malignant or neoplasm, infection, inflammation or systemic diseases of the musculoskeletal system) and Lumbar pathology; for example, fractures, spinal stenosis, disc herniation, spondylitis

- Neurological impairment (reflex changes or lower extremity muscle weakness)

-Vascular disease e.g. stroke, coronary artery disease, coronary heart disease, atherosclerosis, venous thrombosis, hypertension etc.

- Accident or orthopedic surgery history related to the spine, SIJ, or hip joints within 3 months prior to the study

- Contraindications of SIJ mobilization such as inflammatory arthritis, malignancy, bone disease, neurological involvement, fracture (recent or unhealed), congenital bone deformities, vascular disorders, rheumatoid collagen necrosis, joint ankylosis, and vertebrobasilar insufficiency, osteoporosis, pregnancy,

history of malignancy, hypermobility, neurological signs, spondylolisthesis and previous SIJ mobilization therapy less than 48 hours

- Physical deformity or psychiatric condition and pregnancy

- The participants are unable to follow instructions

2. Method

This study was approved by the Khon Kaen University Ethics Committee for Human Research (HE541139). A randomized controlled trial study had been conducted in the clinic of Rehabilitation Medicine department Srinagarind hospital, Khon Kaen University. Participants qualified were recruited and assigned into categorized groups according to block-style randomization enclosed in envelopes for either experimental or control group.

2.1 Sacroiliac joint mobilization Group

Participants were treated with SIJ mobilization 30 oscillations/ set, 3 sets/ one side, 2 minutes/side (total within 4 minutes). They were tested by Modified-modified Schober's test, VAS, and PPT as pre and post-treatment.

2.2 The control group

The control group was instructed the same assessments and position (rest in side lying position for 2 minutes/ side) as the experimental group but they were with the sham manual method. Both groups came back again for re-assessment (Modified-modified Schober's test, VAS, and PPT) within 48 hours after treatment. At the end of this study, the participants were provided treatments prescribed by physician.

3. Outcome measurements

3.1 Visual Analogue Scale

Pain intensity was recorded by Visual Analogue Scale (VAS) [14] with reliability and sensitivity acquired [15]. The measurement format featured with one 10 cm straight line scored ranging pain level from 0 to 100, each respondent had located their pain intensity at any point on the line due to their pain feeling (0 represented no pain and 100 for maximum pain as their ever experience).

3.2 Pressure Pain Threshold

Pressure Pain Threshold (PPT) was tested using a digital algometer [16]. Landmarks of this investigation were the erector spinae or gluteus maximus muscles where the most pain located.

3.3 The Modified-modified Schober's test

Lumbar spinal flexibility in range of flexion was assessed by the Modified-modified Schober's test. The Modified-Modified Schober's test was the method to determine lumbar spine range of motion. This method involved using a tape measure held directly over the spine between points 0 to 15 cm above the lumbosacral junction (PSIS). The 0 cm mark represented the spinal intersection of a horizontal line drawn between the left and right PSIS. A second mark was placed at above 15th cm. The sub-

ject was instructed to stand in the neutral standing position then the clinician stood behind. They were asked to stand with knee locked and bent forward as far as possible, while the pelvis was stabilized manually, to achieve full flexion. Then the distance between the skin marks were measured [17].

4. Data Analysis

The data were analyzed using statistics software SPSS 17. Sample size in this study was calculated from the pilot study (5 males and 5 females with a mean age of 36.3 ± 10.00 years). Data for control and sacroiliac joint mobilization groups were presented as Mean±SD and 95% Confidence Interval of the Difference (95% CI). The differences between groups were significant different at p-value<0.05 and were tested by *Independent sample t test.* Significant difference of internal group was determined by using one sample t-test. Intra-rater reliability (ICC= 0.98, 95%CI 0.92 to 0.99) and Inter-rater reliability (ICC= 0.97, 95%CI 0.82 to 0.99) of Modified-modified Schober's tests were analyzed by using Intraclass Correlation Coefficient (ICC), indicating excellence reliability.

Results and Discussion

1. Participants Characteristics

Screening evaluations were performed on 21 non-specific low back pain (NSLBP) patients with SIJD in the Rehabilitation Medicine Department Srinagarind Hospital during September to October, 2011. Five patients were excluded with the exclusion criteria. Sixteen patients with NSLBP met the inclusion criteria and were included to participate in this study.

