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The Effect of Core Stabilization Exercises Using a Sling on Pain and Muscle Strength of Patients with Chronic Low Back Pain

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Abstract. [Purpose] This study examined the feasibility of using an intervention of core stabilization exercises using a sling to control pain and muscle strength of patients with chronic low back pain. [Subjects] The subjects, 30 chronic low back patients, were divided randomly into two exercise groups: one group performed core stabilization exercises using a sling (n=15), and the other group performed mat exercises group (n=15). Each exercise program was performed three days per week for four weeks. Pain and muscle strength were measured before and after the intervention. Pain was assessed using a visual analogue scale (VAS) and muscle strength was measured with a Tergumed device. [Results] The differences in the VAS scores for the sling exercise and mat exercise program were statistically significant between pre and post intervention in both groups. Muscle strength increases were also statistically significant. However, the comparison of sling exercise and mat exercise program showed no statistically significant differences between the groups, post-intervention. [Conclusion] Both the sling exercise and the mat exercise program reduced chronic low back pain improved patients' lumbar muscle strength, and decreased VAS scores; and the sling exercise was more effective than the mat exercise program. Further study is needed to develop the sling exercise for effective use in clinical practice for the treatment of chronic low back pain.
Key words: Chronic low back pain, Core Stabilization Exercise, Sling exercise

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INTRODUCTION

Low back pain is typically alleviated through 1–2 months of continued and mostly conservative treatment methods. However, some low back pain patients continue to experience pain for more than 12 weeks. This type of pain is categorized as chronic low back pain.

Over the course of their lives, 70–85% of people will experience low back pain and over 80% will experience recurrence of the pain[1)]. Although 80–90% of patients recover within 6 weeks[2)], a fraction (5–15%) do not recover from the pain[3)]. Due to the development of low back pain, sufferer's extent of activity is reduced in order to limit the amount of pain, and this results in weakening of the back muscles and functional decline[4)]. The requirement for long-term bed rest is the main reason for delayed treatment. A greater recovery rate is therefore seen for proactive activities and exercise programs than for bed rest[5)]. Proactive activities and exercise programs reduce the amount of pain, while improving physical strength and endurance; thereby improving functional ability, reinforcing psychological stability, and reducing stress and fatigue[6, 7)].

Strength training, flexibility improvement training, and cardio-training are being researched as exercises to reduce back pain[8, 9)]. Recently, a core stability exercise for controlling spine segments and providing stability has been used with a focus on treating instable spinal segments[10)]. The success of the core stability improvement exercise in alleviation of chronic back pain and prevention of recurrence has also prompted the use of slings during exercises for back pain.

The use of a sling in a core stability exercises allows active participation by back pain patients in their treatment. In particular, this treatment method may be used effectively in an antigravity state, such as performing exercises in water, and patients using this method may can begin to exercise earlier. By reducing the amount of weight exerted by gravity, the method may also contribute to stabilizing back pain. In other words, this exercise method integrates the concept of core stability exercise and the latest exercise treatment theories as a new approach to exercise treatment[11)].

However, the effectiveness of the use of a sling for chronic low back pain patients has not been sufficiently studied, especially in comparison to the effectiveness of the generally used mat exercises. Therefore, the aim of the present study was to compare the sling and mat exercises on pain and on the ability of extensor muscles in order to ascertain the most effective exercise method for patients with chronic low back pain.

Table 1. Characteristics of study participants

	Sling Exercise Group (n=15)	Mat Exercise Group (n=15)
Age (years)	20.1 ± 0.7	20.5 ± 0.5
Height (cm)	168.2 ± 9.0	164.5 ± 4.6
Weight (kg)	56.9 ± 14.3	54.7 ± 7.6

(n=30) (mean ± SD)

SUBJECTS AND METHODS

Subjects

The study subjects were 30 university students of C University located in S city, who were in their 20s, complained of chronic low back pain, and who scored less than 18 on Handler's 10-minute long differential aptitude test. None of the test subjects who agreed to participate received any type of treatment during the test period and none of them had motor paralysis or disabilities. Half (n=15) of the students were randomly assigned to a sling exercise group and the remaining 15 to a mat exercise group (Table 1).

