



Original Article

## The change of pain and lumbosacral sagittal alignment after sling exercise therapy for patients with chronic low back pain

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**Abstract.** [Purpose] This study was conducted to quantify the effect of sling exercise therapy in the recovery of lumbosacral sagittal alignment (LSA) and in the control of low back pain. [Subjects and Methods] A total of 102 chronic low back pain patients were divided into two groups, a physical therapy group and a sling exercise group. In both groups, programs were conducted thrice a week for twelve weeks. With respect to LSA, pelvic tilt (PT), sacral slope (SS), and pelvic incidence (PI) were measured with plain radiography. Pain was measured on a visual analogue scale (VAS). [Results] Differences were found in visual analogue scale, delta score of visual analogue scale, pelvic tilt, delta score of pelvic tilt, and delta score of pelvic incidence between sling exercise therapy and physical therapy groups. VAS, pelvic tilt, and pelvic incidence was positively changed after sling exercise. However, only the visual analogue scale was found to be improved after physical therapy. [Conclusion] Sling exercise therapy and physical therapy were effective in reducing pain. However, pelvic tilt and pelvic incidence were positively changed after sling exercise therapy for Lumbosacral Sagittal Alignment, but were unchanged after physical therapy. Therefore, sling exercise therapy is more effective than physical therapy for the recovery of Lumbosacral Sagittal Alignment in patients with chronic low back pain.

**Key words:** Sling exercise, Lumbosacral, Low back pain

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### INTRODUCTION

Approximately 80–90% of Koreans experience low back pain (LBP) at least once during their life<sup>1)</sup>. Generally, acute low back pain (ALBP) can be cured in 10–12 weeks with conservative treatment<sup>1)</sup>. However, 60–75% of patients who recover from acute back pain experience recurrence, and 7–10% of those have somatoform disorders caused by chronic low back pain (CLBP)<sup>2)</sup>. It has been reported that to reduce LBP, exercise therapy for muscle strengthening of the lumbosacral area is more effective at stabilizing the pelvis than conservation physical therapy or pharmacotherapy, which could be considered passive treatment<sup>3)</sup>. Physical therapy is based on scientific knowledge, and clinical practitioners in various medical sectors perform medical activity, using field specific knowledge. They also offer medical services of attending to initial cues from their patients, assessing the medical conditions, and managing the treatment of patients<sup>4)</sup>. It is known that sling exercises may reduce pain by increasing the intervertebral disc space<sup>5)</sup>. However, LBP may recur and increase when the muscular strength of the lumbosacral area is weakened<sup>6)</sup>. The sling is a device with a swaying rope that is used to reduce the individual's weight load, similar to performing exercises in water<sup>7)</sup>. Recently, the active research area has found that normal spinal alignment is

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more effective than the recovery of muscular strength for patients with CLBP.

Spinal alignment is represented by pelvic tilt (PT), sacral slope (SS) and pelvic incidence (PI). PI is a constant parameter that is an important anatomic factor for sagittal balance regulation<sup>9</sup>. If spinal alignment is above the normal range, pain can be caused by localized compression in vertebra joints and intervertebral discs<sup>10</sup>. With the recent increase in sedentary lifestyle, the lumbosacral-pelvic sagittal alignment (LSA) of average individuals is above the normal range and there has concurrently been an increase in LBP<sup>10</sup>. This study was conducted to observe how sling exercise therapy affects the lumbosacral alignment (LSA) and pain in patients with CLBP.

## SUBJECTS AND METHODS

The subjects of this study were patients who did not get spinal surgery or did not have a fracture, tumor, inflammation, and metabolic disease in HO hospital which is located in Yongin-si, Gyeonggi-do, South Korea.