Table 1 shows the clinical characteristics of the participants. They were equally divided into 2 groups by 4 males and 4 females in sacroiliac joint mobilization group as same as the control group (aged mean as 39.3 ± 12.7 years). There were no significant differences between groups on age, pain duration, and all measure parameters base line.

2. Immediate effects of sacroiliac joint mobilization on alteration of lumbar spinal flexibility, visual analogue scales, and pressure pain threshold for both groups

The results from t-test analysis showed a significant difference altered in lumbar spinal flexibility, pain perception level, and pressure pain threshold (PPT) in the treatment group treated with SIJ mobilization whereas the control group done with sham manual method. There was no significant difference in lumbar spinal flexibility mean change. The data were shown in Table 2 and Figure 1. Moreover, the treatment group had showed increasing of lumbar spinal flexibility, decreasing of pain level, and increasing of pressure pain threshold significantly when compared with the control group. The data were shown in Table 2-4 and Figure 1-3. Adverse effect after sacroiliac joint mobilization in NSLBP with SIJD patients was not found in this study.

3. Possible reasons of Sacroiliac joint mobilization effect of lumbar spinal flexibility and pain level

SIJ mobilization is another method of physical therapy treatment. The advantages of this procedure have been reported in many aspects, such as decreasing of LBP [6], restoring balance in joint kinematics (promote balance in anterior and posterior tilt of the innominates), restoring pelvic symmetry, correcting the SIJ dysfunction, restoring muscle length, and increasing muscle strength in lumbopelvic and lower limb musculature [10]. To date, few studies have evaluated the effects of SIJ mobilization on surrounding muscle length and strength, but no previous study has evaluated the procedure impacting on lumbar spinal flexibility and pain perception.

Previous study has suggested that the primary effect of SIJ mobilization is a stretch of the connective tissue with mobilization of the passive congestion associated with immobility. Its might also anticipate modulation of neural activity to relieve pain and discomfort and restore more normal neural activity in spinal cord segments [18]. Passive movement effects when direct movement relates dysfunctions, i.e. movements, muscle spasm or positions that repeatedly cause patients to have pain and functional activity limitations. Passive SIJ mobilization might restore structures to normal position or pain-free status; so as to recover a full range painless motion, there may be possible reasons of lumbar spinal flexibility increasing [19].

The connective tissues might be shortened and tightened as the result of altered position of SIJ articulation and the healing of the inflammatory process following injury [18]. Moreover, based on the anatomical characteristics of the SIJ were associated with the lumbopelvic rhythm and many muscles across the SIJ, Some study had suggested that the function of SIJ was linked with the lumbar spine and the hip (lumbopelvic rhythm). Additionally, movement of SIJ mechanism appeared to be mainly passive, in response to muscle action in the surrounding area above and below. The researcher has believed that SIJ mobilization would decrease lumbar spinal stress by restoring normal function of SIJ, promote pelvic symmetry, correct the SIJD, and relax surrounding muscles of SIJ [20]. The purpose of this study was to investigate the immediate effects of SIJ mobilization on lumbar spinal flexibility, pain perception, and PPT when compared with the control group in patients with NSLBP associated with SIJD.

Nutation-counternutation technique is one direction of physiological movement of SIJ mobilization. A wealth of this technique effects to flexibility in treating a wide range of conditions. Understanding the mechanisms under the body's physiological response to passively SIJ mobilization will help alter the position of the ligament and joint capsule so that the range of movement of SIJ becomes full and pain-free. In addition, SIJ mobilization could be stretched a stiff

pain-free joint to improve the range of motion until it reaches the stage of being functional once more. When pain-free has been restored, the next step is to prevent recurrences by exercise designed to maintain ideal alignment and functional stability of the joint [21]. Another SIJ mobilization outcome might be the stretching of shortened connective tissues surrounding SIJ. Moreover, an earlier passive motion might be the movement of fluid, both intravascular and extravascular by wringing out the tissue. Moreover, this technique is passive rhythmic articulation movement of SIJ that contains the mechanical code elements for pumping (intermittent compression, cyclical and repetitive) that are likely candidates to affect fluid flow, and pain processes at the tissue dimension. SIJ mobilization may be associated with the direct effects on the chemical and mechanical aspects of pain relief. The mobilization forces will have an effect on fluid flow through the damage tissue. Such changes in fluid dynamics could reduce the chemical source of irritation by washing out the inflammatory chemicals at the site of damage. SIJ mobilization could also reduce the mechanical irritation at the site of injury. It would be expected that following mobilization treatment technique, chemical and mechanical irritation would gradually return by the build up of inflammatory by producing mechanical pressure. This would partly account for the gradual pain relief often observed on successive sessions.

