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The Effects of Lumbar Stabilization Exercise on Pain-related Functions of Industrial Workers with Chronic Low Back Pain and Lumbar Instability

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요부안정화운동이 요부불안정성을 가진 산업체 만성요통환자의 통증관련 기능에 미치는 효과

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Abstract The purpose of this study is to investigate the effects of lumbar stabilization exercise on pain-related function of industrial workers with chronic low back pain and lumbar instability. 20 industrial workers with chronic low back pain were divided into two groups, control group(n=10) and experimental group(n=10). Back muscle strength, flexibility, and balance ability were measured to assess physical functions, and visual analog scale(VAS) was used to evaluate pain levels. In both groups, back muscle strength and balance ability increased significantly, and pain levels decreased significantly. In comparison between the groups, the experimental group compared to the control group showed significant improvement in balance ability and significant diminishment in pain levels. In conclusion, the lumbar stabilization exercise has positive effects on industrial workers with lumbar instability and chronic low back pain by improving balance ability and reducing pain.

Key Words : Chronic Low Back Pain, Lumbar Instability, Lumbar Stabilization Exercise, Pain, Physical Functions

요 약 본 연구의 목적은 요부안정화운동이 요부 불안정성을 가진 산업체 만성요통환자의 통증관련 기능에 미치는 효과를 알아보고자 하였다. 산업체 만성요통환자 20명을 대상으로 대조군과 실험군으로 10명씩 할당하여 신체기능은 배근력, 유연성, 균형능력을 측정하였고, 통증은 visual analog scale(VAS)를 이용하였다. 연구결과 두군 모두 운동 후 배근력과 균형능력은 유의하게 향상되었고, 통증은 유의하게 감소되었다. 군간 비교에서는 실험군이 대조군에 비해 균형능력이 유의하게 향상되었고, 통증은 유의하게 감소되었다. 결론적으로 요부안정화운동은 요부 불안정성을 가진 산업체 만성요통환자의 균형능력을 향상시키고 통증 감소에 긍정적인 영향을 미친다.

주제어 : 만성요통환자, 신체기능, 요부불안정, 요부안정화운동, 통증

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1. Introduction

80% of Industrial workers experience low back pain once or more in their lifetimes[1], and 35% of them suffer from recurrent low back pain[2]. Work-related physical exposures, especially heavy lifting and manual materials handling, working in awkward posture, and whole-body vibration, are well established risk factors for low back pain[3, 4].

Concerning low back pain that occurs in industrial settings, the treatment period is longer than that of general low back pain due to difficulties in prevention and lack of understanding its nature and causes[5], and it has a high relapse rate of 60%[6]. Also, its high medical bills and decreased productivity from loss of labor exert a negative influence on national economy[7].

When low back pain lasts more than 3 month, resultant deep muscle imbalance and loss of proprioception restrict pelvic mobility, which leads to lumbar instability[8, 9, 10]. Such lumbar instability decreases postural control capacity, hinders maintaining neutral position, and causes pain and recurrent injuries[11].

Lumbar stabilization exercise improves postural alignment by activating both transverse abdominis and multifidus muscle and promotes normal exercise aspect by improving balance ability; thus, it is effective in pain relief, functional improvement[12, 13], and especially chronic low back pain treatment[14].

In Cairns et al[15] study that compared the effects of spinal stabilization exercise and general active exercise on chronic low back pain patients without lumbar instability and Koumantakis et al[16] study that compared a group with general exercise and a group with both lumbar stabilization exercise and general exercise, both groups showed decrease in pain intensity and improvement in physical functions. No statistically significant difference was reported between two groups. These results suggest that the lumbar stabilization exercise was performed regardless of lumbar instability.

Recently, a lot of research applying lumbar segmental stabilization exercise to chronic low back pain patients is being conducted[17, 18, 19, 20]. Nonetheless, research focusing on the lumbar instability is insufficient, although there is a close association between low back pain and the lumbar instability and the lumbar instability greatly and positively affect low back pain.

Therefore, this study intends to investigate the effects of lumbar stabilization exercise on physical functions and pain levels of industrial workers with chronic low back pain, and to compare a group with lumbar instability to a group without lumbar instability.

2. Subjects and Method

2.1 Subjects

Among workers with chronic low back pain who attend K tire rehabilitation center, 30 workers who have experienced neither orthopaedic, neurosurgical spinal surgery nor occupational rehabilitation for low back pain in past two years are selected as initial participants. After lumbar instability test, 20 workers with either positive or negative result who agreed upon participating the study were selected as final subjects. The purpose and methods of this study were explained to all the participants, who read and signed an informed consent from that revealed all the details of the study protocol, which were approved by the ethics committee of Honam University (No. 1041223-201504-HR-041-01).

2.2 Methods

Among Lumbar instability was tested by prone instability test[21], posterior shear test[16], and passive lumbar extension test[22]. Those who showed positive results in all three tests were selected to be experimental group, and those who are with negative results in all three tests were selected to be control group. Their muscular strength, flexibility, balance ability, and pain levels were measured so as to examine the changes before and after the experiment.

