

Original Article

## The effect of actively induced vibration using shoulder joint on pain and dysfunction in patients with low back pain

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**Abstract.** [Purpose] This study aimed to determine the effect of a Flexi-Bar exercise program with vibration stimulation on pain and dysfunction in patients with low back pain. [Subjects and Methods] This study included 30 patients with low back pain. The participants were divided into a control (n=15) group and an experimental group (n=15). General physical therapy was used in both groups. A Flexi-Bar exercise program with vibration stimulation was used in the experimental group. The Visual Analog Scale was used to measure pain severity. The Oswestry Disability Index was used to measure the extent of dysfunction due to low back pain. [Results] The VAS and ODI of the experimental group showed a significant difference compared to that of the control group. [Conclusion] The results show that a Flexi-Bar exercise program with vibration stimulation is effective in alleviating pain and dysfunction in patients with low back pain.

**Key words:** Flexi-Bar, Pain, Dysfunction

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### INTRODUCTION

Patients with low back pain experience continuous pain, and dynamic contributory factors include malfunction of the lumbar muscles, including the internal oblique, transversus abdominis, and multifidus<sup>1)</sup>. Lower limb and waist pain are increased on walking and standing in patients with low back pain<sup>2)</sup>. Low back pain is caused by lumbar instability, with weakened muscles, soft tissue damage, and degenerative changes. Lumbar stability enables conscious or unconscious control of major and minor joint movements<sup>2, 3)</sup>. To perform fluid movements, harmonious co-contraction is required between the deep muscles (which correctly maintain lumbar alignment and provide stability) and the superficial muscles (which manage external loads or enable psychokinesis)<sup>3, 4)</sup>. Stabilizing exercise induces co-contraction of trunk muscles and improves posture stability by restoring the ability to control functional posture and movement<sup>5)</sup>. Such exercise is essential for lumbar pain patients, because it is not subject to limitations of place, time, or cost<sup>6)</sup>. Although stabilizing exercise has its benefits, a limitation is the need for the assistance of a therapist to accurately perform movements; similar to isometric exercise, it is difficult to motivate participation to prevent recurrence of disease, and to correctly determine the amount and intensity of exercise<sup>5, 6)</sup>. The Flexi-Bar is a 152-cm-long flexible bar that transmits 5-Hz vibration stimulation to the entire body and stimulates muscular activity of the limbs and trunk while the user actively shakes the flexible bar<sup>7)</sup>. The Flexi-Bar is safe at low-amplitude vibration stimulation, and can easily be used without special techniques<sup>7)</sup>. The speed and amplitude of vibration caused by the Flexi-Bar can be controlled by active vibration stimulation release by the user<sup>7, 8)</sup>. A strong point is that

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**Table 1.** General characteristics of subjects

	Experimental group (n=15)	Control group (n=15)
Gender (male/female)	8/7	7/8
Age (years)	60.0 ± 11.0 <sup>a</sup>	63.6 ± 7.6
Weight (kg)	67.0 ± 4.9	68.4 ± 8.0
Height (cm)	168.6 ± 8.0	165.4 ± 7.7

<sup>a</sup>Mean ± SD.

**Table 2.** Comparison of the results of the VAS and ODI between the experimental and control groups

	Group	Pre	Post	Difference value
VAS (score)	Experimental group	6.8 ± 0.9	3.7 ± 1.3*	-3.1 ± 1.7 <sup>#</sup>
	Control group	6.0 ± 0.8	5.7 ± 0.7	-0.3 ± 0.6
ODI (score)	Experimental group	35.4 ± 3.1	29.8 ± 1.8*	-5.5 ± 3.4 <sup>#</sup>
	Control group	33.8 ± 2.7	32.9 ± 2.1	-0.9 ± 1.7

<sup>a</sup>Mean ± SD, VAS: Visual Analog Scale; ODI: Oswestry Disability Index.

\*p<0.05: Significant differences between pre- and post-test.

<sup>#</sup>p<0.05: Significant differences between the experimental and control groups.

it can be performed in various positions safely and easily<sup>8</sup>). Monfort-Pañego et al.<sup>9</sup>) reported that the Flexi-Bar can improve lumbar stability if used in the correct position, posture, and amplitude. This study aimed to determine the effect of a Flexi-Bar exercise program with vibration stimulation on pain and dysfunction in patients with low back pain.