Lederman [22] and Zusman [23] suggested that effects of SIJ mobilization can be described in three dimensions. The local tissue is where the direct physical effects of treatment technique take place. It is the affections directly under the physician's hands-soft tissues; skin, muscles, tendons, ligaments, joint structures, and different fluid systems, such as vascular, lymphatic and synovial. Some of these responses can be attributed to the effects of SIJ mobilization on physiological processes such as

- SIJ mobilization may facilitate the repair process and help improve the tissue's mechanical and physical behavior, such as tensile strength and flexibility. It may also prevent the occurrence of adhesion and shortening the tissue.

- SIJ mobilization may facilitate fluid flow physiology dynamics of the local tissue, improve the cellular environment and support the repair process. Its mechanism may also help reduce pain by encouraging the removal of inflammatory by producing and reducing tissue eodema. This role of mobilization in stimulating flow is also important in affecting synovial flow and joint repair processes. It may help reduce joint inflammation, effusion and pain.

- Chronic musculoskeletal disorder should be a cause of soft tissue shortening and can be long-term adaptive postural changes. SIJ mobilization can be used to re-elongate shortened tissues and break adhesion, improving the range of motion and restoring

normal function.

- Manual gating of muscle pain should be close to the area of damage (pain) by SIJ mobilization. The common observation that muscle pain can be reduced by stretching is possibly related to the stimulation of muscle mechanoreceptors to the exclusion of nociceptors. Pain relief may occur when the muscle's mechanoreceptors gate the pain sensation conveyed by the nociceptors.

- The psychodynamics of touch from passive SIJ mobilization can provide psychological influences on emotion responses, mood changes, behavioral changes, altered in pain perception and tolerance. It will be transmitted to the body as complex physiological responses of three principal pathways: motor system- localized change in muscle tone (motor system), altered autonomic and visceral activity (sympathetic and parasympathetic autonomic system) and facilitated self regulation via hypothalamic-pituitary-adrenal glands (neuroendocrine system). Furthermore, SIJ mobilization may help reduce stress and anxiety related to physiological changes, which may be the cause of psychosomatic conditions. It can guide patients to normal posture and movement patterns that reduce mechanical stress on the musculoskeletal system. Where specific areas of the musculoskeletal are held in stress or tension, patients can be guided in how to relax these areas. They may report that they have less pain or are experiencing a physical sense of well-being.

Conclusion

NSLBP patients with SIJD are those in which connective tissues and structure have altered, for example in loss of range of motion, muscle spasm and SIJ asymmetry. These are mostly affected by passive rhythmic muscle stretching manual therapy that aim to promote length adaptation in the connective tissues. As of the authors belief, main mechanical effects may occur in three processes at the tissue dimension of SIJ mobilization, as such adequate mechanical cyclical movement assist tissue repair, pain free range repetitive motion assists fluid flow dynamics, and adequate tensional force with slowly stretches and repetition assist tissue's length adaptation. The results of this study provide that SIJ mobilization in NSLBP patients with SIJD for 2 minutes per side is effective in increasing lumbar spinal flexibility and helps reduce low back pain level. SIJ mobilization is a non-pharmacological treatment without adverse effects, can lead to improvement of back flexibility and immediately helps reduce pain after treatment without adverse effect when compared with the control group to whom the sham treatment was provided.

Suggestions

This study has some limitation that should be addressed; only 4 minutes may affect small changes in outcome measurement. There was no previous data providing the standard treatment force and time of SIJ mobilization on lumbar flexibility. Then, force

and time of responsiveness should be further studied for more implementation on this useful and important medical treatment.