The patients were divided into a sling exercise group (SEG, n=53), whose mean age, height, weight, and body mass index (BMI) were  $49.5 \pm 10.6$  years,  $165.9 \pm 8.6$  cm,  $64.9 \pm 13.6$  kg, and  $23.3 \pm 3.1$  kg/m<sup>2</sup>, respectively, and a conservation physical therapy group (PTG, n=49), whose mean age, height, weight, and body mass index (BMI) were  $50.5 \pm 9.1$  years,  $164.5 \pm 6.3$  cm,  $61.6 \pm 7.0$  kg, and  $22.7 \pm 1.3$  kg/m<sup>2</sup>, respectively. There were no significant differences between groups with respect to baseline characteristics. All patients read and signed informed consent forms in accordance with the ethical standard of the Declaration of Helsinki. The two treatment programs, consisting of sling and conservation physical therapy, were conducted thrice a week for twelve weeks. The sling exercise program was based on a lumbar stabilization exercise that works on part of the trunk, and a pelvic stability exercise series that consisted of six movements: trunk-pelvis stretching, a hip-trunk bridging exercise, a pelvic tilting exercise (anterior, posterior, lateral side), a lower crossed exercise, a trunk rotation exercise, and an oscillating trunk-pelvis exercise. These were carried out in the supine position. Each action was performed 10–15 times for one set and the set repeated three times, there was a 90-second rest period after each set. In the event of pain or muscle paralysis, exercise was suspended. Each action was described to the patient verbally. In addition, a superficial heat pack was applied for 15 to 20 minutes. This was followed by five minutes of ultrasound treatment (SM-250, Samson Med, Seoul, Korea) at a frequency of 1 MHz using a five cm<sup>2</sup> in ultrasound head at an intensity of 1.5 W/cm<sup>2</sup> in continuous mode. Patients received 15 to 20 minutes of Interferential Current (IFC) treatment (SM-850P, Samson Med, Seoul, Korea) at an intensity of 25 mA. When patients felt that they needed extra exercise 15 to 20 minutes of traction treatment less than 50% of bodyweight was also given. Finally, light walking at a speed of 4–5 km/h for less than 10 minutes was allocated to the patients. The PI was measured with plain radiography (R-630-150, Dongkwang, Korea) of the lumbar region and magnifying the images 3 times by using a picture archiving and communication system (PACS; Infiniff, Korea). Each patient underwent a 30 × 90 cm lateral radiograph of the lumbosacral region, with the individual standing, knees extended, and arms flexed in front. Radiographs were printed on acetate. Care was taken to ensure that the radiograph included both femoral heads. If the femoral heads did not overlap in the radiograph, the midpoint of the line connecting the isocenter of both femoral heads was taken as a reference point. The pelvic incidence (PI) was defined as the angle between the line perpendicular to the sacral plate and the line connecting the midpoint of the sacral plate to the bicoxofemoral axis. The PI is a morphological parameter, which stays constant, independent of the spatial orientation of the pelvis. The sacral slope (SS) corresponds to the angle between the sacral plate and the horizontal plane, and SS is a positional parameter, varying according to pelvic positioning. The pelvic tilt (PT) corresponds to the angle between the line connecting the midpoint of the sacral plate to the bicoxofemoral axis and the vertical plane. Like the SS, the PT is also a positional parameter.

The degree of low back pain is measured with the VAS, which was developed in 1974 by Huskisson<sup>11</sup>). Subjects check the degrees of subjective pain on a 10 cm line, on which 0 cm indicates “no pain”: at the left end and 10 cm indicates “very severe pain” at the right end. The VAS score is determined as the measurement from the left side, with a higher score meaning more severe pain intensity. Data were statistically analyzed by using the IBM SPSS Statistics for Windows Program (version 22.0). All data using paired and independent t-tests were performed for intra and intergroup comparisons of PI, PT, SS, and VAS. To evaluate the pre and post change rate in each group the % delta score was calculated % delta score was calculated, Statistical significance was accepted at values of  $\alpha < 0.05$ .

## RESULTS

The VAS scores in the SEG were significantly higher than in the PTG before treatment ( $p=0.020$ ). However, the SEG was significantly lower than PTG after treatment ( $p=0.000$ ). In addition, SEG was significantly higher than PTG in delta score of VAS ( $p=0.000$ ), while SEG was significantly higher than PTG in PT ( $p=0.007$ ). SEG had high delta scores of PT and PI ( $p=0.000$ ). VAS, meanwhile, was significantly reduced after treatment in both groups ( $p=0.000$ ) ( $p=0.000$ ). PT was significantly decreased in SEG ( $p=0.000$ ), while PI was significantly increased in SEG ( $p=0.000$ )(Table 1).

**Table 1.** Comparison of VAS, SS, PT and PI among the groups (Mean ± SD)

|             |         | SEG            | PTG          |
|-------------|---------|----------------|--------------|
| VAS (score) | Pre*    | 6.6 ± 1.4      | 6.1 ± 0.7    |
|             | Post*** | 3.6 ± 1.0†††   | 4.8 ± 0.5††† |
|             | Δ%***   | -45.7 ± 13.6   | -20.7 ± 10.3 |
| SS (°)      | Pre     | 34.4 ± 9.7     | 34.9 ± 6.4   |
|             | Post    | 35.7 ± 6.1     | 35.2 ± 6.8   |
|             | Δ%      | 9.8 ± 31.4     | 1.9 ± 16.2   |
| PT (°)      | Pre**   | 14.2 ± 6.6     | 13.8 ± 5.5   |
|             | Post    | 12.5 ± 0.4†††  | 13.1 ± 5.6   |
|             | Δ%*     | -23.7 ± 34.7   | 6.4 ± 73.0   |
| PI (°)      | Pre     | 48.2 ± 9.3     | 48.7 ± 8.8   |
|             | Post    | 51.5 ± 11.3††† | 48.2 ± 8.5   |
|             | Δ%***   | 7.2 ± 14.0     | -0.7 ± 7.7   |