TF-300-9 by NURYTEC was used for measuring back muscle strength. Subjects were asked to stand with their feet at shoulder width. Maintaining stretched knees, they bended at the waist about 30 degrees and pulled the handle upwards. Back muscle strength was measured by kg. It was measured twice, and the better result was recorded.

TF-300-12 by NURYTEC was used for measuring flexibility. While sitting with knees stretched, subjects slowly bended their upper body. When their middle fingers reached the farthest point and stayed for about 2 seconds, then the gradation was read and recorded by cm. It was measured twice, and the better result was recorded.

TF-300-18 by NURYTEC was used for measuring balance ability. While standing with their feet at shoulder width and their arms spreaded out at shoulder height, subjects closed their eyes and took their one foot off the ground. Time was measured while standing on one foot. It was measured twice, one with the left foot and one with the right foot, and the better result was recorded.

Visual analog scale(VAS), developed by Scott & Huskisson, was used for measuring pain levels. Subjectively sensed low back pain was marked on a 0~10cm line. 0 means no pain, and 10 means the severest pain.

2.3 Exercise program

As for Lumbar stabilization exercise, the program that Imai et al[23] and Akuthota[24] suggested was used with several modifications. The exercise was composed of 10 minutes of warming up, 30 minutes of main exercise, and 10 minutes of cooling down. It was conducted 3 times a week for 8 weeks. Warming up and cooling down was carried out on a treadmill. Subjects held the last motion of each main exercise for 15 seconds and rested 5 seconds before moving to the next exercise. Total 3 sets of exercise were performed with one set of 10 repetitions. It was conducted on the ground for first 4 weeks and on a swiss ball for the rest four weeks. Bridge exercise is performed while subjects are lying supine with their knees bent 90° and their feet flat on the floor. While maintaining the neutral position, hips are raised and paused at the top. Single leg raising in the Bridging is performed by extending, raising, and maintaining one leg in a bridging position. The same is applied to the opposite side. Contralateral arm & leg raising in the bridging is performed by raising and maintaining the opposite arm and leg simultaneously at shoulder height. The same is applied to the opposite side. Single leg heel bridge is performed while lying supine and maintaining the lumbar neutral position. A side of hip and heel are lifted and maintained. The same is applied to the opposite side. Single arm raising in the quadripedal is performed while subjects are on all fours. One arm is slowly raised at shoulder height and maintained. The same is applied to the opposite side. Single leg raising in the quadripedal is performed while subjects are on all fours. One leg is slowly raised at shoulder height and maintained. The same is applied to the opposite side. Single arm & leg raising in the quadripedal is performed while subjects are on all fours. One arm and one leg are simultaneously and contralaterally raised at shoulder height and maintained. The same is applied to the opposite side. Side bridge is performed while lying on side. The upper body is supported by a forearm, and l legs are stretched straight. Hips are raised upward by lateral flexion of spine. The same is applied to the opposite side.

The exercise program is summarized as follows<Table 1>.

<Table 1> Exercise program

warming up	treadmill exercise	10min
main exercise	Bridge exercise Single leg raising in the Bridging exercise Contralateral arm & leg raising in the bridging exercise Single leg heel bridge exercise Single arm raising in the quadripedal exercise Single leg raising in the quadripedal exercise Single leg & arm raising in the quadripedal exercise Side bridge exercise	30min(10 repetitions × 3set) 1-4 week : floor 5-8 week : swiss ball
cooling down	treadmill exercise	10min

2.4 Data analysis

All data are presented as mean±SD, and all statistical analyses were completed using SPSS version 18.0 for Windows. The Shapiro-Wilk test was performed as a test of normality. All statistical tests used an alpha level set at $p<0.05$. Changes from baseline to the end of the intervention were determined using the paired t-test and the independent t-test.

3. Results

3.1 The general characteristics of the study subjects

Subjects were total 20, 10 in the experimental group and 10 in the control group. Subjects were all male. The mean age, mean height, mean weight, and mean years of service of the experimental group were 43.7±5.60 years old, 170.69±2.94㎝, 72.65±6.69㎏, 16.60±8.09 years, respectively. The mean age, mean height, mean weight, and mean years of service of the control group were 45.5±5.95 years old, 171.30±3.24㎝, 69.98±6.44㎏, 18.30±6.46 years. There was no significant difference of general characteristics between groups($p>0.05$)<Table 2>.

<Table 2> The general characteristics of the study subjects

	EG(n=10)	CG(n=10)
Age(years)	43.7±5.60	45.5±5.95
Height(㎝)	170.69±2.94	171.30±3.24
Weight(㎏)	72.65±6.69	69.98±6.44
Work(years)	16.60±8.09	18.30±6.46

Mean±SD. EG, Experimental group; CG, Control group

3.2 Change of back muscle strength

Back muscle strength before the exercise was 54.77㎏ in the experimental group and 54.04㎏ in the control group, and that after the exercise was 59.29㎏ in the experimental group and 55.39㎏ in the control group, which shows statistically significant improvement after the exercise but no significant difference between groups<Table 3>.