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Table 1 Demographic characteristic of NSLBP with SIJD patients tested by Independent sample t-test

Variables	Treatment group (Mean±SD)	Control group (Mean±SD)
Age (years)	41.98±14.13	36.7±11.46
Pain duration (months)	7.88±4.15	9±6.6
Schober's test base line (cm)	18.39±1.05	18.08±1.1
VAS base line (mm)	64.5±13.29	65.13±10.49
PPT base line (kg)	2.99±1.19	3.23±1.19

Table 2 Data of lumbar spinal flexibility (Modified-modified Schober's test (cm))

Group	Pre treatment (Mean±SD)	Post treatment (Mean±SD)	Mean change (Mean±SD)	95% CI	p value
Treatment	18.39±1.19	19.10±1.27	0.71±0.53	0.27-1.15	0.007*
control	18.08±1.10	18.20±1.05	0.12±0.15	-0.01-0.24	0.07

(* Statistical significant difference between the groups were tested by t test at $p<0.05$)

Table 3 Data of pain perception level (Visual Analogue Scales (mm))

Group	Pre treatment (Mean±SD)	Post treatment (Mean±SD)	Mean change (Mean±SD)	95% CI	p value
Treatment	86.75±18.60	64.50±13.29	22.25±9.56	14.26-30.24	0.001*
control	68.25±11.30	65.13±10.49	3.13±3.23	0.43-5.82	0.03*

(* Statistical significant difference between the groups were tested by t test at $p<0.05$)

Table 4 Data of pain threshold level (Pressure Pain Threshold tested by algometry (kg))

Group	Pre treatment (Mean±SD)	Post treatment (Mean±SD)	Mean change (Mean±SD)	95% CI	p value
Treatment	2.99±1.19	4.80±1.81	1.81±0.97	0.99-2.61	0.001*
control	3.23±1.19	3.34±1.20	0.11±0.11	0.14-0.20	0.03*

(* Statistical significant difference between the groups were tested by t test at $p<0.05$)

