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Pole Exercise on Thorax Cage and its Influence on the Flexibility in Low Back-pain Patients

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Abstract

Background: Low back pain (LBP) has been common clinical and neuromusculoskeletal disorders. Authors have continued clinical practice and research concerning LBP and rehabilitation, associated with the efficacy of pole exercise movement and application.

Methods: Subjects were 18 LBP patients with 46.6 ± 5.8 years old. They were randomly assigned to two groups, which are pole exercise and control groups. Group 1 continued axial rotation, lateral bending and forward/backward rotation along Moriyasu method 10 times 3 sets per day for 2 weeks. Group 2 continued Slump Stretching and Gluteus Stretch in the same way. The biomarkers include Finger Floor Distance (FFD) and Numerical Rating Scale (NRS) before and after the intervention.

Results: Both groups showed significant improved results in FFD and NRS between before and after the intervention. Group 1 showed significant improved results in FFD and NRS after intervention, which were 5.2 ± 9.4 cm *vs.* 15.7 ± 7.0 cm, and 3.0 ± 2.1 *vs.* 5.1 ± 1.3 respectively.

Conclusion: The results suggested that continuous daily pole exercise would be effective for improved flexibility and motor function for thorax cage and vertebrae. Further study and comparative evaluation among LBP, pole exercise, FFD and other biomarkers will be expected in the future.

Keywords: Pole exercise; Low Back Pain (LBP); Thoracic cage; Finger Floor Distance (FFD)

Abbreviations: Low Back Pain (LBP); Finger Floor Distance (FFD); Shoulder Extension Test (SET); Lumbar Multifidus (LM); Rectus Abdominis (RA); External Oblique (EO); Internal Oblique (IO); Erector Spinae (ES)

Introduction

In recent years, low back pain (LBP) has been one of the most common clinical and neuromusculoskeletal disorders. It seems to show more than 75% lifetime rate of prevalence in a person [1]. Concerning the pathogenesis of chronic LBP, there have been various contributing factors. They include muscle imbalance, degenerative changes, genetic predisposition, psychological and socioeconomic influences [2]. LBP lasting more than 3 months was classified as chronic situation, and the importance of the earlier therapy has been described for long [3].

In the case of patients with LBP, the extension mobility of thoracic spine has been rather restricted or limited [4]. Especially, from unstable lumbar spine with less movement and pain, the mobility of adjacent spinal joints has been decreased including thoracic cage and vertebrae. Moreover, thoracic spine has been directly combined with the thoracic cage and joints, and then mutual influence among them has been important for body movement and respiration.

For patients with LBP, spinal joint mobilization can relieve the pain [5]. There was a positive efficacy on proprioceptive sensation by the application of thoracic spine mobilization [6]. Furthermore, applied with thoracic spine mobilization, patients with LBP showed improved pulmonary function [7].

Concerning the spinal flexion mobility, authors and colleagues have reported the exercise efficacy of the lower thorax [8]. In patients with LBP, there are reports of relationship among LBP, thoracic flexibility/stability, dysfunction of lumbar multifidus (LM) in asymmetry/muscle thickness reduction [8].

Furthermore, authors and co-researchers have continued clinical research and rehabilitation which focuses the spinal rigidity and flexibility by performing pole exercise in various conditions [9]. Pole exercise has several aspects with manual therapy, physical therapy, gymnastics therapy. It has been evaluated as effective and simple, and it can be helpful for better physical function in a short time [10].

By clinical application of pole exercise at standing position and sitting position, author's group showed the actual effects from the viewpoints of some examinations including Finger Floor Distance (FFD), Body warp prone position, Shoulder Extension Test (SET) and so on [11]. Those results suggested the improved flexibility and motor function for thorax cage and vertebrae.

There have been not so many previous reports concerning the relationship between LBP and the thoracic function, vertebral stability and flexibility. Consequently, we have focused clinical research concerning these functions in patients with chronic LBP, and will report them in this article.