A visual analogue scale (VAS), consisting of a 10 cm rule without markings, was used to assess the test subjects' subjective pain[12]. A Tergumed device (Proxomeds, Germany) was used to measure extensor and stretching strengths. This device reduces resistance at a certain weight and provides a measure of the range of motion (ROM) and power. The reliability levels of the ROM and isometric strength measurement had ICCs of 0.81–0.86[13]. The test subject's thighs above the knee were set parallel and the pelvis was completely fixed to the pelvis fixation plate using hip and thigh restraints. Measurement was done by pushing the plate while applying force to the back pad for 2 to 3 seconds. When the highest point was reached, the test subject was told to maintain maximum contraction for 1 to 2 seconds. This was measured 3 times and the test subjects were allowed 30 seconds of rest in between the measurement[14].

Handler's 10-minute long differential aptitude test was used to select chronic low back pain patients[15]. It is a 15-item survey developed to measure alleviated or aggravated pain concerning low back pain patients' functional differences. The patient indicates his or her own reactions. Considering the test subjects' young age, Item 10 regarding sexual intercourse was excluded from the survey. In general, patients who score 18 or less are considered chronic back pain patients. Back pain complaints by patients with scores less than 14 are more objectively categorized[16].

Methods

The two exercise programs, consisting of sling or mat exercises, were conducted three times a week for four weeks. The sling exercise program was part of a core stability exercise that consisted of 6 movements: body stretch, standing, pushing the upper body while seated, strengthening abdomen while standing, lying on the front, and lying on the back. Each action was maintained for 20 seconds followed by a 10-second rest. Each action was performed 6 times for one set and repeated in three sets, with a 90-second rest between sets. In the event of pain or muscle paralysis, exercise was suspended. Each action was orally described to the patient.

The mat exercises consisted of a preparatory exercise, belly blaster, cobra, butterfly, 3-stage pelvis stability exercise, hamstring stretch, folding knees to the chest, twisting the spine while lying down, abdominal breathing, cross extension, cobra, and a final abdominal breathing. Each action was maintained for 10 seconds (except for abdominal breathing, which was maintained for 20 seconds on the right side and 20 seconds on the left side), with a 10-second rest between actions. Each action was conducted twice in a set and repeated for a total of two sets, with a 15-second rest between sets. In the event of pain or muscle paralysis, the exercise was suspended. Each action was orally described to the patient.

Data were statistically analyzed using Windows SPSS Version 12.0 Program. All the data using the Kolmogorov-Smirnov test result verifying the normality and parametric test was used for the normal distribution. Changes before and after exercise were compared using the paired t-test. Changes between the two groups were compared using the independent t-test. Statistical significance was accepted at values of $\alpha<0.05$.

RESULTS

Subject's general characteristics before conducting the exercise programs showed no statistically significant differences in terms of pain between the sling exercise group and the mat exercise group. The sling exercise group and the mat exercise group showed significant improvements in pain after the exercise intervention ($p<0.05$). However, no statistically significant difference was seen in the degree of pain between the two groups ($p<0.05$) (Table 2).

The body extensor muscle strength test before exercise showed no statistically significant difference between the sling exercise group and the mat exercise group and both groups showed significant improvements after the exercise intervention ($p<0.05$). A comparison of the degree of change in extensor muscle strength after the exercise intervention showed no statistically significant difference between the two groups ($p<0.05$) (Table 3).

DISCUSSION

Regular exercise by chronic back pain patients has the

Table 2. Comparison of vas data between the sling and mat exercise groups

VAS Data	Sling Exercise Group (n=15)	Mat Exercise Group (n=15)
Pre-intervention	4.5 ± 0.5	4.6 ± 0.5
Post-intervention	1.3 ± 0.5*	1.8 ± 0.6*
Change in VAS	3.2 ± 0.6	2.8 ± 0.8

(mean ± SD) (unit: cm) Value are Mean ± SD; *= $p<0.05$.

