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Original Article

The effects on postural control and low back pain according to the types of orthoses in chronic low back pain patients

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Abstract. [Purpose] This study investigated how types of lumbosacral orthoses applied to patients with chronic lumbar pain affect postural control and low back pain. [Subjects and Methods] Ten subjects were randomly selected and allocated to each a group wearing soft lumbosacral orthoses and a group wearing rigid lumbosacral orthoses. They wore the lumbosacral orthoses for 4 weeks. Pain index and postural control were measured on the first day of wearing lumbosacral orthoses and 4 weeks later. Pain index was evaluated using a visual analogue scale, and postural control was measured using a Balance measurement system. The measurements examined included the overall balance index, anteroposterior balance index, and mediolateral balance index. [Results] There were statistically meaningful within-group differences in all variables, the visual analogue scale, overall balance index, anteroposterior balance index, and mediolateral balance index, in the group wearing soft lumbosacral orthoses. There were meaningful differences in visual analogue scale, overall balance index, and mediolateral balance index in the group wearing rigid lumbosacral orthoses. Furthermore, there was a meaningful difference in anteroposterior balance index between the group wearing soft lumbosacral orthoses and the group wearing rigid lumbosacral orthoses. [Conclusion] The results of the present study showed that wearing soft lumbosacral orthoses was more effective than wearing rigid lumbosacral orthoses.

Key words: Soft lumbosacral orthoses, Rigid lumbosacral orthoses, Low back pain

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INTRODUCTION

Low back pain is a pain appearing between 12th rib and hip with or without leg pain[1)]. It is one of the most common diseases, and the prevalence rate of this disease is 60 to 85% over the course of an entire lifetime and 15 percent among adults[2, 3)]. About 10% of patients with low back pain have low back pain for more than 6 weeks, and 5% of these patients have pain for more than 3 months. So low back pain brings about a decline in physical activity due to difficulties faced in daily living and emotional stress. It has negative effects such as muscle atrophy, decrease of muscle strength and bone density, and deformation of the musculoskeletal system through loss of the balance of the normal spine[4)]. Patients with low back pain are given improper sensory information on the location of the body in relation to gravity and supporting surfaces due to changes in the character and quantity of proprioceptive inputs from muscle spindles, Golgi tendon organs, joints, and skin receptors[5)]. Various problems occur in the somatosensory system of patients with chronic low back pain. Decrease of the mobility and stability of the waist occurs in these patients, and these bring about a decline of muscle strength and coordination capability

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and a change in proprioception[6, 7]. These disabilities of the musculoskeletal system affect balance performing ability and limit use of a proper exercise strategy in perturbation[3]. In particular, patients with low back pain have a decreased balance ability compared with normal individuals[5]. When the human body is exposed to an unexpected load, muscles have to respond quickly to maintain the body's balance and posture against the load. It is said that patients with low back pain will have problems with balance and maintaining posture caused by a delayed response time[8, 9]. In patients with low back pain, wearing an orthosis is considered a method of solving these problems, as it provides mechanical support and psychological stability. As a result, it decreases low back pain by decentering the weight of the upper body concentrated on the waist[10]. In particular, it is said that it can stabilize the lumbosacral area by decreasing lordosis and segmental movement of the lumbar body[11]. Orthoses can be divided into soft and rigid orthoses according to the material comprising them. Soft orthoses are called corsets or belts and are made from a neoprene material. They can increase the intra-abdominal pressure and improve low back pain by altering the muscles around the trunk and abdomen. Rigid orthoses are made from polyethylene and are prescribed to limit movement of the spine locally or segmentally[12, 13]. There is lack of research on comparing these two types of orthoses. Therefore, the aim of this study was to investigate how application of these two types of lumbosacral orthoses to patients with chronic low back pain affects postural control and low back pain.