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Patients and Methods

The enrolled subjects were 18 patients (46.6 ± 5.8 years old, 7 men and 11 women) with chronic LBP. The characteristic details of the subjects were that they have been undergone as outpatients and no apparent image findings assistant with the related pain. Furthermore, the back pain has been lasting for more than one month. These 18 subjects were randomly assigned to two groups. One includes 9 people as the pole exercise group and another includes 9 people as the control group. The pole group showed 9 subjects with M/F 3/6, 46.1 ± 6.0 years old and the control group showed 9 subjects with M/F 4/5, 47.1 ± 5.6 years old, respectively.

The study of Exercise therapy was given for two groups as follows. Group 1 of pole exercise had (i) axial rotation, (ii) lateral bending and (iii) forward and backward rotation along the pole motion of Moriyasu method [9]. Subjects were taught how to continue this exercise at home every day for 2 weeks. They conducted 10 times in each movement (i, ii, iii) for 3 sets per day Figure 1 [9]. The Moriyasu pole was used for the daily continuous clinical research. As the alternative methods, straight and hard poles were also practically used, such as bar-like vinyl chloride pipes, wooden bars, plastic bars, and so on.

On the other hand, patients of group 2 were instructed to exercise other movement as control. They continued Slump Stretching and Gluteus Stretch for 3 sets with 10 times each for 2 weeks Figure 2.

For the evaluation methods, the degree of body flexibility was measured and compared at the time when physical therapy was started and after 2 weeks. The standard FFD was mainly used [11]. This examination is to evaluate the flexibility of the trunk. First of all, the subject can stand with his feet about 15 cm apart on the table [12,13]. Consequently, the subject keeps his knees stretched and let the trunk bend forward as much as possible. At that point, the examiner measures the distance between the fingertip of the subject and the floor [11-13].

The distance between fingertip and floor surface is to be measured. If the finger does not reach the floor, the result becomes a negative numerical value. When the subject is bending forward without bending the knees, the important point would be not to use the reactionary power [11,12]. The distance is checked and measured between the longest finger and the floor. The negative result is that the fingertip can reach the floor. The positive and/or abnormal result is that the fingertip does not reach the floor, suggesting dysfunction of thoracic kyphosis, lumbar kyphosis, and posterior sacral incline, and so on [11,12].

Furthermore, the degree of the pain was also evaluated. This method included Numerical Rating Scale (NRS) in the final limb position that was performed according to the rating of the subject in FFD [14]. In other words, the pain level at the final evaluation. The detail pain level was that the first evaluation was set as point 10, and no pain was set as point 0. The evaluation was performed by 11 levels of scale at the final evaluation [15].

Ethical considerations

Based on the Declaration of Helsinki, this research was explained to the subjects concerning the purpose of the research and informed consents were obtained from them [16].

Statistical analysis

In this study, the FFD and NRS values were set as dependent variables for statistical analyses. Independent variables were set as each point of the time (before and after intervention) and intervention

Figure 1: Intervention of pole exercise for thoracic vertebrae in Group 1.

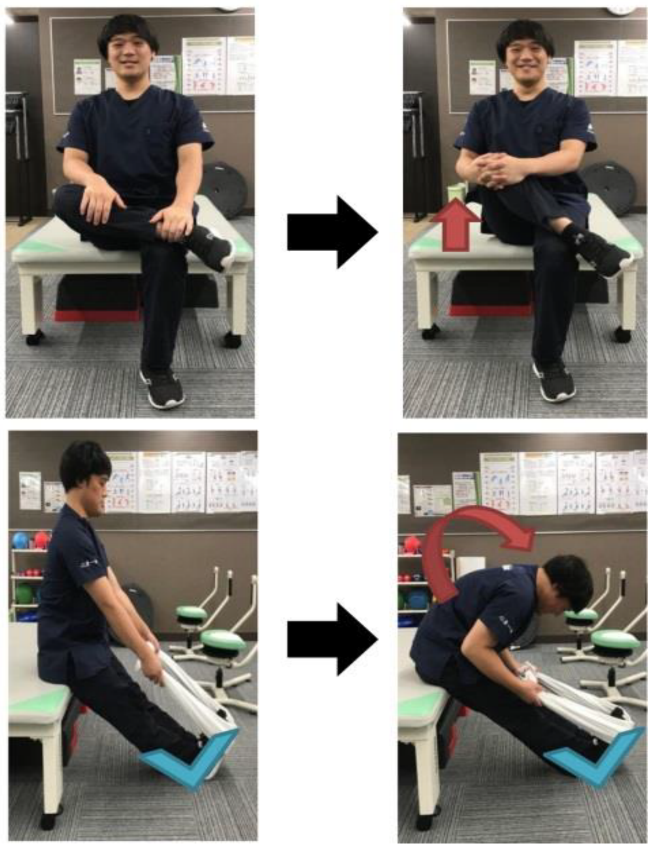

Figure 2: Intervention of lower body exercise in Group 2.