<Table 3> Change of back muscle strength

	Pre	Post	p-value
EG(n=10)	54.77±11.79	59.29±12.26	0.003
CG(n=10)	54.04±9.47	55.39±8.97	0.022
p-value	0.880	0.428	

Mean±SD. EG, Experimental group; CG, Control group

3.3 Change of flexibility

Flexibility before the exercise was 2.40 in the experimental group and 2.50 in the control group, and that after the exercise was 3.30 in the experimental group and 3.00 in the control group, which shows no significant difference in both groups<Table 4>.

<Table 4> Change of flexibility

	Pre	Post	p-value
EG(n=10)	2.40±3.47	3.30±3.43	0.054
CG(n=10)	2.50±3.37	3.00±2.54	0.177
p-value	0.949	0.827	

Mean±SD. EG, Experimental group; CG, Control group

3.4 Change of balance ability

Balance ability before the exercise was 9.10 seconds in the experimental group and 8.80 seconds in the control group, and that after the exercise was 12.30

seconds in the experimental group and 9.70 seconds in the control group, which shows statistically significant improvement after the exercise but no significant difference between groups<Table 5>.

<Table 5> Change of balance ability

	Pre	Post	p-value
EG(n=10)	9.10±3.41	12.30±3.62	0.000
CG(n=10)	8.80±1.69	9.70±1.42	0.041
p-value	0.806	0.049	

Mean±SD. EG, Experimental group; CG, Control group

3.5 Change of pain

Pain before the exercise was 6.50 scores in the experimental group and 4.50 scores in the control group, and that after the exercise was 6.80 scores in the experimental group and 5.50 scores in the control group, which shows statistically significant improvement after the exercise but no significant difference between groups<Table 6>.

<Table 6> Change of pain

	Pre	Post	p-value
EG(n=10)	6.50±0.71	6.80±1.32	0.000
CG(n=10)	4.50±0.85	5.50±0.97	0.004
p-value	0.534	0.025	

Mean±SD. EG, Experimental group; CG, Control group

4. Discussion and Conclusion

Assessing lumbar instability of chronic low back pain patients are very important for proper treatment and prognosis determination[25].

Lumbar stability means stable, continuous moving status rather than maintaining in a static condition[26], and in order to maintain lumbar stability, the passive support of bones and ligaments are needed as well as the interaction of control systems by the central nervous system[27, 28]. Therefore, strengthening active support by exercise can improve physical functions and pain levels of low back pain patients by recovering spinal stability.

When low back pain patients move their nether extremities, lumbar instability can be caused due to the decline of the interaction between the law back and pelvic muscles, which leads to abnormal posturing and delay in reaction time[29, 30, 31]. Moreover, amyotrophia may occurs to muscles surrounding the spine, which worsens lumbar instability by degenerating physical functions such muscle strength, muscle endurance, and flexibility. and this causes a vicious circle; as a result, low back pain becomes chronic[32, 33]. Patients with chronic low back pain have weak lumbar muscle strength compared to patients with acute low back pain[34, 35]. Especially, industrial workers are prone to chronicization due to anatomical and physiological factors and their repetitive work of lifting and carrying heavy objects[36].

Lumbar stabilization exercise is an exercise that induces postural control and motor control by activating reduced sensory function and central regulation function[27]. By inducing cocontraction of synergist and antagonist, lumbar stabilization exercise improves trunk stability, which can have positive effects on chronic low back pain patients with lumbar instability, and that is the reason for this clinical experiment.

In this study, back muscle strength and balance ability improved significantly after lumbar stabilization exercise, and pain levels declined significantly. Moreover, when both groups are compared, the experimental group showed significant improvement in balance ability and significant reduction in pain levels.

Critchley et al[19] reported that when usual outpatient physiotherapy, spinal stabilization exercise, and physiotherapist-led pain management were compared, spinal stabilization exercise group showed the most significant improvement according to Roland Disability Questionnaire score. Muthukrishnan et al[20] reported in their study that compared conventional physiotherapy group and core stability exercise group with healthy control group, ground reaction forces, which provide the index for static balance ability, showed more significant improvement than general physical therapy group. Also, Franca et al[13], after comparing lumbar stabilization exercise and muscular strengthening in aspecific chronic low back pain patients, reported that lumbar stabilization exercise showed more significant decrease in VAS and Oswestry disability questionnaire score.

This result is interpreted as that lumbar stabilization exercise applied to chronic low back pain patients improved the muscular functions of maintaining center of gravity, which decreased postural sway and improved balance ability. Accordingly, muscle balance could equally distribute the load applied to spinal muscle resulting in pain relief.

As a result, we come to this conclusion that lumbar stabilization exercise for 8 weeks is effective in relieving pain by improving the balance ability of CLBP with lumbar instability and resultingly muscle efficiency.

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