Table 3. Comparison of trunk extensor strength between the sling and mat exercise groups

Trunk Extension Power Data	Sling Exercise Group (n=15)	Mat Exercise Group (n=15)
Pre-intervention	408.4 ± 241.6	371.1 ± 77.6
Post-intervention	685.1 ± 350.2*	506.3 ± 88.6*
Change in Trunk Extensor Strength	276.7 ± 171.4†	135.2 ± 0.61.1

(mean ± SD) (unit: N) *: Paired t-test value, †: independent t-test value, ; *= $p<0.05$, †= $p<0.05$.

following effects: reduced pain, improved muscle strength, increased stability and coordination, improved quality of life, better body stability and function, and positive psychological aspects. Exercises for low back pain include those aimed at improving muscle strength, flexibility, and cardiovascular function. Current research is now focusing on the effect of core stabilization exercises on the alleviation of low back pain.

In the present study, we found that core stabilization exercises using a sling system affected subjective pain when compared with mat exercises. However, a comparison of the degree of change after the exercise intervention indicated no significant statistical difference between the groups. This result contradicts that of Park Hye-sang[17], who found a significant difference in pain improvement between a group that used a core stabilization exercise using a ring and a group that did not; Unsgaard-Tondel et al.[18] and by Pereira et al.[19] also reported significant differences. On the other hand, Nam Hyeong-chun[20] compared pain indexes using Handler's 10-minute long differential aptitude test between a sling exercise group and a ring exercise group, but found no significant between group difference in the post-intervention changes, as in the present study.

A core stability exercise is conducted within a range free from pain by adopting isometric stabilization exercises that control unstable posture and that provide lower lumbar postural control for functional activities. The purpose of treatment is to reduce the maximum amount of stress physically applied to the spinal structure while the patient executes optimal functions and to develop and improve muscles including the erector spinae, multifidus, quadrates lumborum, and musculi abdominis. All of these muscles help to maintain adequate neurological muscle control and coordination and are involved in the stabilization of the lower lumbar area[21]. Core stabilization exercises allow recovery of the function of local muscles and the latissimus dorsi, thereby contributing to improvement in body posture. Pain is reduced by decreasing the transmission of pain stimuli from the ligaments and articular capsules to the spine.

Extensor muscle strength in the sling and mat exercise groups showed significant differences after exercise intervention in both groups. The statistically significant difference seen between the two groups indicates that the sling core stabilization exercise does improve muscle activity, as confirmed by studies based on using ultrasonic images[22], while reducing pain, increasing the range of activity, and improving quality of life and functional capacity[18]. Women who complained of low back pain and pelvis pain after giving birth also responded positively to core stabilization exercise and showed a decrease in pain and increased quality of life and functional capacity[23].

Nam Hyeong-chun[20], used electromyography to compare a sling exercise with a mat exercise, and found a significant increase in muscle activity in the obliquus externus and erector spinae muscles after the exercise for the sling group but not for the mat group. Neither group showed a significant difference in terms of exercise-related muscle strength change. These results differ from those of the mat exercise group in the present study, in which a significant change was seen in the strength of the extensor muscle. This suggests that the exercise program used in this study may lead to greater strength improvement than the programs used in previous studies. A previous study comparing bodily coordination after conducting a sling exercise and a mat exercise for 4 weeks also showed a significant increase in muscle strength in both groups[24].

The results of the present study indicate that core stabilization exercises are effective at reducing pain and improving extensor muscle when used as sling or mat exercise, and are successful at reducing pain and improving muscle strength. In particular, extensor muscle strength showed a significant increase after both sling exercise and mat exercise. A sling is a good tool to use in an exercise program that is focused on increasing extensor muscle strength for those who have difficulty moving on the mat and maintaining position. In places where use of a sling is difficult, the sling may be replaced by a mat. Subsequent studies should focus on alleviation of pain and improvement of quality of life and functional capacity, before focusing on muscle strength.

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