SUBJECTS AND METHODS

The institutional review board of Sehan University approved the research ethics of this research as a clinical trial (document number 2016-2), and all subjects understood the purpose of the study very well and provided written informed consent prior to participation in the study, in accordance with the ethical standards of the Declaration of Helsinki. Twenty patients with chronic low back pain were registered as subjects for this prospective experimental research. The experiment was conducted during the 4 weeks starting on March 14, 2016, and ending on April 8, 2016. This research selected subjects who had low back pain for more than 3 months and no vestibular disease or disease in the ear, nose, and throat. Furthermore, it selected patients who had no neuropsychiatric impairments, visual handicaps, or episodes of dizziness or mild headache. Ten subjects were randomly assigned to each of a group wearing soft orthoses and a group wearing rigid orthoses (Table 1). They wore the orthoses for 4 weeks, and the pain index and postural control were measured on the first day they wore the orthoses and 4 weeks later. Pain index was evaluated using a visual analogue scale (VAS). Postural control was measured using a Biodex System 3 isokinetic dynamometer (Biodex Medical System, Shirley, New York, USA). Subjects stood on a fixed foot plate for measurement of postural control. The foot plate was set such that it could move within a range of 5 degrees so that the central point of the subjects could be adjusted before testing. It has the following limits with respect to movement: 8 degrees anterior, 4 degrees posterior, and 16 degrees lateral. The mean angle out of center based on biomechanics was measured and converted into a stability index. A low stability index indicates a stable state, and a high stability index indicates an unstable state. The measurements examined included the overall balance index (OBI), anteroposterior balance index (API), and mediolateral balance index (MBI). The change in overall movement was measured with the OBI, the change in the sagittal plane was measured with the API, and the change in the coronal plane was measured with the MBI. Data analysis was performed using PASW Statistics for Windows, Version 18.0 (SPSS Inc., Chicago, IL, USA), and the general characteristics of the subjects were tested for normality using the Shapiro-wilk test. The paired t-test was used to compare changes within groups, i.e., the rigid orthoses group and soft orthoses group. ANCOVA was used to compare changes between groups. The significance level was set to α=0.05.

RESULTS

The results of comparison by paired t-test between before and after application of the orthoses revealed statistically meaningful within-group differences in all variables, i.e., VAS ($p<0.01$), OPI ($p<0.05$), API ($p<0.001$), and MBI ($p<0.05$), in the group wearing soft orthoses (Table 2). There were meaningful differences in VAS, OBI, and MBI in the group wearing rigid orthoses ($p<0.05$) (Table 3). Furthermore, the results of comparison between the groups by ANCOVA revealed that there was a meaningful difference in API in the group wearing soft orthoses ($p<0.01$). The results showed that wearing soft orthoses was more effective than wearing rigid orthoses (Table 4).

DISCUSSION

This study compared pain index and postural control measurements between before and after wearing soft lumbosacral orthoses and rigid lumbosacral orthoses for 4 weeks in 20 subjects with chronic low back pain (10 in each group) to investigate the effects on postural control and pain. It has been reported that patients with low back pain exhibit a decrease in endurance, decrease in flexibility, and limited range of motion and also that these symptoms affect balance ability compared with normal individuals[5, 14]. Lumbosacral orthoses for patients with low back pain can decrease low back pain and help to improve balance ability by stabilizing the lumbosacral area[10, 11]. Redford et al.[15] reported that lumbosacral orthoses used a lot by patients with low back pain can mitigate pain by limiting movement of the trunk and decreasing the load on the waist by transmitting forces applied to intervertebral discs to soft tissue surrounding the abdomen. Million et al.[16] divided their