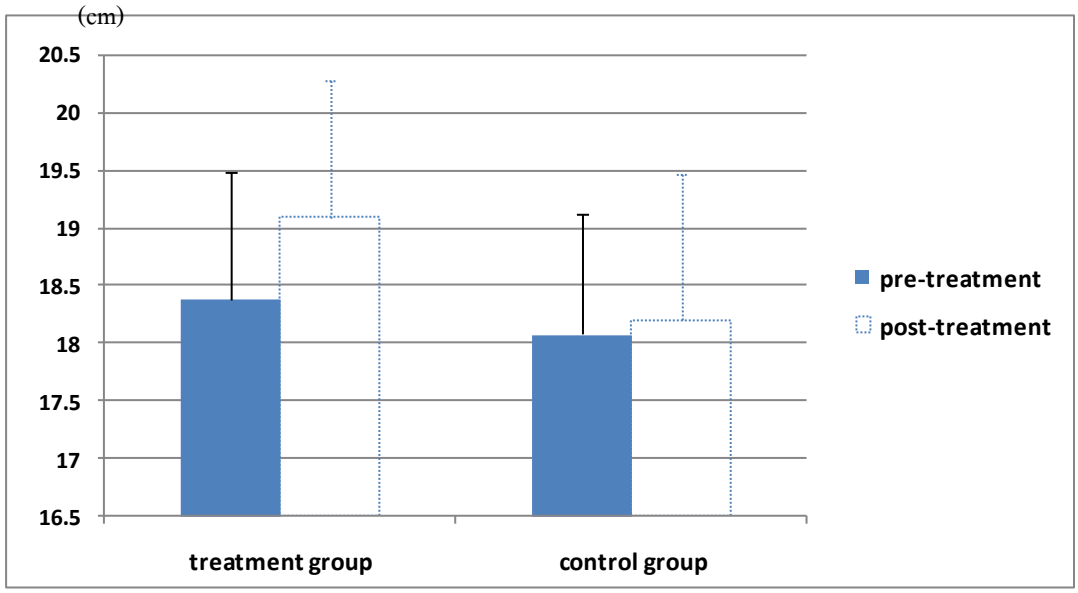

Figure 1 Lumbar spinal flexibility changes (cm) in mean between groups

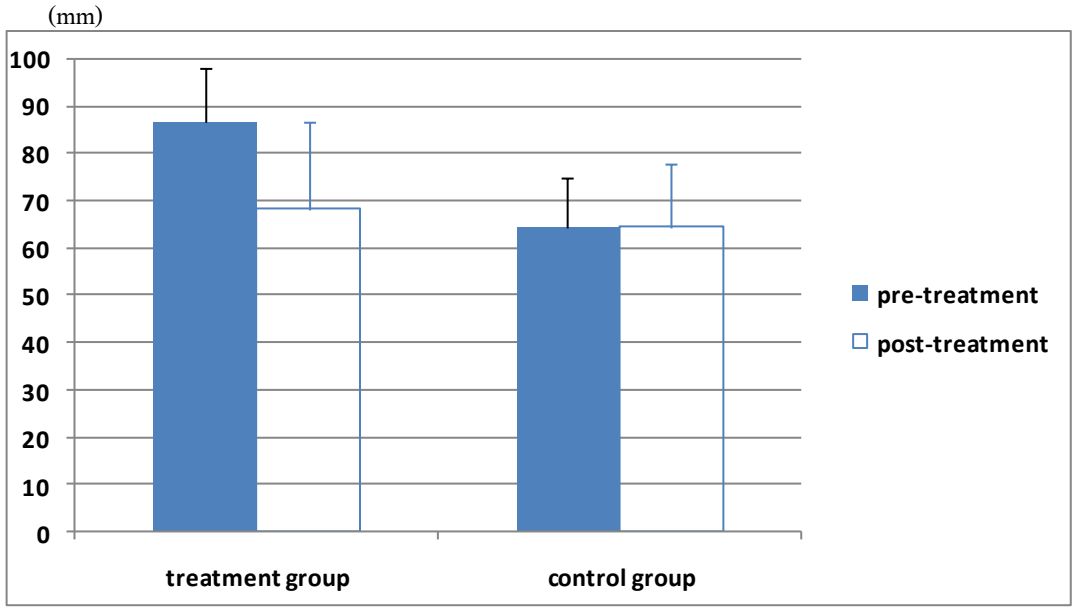

Figure 2 Visual analogue scales changes (mm) in mean between groups

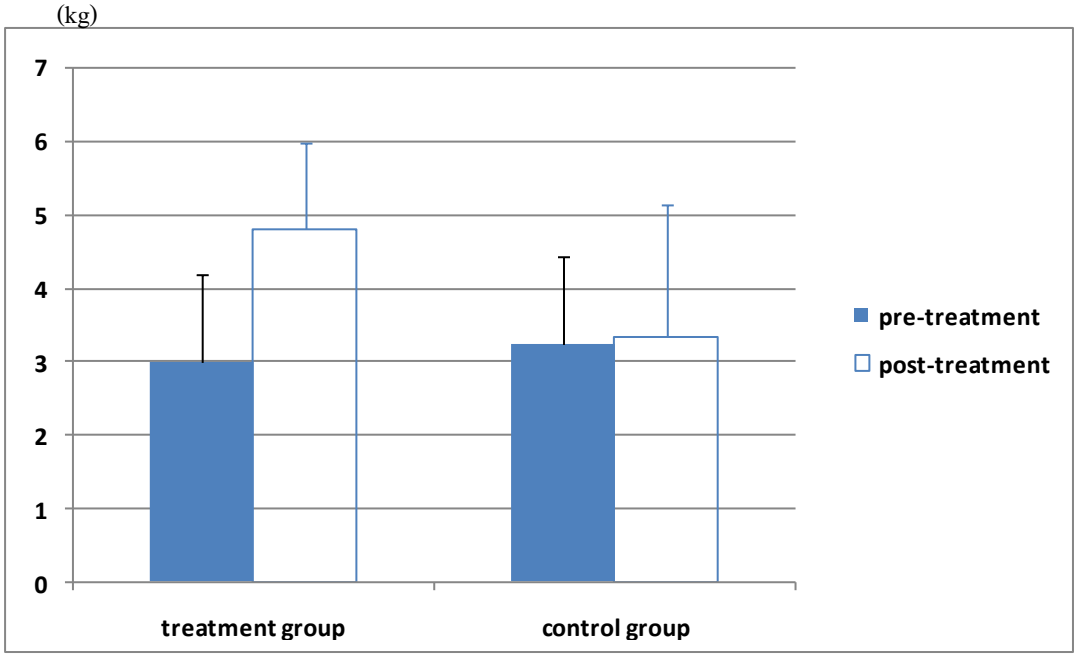

Figure 3 Pressure pain threshold changes (kg) in mean between groups