conditions (pole group and control group). As described above, the research was conducted using the two-way ANOVA method. When the effect was found by the analysis of variance, the simple main effect was evaluated.

On the other hand, when an interaction was observed, a multiple comparison test was performed by the Tukey-Kramer method. In the all analyses mentioned above, a risk rate of less than 5% was considered to be significant. As described above, statistical analysis was performed by a standard method [17].

Results

Regarding the data of FFD, before the intervention, the pole group showed 26.1 ± 5.8 cm and the control group showed 29.1 ± 4.3 cm Table 1. After the intervention, the pole group was 5.2 ± 3.1 cm and the control group was 15.7 ± 2.4 cm Table 1. The Both group showed significant difference ($p<0.05$) Table 1. The NRS showed 10 in both groups before the intervention and after the intervention the result was 3.0 ± 0.7 in the pole group and 5.1 ± 0.4 in the control group Table 2. The Both group showed significant difference ($p<0.05$) Table 1.

As a result of analysis of variance (ANOVA), the effect was recognized depending on the time of FFD intervention. However, there was no effect on the intervention condition, and no interaction was observed. NRS showed an effect on both the intervention time and the intervention condition, and an interaction was also observed Table 2.

Regarding a simple main effect test for the time of intervention for changes in FFD, both groups showed a significant improvement after intervention compared to before intervention. When a multiple comparison test was performed for changes in NRS, both groups showed a significant decrease after intervention compared to before intervention. Further, after the intervention, there was a significant difference between the pole group and the control group. It was significantly reduced compared to the pole group and the control group Table 3. There were significant differences of after NRS points and after intervention FFD between the two groups ($p<0.05$) Table 3.

Table 1: Changes in FFD (Finger Floor Distance) after intervention in 2 groups.

	Before Intervention	After Intervention	Significant difference
Pole Group	26.1 ± 5.8 cm	5.2 ± 3.1 cm	p<0.05
Control Group	29.1 ± 4.3 cm	15.7 ± 2.4 cm	p<0.05

Table 2: Changes in NRS (Numerical Rating Scale) after intervention in 2 groups.

	Before Intervention	After Intervention	Significant difference
Pole Group	10pts	3.0 ± 0.7 pts	p<0.05
Control Group	10pts	5.1 ± 0.4 pts	p<0.05

Table 3: Changes in NRS and FFD after intervention in 2 groups. Values show mean ± SEM. n.s: Not Significant.

	Pole Group	Control Group	Significant difference
After NRS	3.0 ± 0.7 pts	5.1 ± 0.4 pts	p<0.05
Before Intervention	26.1 ± 5.8 cm	29.1 ± 4.3 cm	n.s.
After Intervention	5.2 ± 3.1 cm	15.7 ± 2.4 cm	p<0.05

Discussion

In clinical practice, there are lots of patients with LBP. For relieving pain or stiffness in spinal segment, thoracic mobilization has been known and its further evaluation has been expected [18]. Posterior-anterior (PA) mobilization of the T1-T8 level of the thoracic spine was studied. The procedure included the movement using pole exercise with 35 minutes per day for 2 weeks. As a result, chest wall expansion and respiratory biomarkers were improved in experimental group compared with control group [18].

In patients with LBP, spinal joint mobilization can relieve the pain. By the operation of cervical and thoracic joints, respiratory muscles and pulmonary function can be controlled [19]. Their mechanisms include the stimulation of autonomic nerves between the parasympathetic nerves and sympathetic nerves. The former indicates the vagus nerves, which are the 11^{th} cranial nerves. The latter indicates the thoracic vertebrae nerves from the first to the fifth [20].