subjects into a group wearing a lumbosacral corset and a group not wearing the corset. They showed that pain decreased in the group wearing the lumbosacral corset. Sinaki et al.[17] reported that wearing a spinal weighted kypho-orthosis can increase location awareness of the vertebral joint or proprioception, in improve balance and walking quality, and decrease low back pain by increasing the strength of the back extensor muscle patients with osteoporosis-kyphosis over 60 years old and at risk of falls. The present study supported advanced research through the result that pain decreased in both groups, i.e., the soft lumbosacral orthoses and rigid lumbosacral orthoses groups. It is considered that the mechanical characteristics of lumbosacral orthoses decrease pain by increasing the stability of the spine and pelvis. Vogt et al.[18] showed that lumbosacral orthoses can increase joint position sense by increasing afferent proprioceptive inputs through mechanoreceptors of the skin and facilitate voluntary extension of the spine, improve posture, and decrease lordosis of the spine effectively by providing presentment about proper skill of movement and that it can help to maintain proper posture in the lumbar vertebrae via the three-point pressure principle. Kawaguchi et al.[19] reported that a lumbar orthosis increased the muscle strength of the back and abdomen and decreased muscle activity in their study of 31 men. It is said that a lumbar orthosis can enable muscles to work effectively to perform a task. Ivanic et al.[20] reported that the soft spine orthosis, as a corset type, is designed to increase passive stability and uprightness of the waist compared with those resulting from use of a rigid spine orthosis. They also said that soft lumbosacral orthoses are more effective than rigid lumbosacral orthoses. The present study showed that OBI, API and MBI decreased meaningfully between before and after the experiment in the soft orthoses group but that there were meaningful differences in only OBI and MBI in the rigid orthoses group. These result showed that the soft orthoses were more effective than the rigid orthoses in the present study. This supports the findings of previous studies indicating that orthoses do not affect the activity of the abdominal muscles or the ability of the lumbar vertebrae joints in spite of the fact that they became the cause of a decrease in muscle activities or the cause of stiffness in the waste[20, 21]. The API represents the change in postural control in the sagittal plane. Rigid orthoses are mainly prescribed to protect the spine or facilitate healing and to limit movement of the spine locally or segmentally[13]. It has also been reported that spinal orthoses affect erector spinae muscle more than abdominal muscles[21]. A rigid orthosis limits the movement of the spine by more than a soft orthosis. So, it is considered that a rigid orthosis affects a change in postural control in the sagittal plane by decreasing the activities of muscles surrounding the waste. These result will help to prepare baseline data providing related information with proper mediation about wearing lumbosacral orthoses rightly. The limitations of this study included that there was no control group and a lack of diversity with respect to the experiment period. Also, the duration the subjects wore the orthoses was not controlled exactly, and it was difficult to generalize. It is considered that prospective studies controlling the study period and

Table 1. Characteristics of the subjects

Variables	Soft orthoses group (n=10)	Rigid orthoses group (n=10)
Age (years)	59.4 ± 5.4[a]	57.3 ± 6.2
Height (cm)	161.1 ± 4.72	161.8 ± 7.79
Weight (kg)	60.9 ± 7.46	60.4 ± 7.85

[a]Mean ± SD

Table 2. Comparison of pre- and post-intervention results in the soft orthoses group

Variables	Soft orthoses group (n=10)	
	Pre-test	Post-test[b]
VAS (score)	3.3 ± 1.64[a]	2.1 ± 1.52**
OBI (°)	1.9 ± 0.51	1.47 ± 0.36*
API (°)	2.18 ± 0.09	1.85 ± 0.07***
MBI (°)	1.21 ± 0.09	1.14 ± 0.09*

[a]Mean ± SD. [b]Paired t-test.
*p<0.05; **p<0.01; ***p<0.001.
VAS: visual analogue scale; OBI: overall balance index; API: anteroposterior balance index; MBI: mediolateral balance index

Table 3. Comparison of pre- and post-intervention results in the rigid orthoses group

Variables	Rigid orthoses group (n=10)	
	Pre-test	Post-test[b]
VAS (score)	3.8 ± 1.75[a]	2.3 ± 1.7*
OBI (°)	2.03 ± 0.76	1.84 ± 0.61*
API (°)	2.11 ± 0.09	2.02 ± 0.19
MBI (°)	1.23 ± 0.11	1.18 ± 0.11*

[a]Mean ± SD. [b]Significance was tested by paired t-test.
*Within-group comparison (p<0.05)

Table 4. Comparison pre- and post-intervention results between groups

Variables	Group	Pre-test	Post-test[b]
VAS (score)	Soft orthoses group	3.3 ± 1.64[a]	2.1 ± 1.52
	Rigid orthoses group	3.8 ± 1.75	2.3 ± 1.7
OBI (°)	Soft orthoses group	1.90 ± 0.51	1.47 ± 0.36
	Rigid orthoses group	2.03 ± 0.76	1.84 ± 0.61
API (°)	Soft orthoses group	2.18 ± 0.09	1.85 ± 0.07*
	Rigid orthoses group	2.11 ± 0.09	2.02 ± 0.19
MBI (°)	Soft orthoses group	1.21 ± 0.09	1.14 ± 0.09
	Rigid orthoses group	1.23 ± 0.11	1.18 ± 0.11

[a]Mean ± SD. [b]Significance was tested by ANCOVA.
*Between-group comparison (p<0.05)

duration the orthoses are worn exactly and including a control group will be needed on the utility of orthoses prescribed as a therapy method for patients with low back pain.

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