## SUBJECTS AND METHODS

This research was aimed at chronic lumbar pain patients with more than 3 months of symptoms. Thirty subjects who understood the nature of the research volunteered to participate in the experiment; 15 subjects (7 men, 8 women) were randomly assigned to the control group, and 15 (7 men, 8 women) to the experimental group. Inclusion criteria were lumbar pain lasting more than 3 months, no history of spine surgery, and the ability to exercise. A history of spine surgery, neurologic symptoms or injury, or inflammatory joint disease were reasons for exclusion. This study complied with the ethical standards of the Declaration of Helsinki, and written informed consent was received from each participant. The ethics committee of Nambu University approved this study. The general characteristics of the participants are presented in Table 1. The mean age, height, and weight were 60.0 ± 11.0 yrs, 168.6 ± 8.0 cm, and 67.0 ± 4.9 kg in the experimental group and 63.6 ± 7.6 yrs, 165.4 ± 7.7 cm, and 68.4 ± 8.0 kg in the control group, respectively. All subjects received lumbar thermotherapy for 30 minutes, electrotherapy for 20 minutes, and ultrasonic therapy for 5 minutes. Both the experimental and control groups stopped drug therapy throughout the course of this research. Additionally, Flexi-Bar exercise with vibration stimulation was provided to the experimental group 5 times a week for 6 weeks. The Flexi-Bar is 153 cm long, weighs 710 g, and is 9.5 mm thick. Exercise can be controlled by changing its weight or thickness. The Flexi-Bar vibrates 270 times per minute, and can be used to exercise the shoulder joint and entire body. Vibration at approximately 5 Hz causes simultaneous contraction of the shoulder and trunk muscles, improves muscular strength and stability in the shoulders and trunk, and enhances proprioceptive sensation. We made the participant hold a Flexi-Bar horizontally with them standing up to start vibration exercise laterally for 10 seconds; then, he was made to hold it vertically to do for the same time. Also, we set 10 times as one set and applied 10 sets. The Visual Analog Scale (VAS) was used to measure pain severity. A linear scale marked 0–10 shows the extent of pain. No pain is defined as 0; maximum pain is 10. VAS is also a highly reliable evaluation method that had study subjects directly mark the degree of pain. The Oswestry Disability Index (ODI) was used to measure the extent of dysfunction due to lumbar pain. The extent of pain, personal hygiene, holding objects, walking, sitting, standing, sleeping, social activity, sexual activity, and travel and movement are included. ODI is a highly reliable evaluation method that consists of 10 questions, with a total score of 50 points ranging from 0 to 5 on a 6-point scale. It can be judged that the higher the total score is, the higher the functional disorder of low back pain patient is. SPSS statistics 19.0 (SPSS, Chicago, IL, USA) software was used to analyze collected data. The paired t-test was used to compare the extent of pain and dysfunction of the experimental and control groups before and after exercise. The independent t-test was used to compare differences between groups. Statistical significance level was set to  $\alpha=0.05$ .

## RESULTS

The changes in the results of the VAS and ODI are presented in Table 2. There were significant differences in these results before and after the experimental intervention. On comparison between the groups, there were greater improvements in the results of the VAS and ODI in the experimental group.

## DISCUSSION

The purpose of this research was to determine the effect of a Flexi-Bar exercise program with vibration stimulation on pain and dysfunction in patients with lumbar pain. A clear difference in pain severity was seen in the VAS of the experimental group. In the comparison between groups, the VAS of the experimental group showed greater differences than the control group. Yang and Seo<sup>10)</sup> reported that pain was alleviated after applying vibration stimulation in patients with lumbar pain. Kim et al.<sup>11)</sup> reported that vibration stimulation using a sling alleviates lumbar pain. Vibration is a convenient, safe, and inexpensive therapeutic method that has been used to control pain<sup>10)</sup>. Vibration stimulation excites receptors that sense vibration and transfer the pain that is controlled by A- $\beta$  and large myelinated nerve fibers<sup>12)</sup>. Vibration decreases the levels of substance P-like immunoreactivity in the CSF<sup>13)</sup>. It also has a neurophysiologic placebo effect that reduces transfer of pain from the peripheral pain receptors to the brain<sup>12, 13)</sup>. On the basis of this result, we can state that the Flexi-bar exercise program with vibration stimulation helps to alleviate lumbar pain. Pain is not only troublesome; it also causes functional problems through abnormalities of posture and stability of the trunk<sup>14)</sup>. Kim et al.<sup>11)</sup> reported that vibration stimulation with a sling decreased the ODI in patients with lumbar pain and improved their functional ability. Moreside et al.<sup>14)</sup> reported that Bodyblade training with vibration stimulation improves core stability of the trunk by activating the deeper muscles. In our study, the ODI score improved significantly in the experimental group. Bogaerts et al.<sup>15)</sup> reported that vibration stimulation activates the muscle spindles and strengthens the muscles that maintain posture stability by improving proprioceptive sense. When vibration stimulation is applied, mobilization of  $\alpha$ -motor neurons is increased and the core muscles of the trunk are activated by strengthening neuromuscular control and increasing proprioceptive sense<sup>16)</sup>. Vibration stimulation acts on the  $\alpha$ -motor neurons, causes contraction of the muscle belly and tendons, and thereby gives rise to myotonic vibration reflection<sup>15, 16)</sup>. This increase in the proprioceptive sense of the muscle is thought to increase muscular activity, as it enables the muscle to carry a greater external load<sup>17)</sup>. The vibration stimulation caused by the Flexi-bar exercise program stimulates the mechanical receptors of the articular capsule of the lumbar joints, enables greater control of posture and motor sense, and improves stability between spinal segments<sup>15-17)</sup>. This study showed that vibration exercise using shoulder joint facilitated proprioception and had an influence on trunk stabilization, and had a positive influence on decreasing the pain and improving the functional disorder of low back pain patients. The limitations of this study were that the physical characteristics and habits of the patients could not be modified. Additionally, as the sample size was small, the results cannot be generalized and applied to all patients with lumbar pain. Further studies with larger samples are required.

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