



Original Article

Effects of increased standing balance on pain in patients with knee osteoarthritis

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Abstract. [Purpose] The purpose of this study was to examine the relationship between standing balance increased through muscle-strengthening exercises and pain in knee osteoarthritis patients. [Subjects and Methods] Thirty knee osteoarthritis patients were equally divided into a strengthening exercise group and an unstable exercise group. Before and after the six-week experiment, the visual analogue scale was measured, and bilateral one-leg standing tests were performed. [Results] In both the strengthening exercise group and unstable exercise group, the bilateral one-leg standing time significantly increased after the six-week experiment. Regarding the visual analogue scale, a pain measurement scale, the strengthening exercise group had significantly decreased pain. The unstable exercise group also had decreased pain, but the decrease was not statistically significant. [Conclusion] In knee osteoarthritis patients, exercises using an unstable base of support and knee-extensor strengthening exercises with gradually increased loads had a positive effect on improving balance ability and decreasing pain.

Key words: Osteoarthritis, Knee pain, Knee exercise

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INTRODUCTION

Osteoarthritis (OA) triggers continuous changes and destruction of the joints, and it is a financial burden for patients. Both the information provided by patients and a scientific approach to their treatment may have positive effects on the health of OA patients' joints and clinical risk¹⁾.

In patients with OA, knee pain is a main pathological symptom, which may cause decreased muscle strength. Interventional treatment through muscle-strengthening exercises in the rehabilitation process may reduce pain and resolve the functional restrictions caused by pain²⁾. A study of arthritic patients aged 55 and older found that muscle function decreased, and there was a significantly negative relationship between age and the maximal contractibility of the quadriceps femoris muscle³⁾. In another study, patients with degenerative knee arthritis who conducted knee extensor and flexor strengthening exercises for 12 weeks saw their pain and functional restrictions decrease, and range of motion increase⁴⁾.

In a study on knee OA, radiological examination showed that the cartilage surface was degenerated, worn, and eroded. However, pain is subjective and may exhibit differences from radiological results. The perception of pain also differs according to individual conditions (physical and environmental)^{5, 6)}.

Therefore, the purpose of the present study was to examine knee OA patients whose physical conditions were controlled in order to conduct knee extensor muscle-strengthening exercises and standing balance exercises, as well as to examine the relationship between increased standing balance and subjective pain.

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SUBJECTS AND METHODS

The subjects were 30 bilateral knee OA patients with grading scores of 1 or 2 based on the four grades used in the Kellgren-Lawrence system. The subjects were selected based on their pathological history and their diagnosis by an orthopedist and a physical therapist. They were equally divided into a strengthening exercise group (SEG = 15) and an unstable exercise group (UEG = 15). The subjects were knee OA patients younger than 65 years who had full range of motion in the knee joints and who had not received surgical treatment on their legs. Patients whose ability to maintain balance was restricted because of central nervous system disease or visual sense disease were excluded.

The general characteristics of the subjects were as follows: 61.47±2.26 years and 62.40±2.61 years for age, 158.33±4.32 cm and 159.60±5.33 cm for height, and 65.40±6.02 kg and 64.07±5.65 kg for weight in the SEG and UEG respectively. There was no statistically significant difference in the general characteristics of the two groups. All the patients understood the purpose of the study and provided written informed consent prior to participation, which was in accordance with the ethical standards of the Declaration of Helsinki.

The SEG conducted knee extension exercises in a sitting posture by gradually increasing the weight from 0 kg to 2 kg and then to 4 kg within the limit of no pain. The UEG stood on an unstable mat for one week and then on an air cushion (TOGU, Prien am Chiemsee, Germany) to increase their ability to support their weight on an unstable base. Both groups performed the exercises twice a day for 15 minutes in each session for six weeks. When the subjects complained of fatigue, they were allowed to rest, and then the exercise was renewed.

Before and after the six weeks of exercise, one-leg standing (OLS) tests of the bilateral legs were conducted. To conduct measurements, a subjective visual analogue scale (VAS) was divided into a maximum of 1 and a minimum of 10. To compare the two groups, an independent samples t-test and a paired samples t-test were conducted. The statistical significance level was set at $p < 0.05$, and the PASW Statistics 18.0 version was utilized.