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001, †††p<0.001

VAS: visual analog scale, SS: sacral slope, PT: pelvic tilt, PI: pelvic incidence, Δ%: delta score, \*paired t-test, †independent t-test

## DISCUSSION

CLBP is generally considered as pain that lasts more than twelve weeks<sup>12</sup>. The reason of LBP is the change of L1 to S1 joint angle. When it changes, the intervertebral disc is deteriorated and the spinal nerve could be compressed which causes the spinal pain<sup>13</sup>.

ALBP caused by strain and sprain can be recovered in twelve weeks and the prognosis is usually good<sup>14</sup>. However, CLBP has a poor prognosis, with long-lasting pain which has a bad influence on a patient's social and psychological stability<sup>14</sup>. In order to maintain normal LSA, normal curvature and balance is needed in the sagittal plane. The curvature normally takes the form of a cervical lordosis, thoracic kyphosis, and lumbar lordosis. These curves reduce impact and aid the effective function of spinal muscle<sup>15</sup>.

Lumbar lordosis (LL) is also closely related to SS and PI<sup>16</sup>. A decrease in lumbar lordosis is an important factor causing various spinal diseases, and can lead to sagittal spinal imbalance<sup>17-19</sup>. It causes pain in specific parts of body from local pressure in lumbar intervertebral discs and spinal joints (Mac-Thiong). This kind of structural problem is known to affect lumbosacral angle, and a lumbosacral angle above the normal range is related to LBP<sup>8</sup>.

Among the interventions aimed at normalizing spinal alignment in patients with CLBP, the effects of laser, massage, and spinal manipulation therapy are temporary. Moreover, aquatic therapy, magnetic therapy, transcutaneous electrical nerve stimulation (TENS), ultrasound, acupuncture, and Pilates were reported to have no effect or unclear effect<sup>20</sup>. Exercise therapy does not help ALBP; however, in CLBP it can reduce pain and improve function, in some cases even raising the possibility of returning to work<sup>21</sup>. In exercise therapy, adding elasticity and weight to the rope sling exercise can be used in various ways to stabilize the muscles and balance of a LBP patient. These methods can relieve pain by stimulating improved proprioception in the neuromuscular system, helping to maintain posture<sup>22</sup>. Twelve weeks of the Neurac sling exercise, a vibration stimulus exercise using a hanging rope, helps to stabilize the lower back and improve posture and balance in the CLBP patient<sup>22</sup>. Furthermore, six weeks of sling exercises and push-ups were more effective for LSA than sling exercises alone<sup>23</sup>.

This study shows that, doing sling exercises for twelve weeks is more beneficial in VAS, PT, and PI than physical therapy. Sling exercises reduced VAS more than physical therapy. VAS decreased more after doing sling exercises than after physical therapy. After performing sling exercises the PT angle had decreased, but after physical therapy the PT angle was either increased or without change. The PI angle increased after sling exercise; however, after physical therapy the angle was either decreased or without change.

The average Korean LSA was reported as SS 38.1 ± 7.3°, PT 11.0 ± 5.9°, PI 48.5 ± 10.9°<sup>24</sup>. However, there were some differences in the angle of LSA by race. Caucasian SS 39.9 ± 8.1°, PT 12.0 ± 6.5°, PI 51.9 ± 10.7°, Asian SS 36.3 ± 7.8°, PT 11.5 ± 5.3°, PI 47.8 ± 9.3°, and American SS 41.9 ± 7.8°, PT 11.9 ± 5.1°, PI 53.2 ± 10.3°<sup>25</sup>.

Although in this study and those of Chung KH<sup>24</sup> and Zárate-Kalfópulos et al.<sup>25</sup> there were differences of LSA between races, after sling exercises. LSA recovered to normal values (SS 35.7 ± 6.1°, PT 12.5 ± 0.4°, PI 51.5 ± 11.3°) in contrast to physical therapy. Summing up the result of this and previous studies, sling exercises are more effective for recovery of LSA than physical therapy.

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