Furthermore, LBP has been correlated with respiratory function [21]. In contrast, patients with pulmonary diseases showed various problems of lungs, respiratory muscles, and also some musculoskeletal disorders [22]. Thus, several factors are involved in respiration movement, including diaphragm, respiratory muscles and thoracic cage. Patients with LBP have commonly problems of musculoskeletal dysfunction of respiratory muscles and rapid fatigue of respiratory muscles during rather low-intensity exercise [23].

LBP has been associated with not only decreased respiratory function, but also impaired control of the body posture [24]. Among them, the diaphragm has been important for regulating spine function and respiration [25]. When patients with LBP use inspiratory muscles, proprioceptive sensation regulating postural control was reduced [26]. Furthermore, patients with LBP revealed elevated diaphragmatic fatigue than normal controls and showed the effect of training of inspiratory muscle for better postural control and less pain intensity [27].

The presence of thoracic displacement affects the alignment of the lumbar spine and may be a factor that easily reduces lumbar stability [28]. The displacement of lateral rib cage may destabilize the activity of the lumbar multifidus (LM). Consequently, it was suggested that trunk function evaluation including lateral displacement of the rib cage and muscular activity around the lumbar pelvic belt may help with a physical therapy approach [28].

As described above, patients with LBP show certain relationship with thorax flexibility, lumbar function and respiratory movement. From these points of view, the methods and results of this study would be discussed. The protocol included the comparison of i) pole exercise intervention on the rib cage and ii) exercise intervention on the lower limbs [9,11].

As the results of current study, both groups showed subjective improvement and also clinical improvement of FFD. The former seemed to show larger effects, where this supposed to be from the results of Tables 1-3. Especially, the comparison after the intervention was 5.2 cm *vs.* 15.7 cm, which was significantly higher in the former. Consequently, the intervention of upper thorax movements would show more effects than that of lower extremities.

On the other hand, some limitation of this investigation may be present. It would be not easy to speculate general tendency that was based on the results of this protocol. Further evaluation will be expected for the comparison among these situations in the future.

Related to this region, the authors group has continued clinical research in various aspects. Patients with LBP showed reduced results of thoracic flexibility and stability, and improved spinal mobility by the exercise of lower thorax [8]. Furthermore, we have been conducting clinical research by applying the pole exercise to a variety of subjects [9,11]. Among them, there were effectiveness of the pole exercise by standing or sitting position by evaluating several orthopedic evaluation methods [9,29]. They include FFD, SET, body warp prone position, and others.

A comparative study was found between flexible pole and rigid pole exercise [30]. It showed significantly higher muscle activities in the case of flexible pole. In other words, a stronger muscle contraction was observed in the maximum voluntary contraction, improvement of coordination and balance [30].

There is another report of pole exercise [31]. Three kinds of exercise with quadruped, side-bridge and standing were continued for months. Before and after these exercise, electromyography of selected trunk muscles was studied, including rectus abdominis (RA), external oblique (EO), internal oblique (IO) and erector spinae (ES). As a result, EO, IO, ES muscle activity revealed significant differences between flexi-bar and non-flexi-bar exercises. From above, flexi-bar seemed to be rather useful in the activation of trunk muscles [31].

In recent study, the effect of flexible or rigid pole training associated with lumbar stabilization and trunk muscle activities were studied [32]. In the study, the percent maximal voluntary isometric contraction (%MVIC) was measured according to the RA, EO, IO and ES muscles. Subjects continued lumbar stabilization exercises on quadruped and curl-up, with the flexible pole or rigid pole. The protocol was to conduct 30-minute session per day, 3 days per week, for 6 weeks. Flexible pole in curl-up and quadruped showed an improvement in trunk muscle activation. The flexible pole combined with lumbar stabilization will be useful as an exercise tool to improve activity of trunk muscles.

Conclusion

In summary, patients with LBP were studied in two groups, which were pole exercise group and control group. The former group showed significant improvement of FFD and NRS. These results suggested that exercise therapy for the thorax using a pole would relieve the pain and improve flexibility of the patients. Current study may be expected to become basal reference data for clinical practice and further research for LBP and rehabilitation in the future.

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