RESULTS

Prior to the experiment, there were no statistically significant differences between the SEG, which exercised with gradually increasing weights, and the UEG, which stood on an unstable base of support. After the six-week experiment, there were also no statistically significant differences between the two groups (Table 1). However, comparison between before and after the experiment in each group showed significant increase in OLS of the bilateral legs and a significant decrease in VAS in the SEG ($p < 0.05$), there was a numerical decrease in VAS in the UEG, but the difference was no statistical significance.

DISCUSSION

The purpose of this study was to examine the effects of muscle-strengthening exercise of the knee extensors and balance ability through standing exercise on an unstable base of support on the decrease in pain in OA patients.

Changes in knee joints that result from aging include weakening of the quadriceps femoris muscle and inability to extend the knee joints completely when the heels contact the ground. Consequently, the step length is reduced, the base of support is narrowed, and balance ability is decreased⁶. Ryo et al.⁷ suggested including change of duration and frequency in strength exercise programs for OA patients because changes of duration and frequency of leg-strengthening exercises decrease knee pain.

In a recent study that examined muscle strengthening of the knee extensors through a two-month home treatment program for knee OA patients, the subjects feared falling and exhibited unstable body sway⁸. The results showed that muscle-

Table 1. Results of testing in the SEG and UEG before and after the interventions

Test		SEG	UEG
		Mean ± SE	Mean ± SE
ROLS (sec)	Before	6.93 ± 0.43	6.67 ± 0.35
	After 6 weeks	7.87 ± 0.31	8.47 ± 0.26
LOLS (sec)	Before	7.13 ± 0.32	6.80 ± 0.22
	After 6 weeks	8.13 ± 0.29	8.47 ± 0.31
VAS	Before	3.80 ± 0.18	3.60 ± 0.19
	After 6 weeks	3.33 ± 0.19	3.40 ± 0.19

SEG: strengthening exercise group; UEG: unstable exercise group; ROLS: right one-leg standing; LOLS: left one-leg standing; VAS: visual analogue scale
Data are expressed as the mean ± standard deviation.

strengthening exercises applied to the knee extensors positively affected standing balance ability, such as by increasing the bilateral OLS maintenance time.

Knoop⁹⁾ applied a home exercise program that included muscle-strengthening exercises and balance exercises six minutes per week for 12 weeks in 159 patients with knee instability, including knee OA. The results showed that the participants' knee instability and pain decreased. In a study of the effects of pain in the knee joints on knee muscle strength, the intensity of the pain restricted knee flexion and extension. In contrast, therapeutic muscle-strengthening exercises decreased articular pain, which was conducive to functional improvement of the legs²⁾. In a five-year longitudinal study of the relationship between the quadriceps femoris muscle and knee-pain aggravation, Glass et al.¹⁰⁾ observed a relationship between the risk of pain aggravation in female OA patients and weakening of the quadriceps femoris muscle. In a study on knee patients, Ahmed et al.¹¹⁾ applied muscle-strengthening exercises to the quadriceps femoris muscle and the hamstring muscle. The results showed decreases in subjective pain, increases in range of motion, and decreases in functional restriction. The results of their research were similar to those of the present study, which found that gradual increases in load led to significant decreases in pain after muscle-strengthening exercises were conducted.

The present study divided the subjects into a muscle-strengthening exercise group and a balance-strengthening exercise group. In the muscle-strengthening group, exercises were performed to strengthen the knee extensor. The results showed no statistical significance between the two experimental groups, and in both groups, there were increases in OLS time and decreases in subjective pain. These results indicate that both the muscle-strengthening exercises and balance exercises stimulated the proprioceptors, which was effective in increasing the knee stability of the OA patients. Moreover, the increase in knee stability was related to the decrease in knee pain.

In conclusion, in early-stage knee OA patients who had not undergone surgery, balance exercises using an unstable base of support and knee extensor muscle-strengthening exercises had positive effects on balance ability, such as in OLS and decreased pain.

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