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Original Article

The effect of horse-riding simulator exercise on the gait, muscle strength and muscle activation in elderly people with knee osteoarthritis

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Abstract. [Purpose] The aim of this study was to examine the effects of horse-riding simulator exercise on gait ability and muscle strength, muscle activation in elderly with knee osteoarthritis. [Subjects and Methods] Thirty elderly patients with knee osteoarthritis were recruited, a horse-riding simulator group consisted of fifteen subjects and they performed exercise three times a week for eight weeks. And each exercise was performed, horse riding simulator exercise for 15 minutes and knee strengthening exercise for 15 minutes. Knee strengthening exercise group consisted of fifteen subjects and performed knee strengthening exercise for 30 minutes. [Results] The horse-riding simulator group showed significant differences after the intervention in timed 10-meter walk test (10MWT), muscle strength, muscle activation. [Conclusion] The results of this study indicate that horse-riding simulator exercise is effective on knee osteoarthritis. Therefore, horse-riding simulator exercise can be used for gait training for knee osteoarthritis.

Key words: Knee osteoarthritis, Horse-riding simulator

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INTRODUCTION

Osteoarthritis is a degenerative disease that is increasing each year. It is caused by several factors, including age, obesity, injury, heredity, and repetitive stress. Osteoarthritis induces structural deformity in the bones and cartilage around the joust, leading to pain, reduced muscular strength, joint dysfunction, and lower quality of life[1–5)]. Duffell et al.[6)] assessed balancing and walking adaptation of patients with early knee osteoarthritis, reporting that the patients with osteoarthritis in their medial knee joints showed reduced postural stability and changed muscular activity patterns. According to research, individuals with mild or moderate bilateral knee osteoarthritis showed weakness in balancing and had a higher risk of falling[7)].

Exercise treatment, electrotherapy, and manual therapy are used in clinical physical therapy to treat pain and dysfunction caused by osteoarthritis[8)]. A simulated horse-riding exercise is one type of physical therapy that may interest patients and motivate them more than other common interventions, as well as significantly affect their balance, bone density, muscular strength, emotions, and walking ability[9, 10)]. Horse-riding simulators are a more convenient therapy option than the horse-riding exercise requiring wide space, and exercise using the simulator is reported to present similar benefits for patients, including significant effects on muscular strength, muscular thickness, and balance[11–13)]. Although Bull and Maary[10)] observed that horse-riding exercise was effective in treating osteoarthritis, few researchers have focused on the effects of horse-riding simulator exercise on walking ability, muscular strength, and lower-limbs activity of older osteoarthritis patients.

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Table 1. General characteristics of the subjects

Variables	HRS exercise group	KS exercise group
Gender (M/F)	7/8	5/10
Age (years)	76.5 ± 8.8	77.7 ± 7.9
Height (cm)	159.3 ± 9.6	157.7 ± 5.8
Weight (kg)	52.4 ± 10.4	55.31 ± 10.1

Mean ± SD: mean ± standard deviation

SUBJECTS AND METHODS

Experimental procedures were performed in accordance with the protocols established by the Institutional Review Board of Daegu University.

The subjects of this study were 30 people who were in a hospital in Y City; they were at least 65 years old, did not experience falling within the past 12 months, and did not have pain to a degree that might affect test performance. Those who had problems with sight, hearing, the nervous system, or the vestibular organ, or who did not understand this experiment, were excluded. All the subjects gave consent for participation after being informed about this study (Table 1).

The participants were divided into two groups: one group participated in a horse-riding simulator exercise (n=15), and one group participated in only knee joint-strengthening exercise (n=15). Both groups performed a 30-minute session of their assigned exercises three times per week for eight weeks. The group that used the horse-riding simulator performed 15 minutes of simulator exercise and 15 minutes of knee-strengthening exercise. The group that performed only knee-strengthening exercise performed straight leg raise-adduction, standing flexion, seated extension, front step ups, and heel raises for a total of 30 minutes. Some of the rehabilitation exercises were designed by Lee and Park[14] based on the accelerated knee joint rehabilitation protocol developed by Shellboume et al[15]. A research assistant demonstrated the horse-riding simulator to help subjects understand how to perform the exercise. The simulator used in this study was a SlimRider (Shinhwa, MX-0004SE, Korea). While on the simulator, the subjects were asked to maintain their posture against movements of the device. A research assistant observed the subjects the whole time in order to prevent falling.

A timed 10-meter walk test (10MWT) was used in this study to assess the walking ability of the participants before and after the intervention. While the subjects walked for 14 meters, we measured the time for the intermediate 10 meters between the first 2 meters of acceleration and the last 2 meters of deceleration. Three trials were performed, and the average value was calculated.

A ME3090 (Sammons Preston, USA) was used to measure the muscular strength of knee extension and flexion. The ME3090 is an analog device that enables measuring the Manual Muscle Test (MMT) for digitization.

A MP35 (Biopac System, USA) was used to measure to electromyography (EMG). Ag-Ag/Cl electrodes (Biopac, diameter 2 cm) were placed on the rectus femoris, the vastus lateralis, the vastus medialis, and the hamstring muscles. The EMG signals were collected at the signal acquisition of 1,000 Hz sampling rate, the signals that were processed by full-wave rectification. The stored data underwent band pass filtering at 30 to 500 Hz using Biopac Student Lab PRO 3.7.1 (Biopac System, USA) and were processed by notch filtering at 60 Hz for noise removal[16].

A paired-samples t-test was performed in order to verify differences within each group before and after the intervention (horse-riding simulator or knee-strengthening exercise), while an independent two-sample t-test was applied in order to compare differences between the two groups. The SPSS 18.0 for Windows was used in statistical processing. The level of statistical significance (a) was set $p<0.05$.

RESULTS

Patients' speed in the 10MWT, their muscular strength, and their EMG values significantly increased after the intervention using the horse-riding simulator exercise ($p<0.05$) (Table 2). No significant differences between the two groups were found before and after the intervention.

DISCUSSION

The results of the 10MWT showed that both the groups using the horse-riding simulator and the control group showed a significant increase in their walking speed after the exercise intervention. These results were consistent with those of Mitani et al.[17], who reported that subjects showed increase in walking ability without significant differences when the subjects walked 5 meters in the 10MWT. Similarly, Kim et al.[18] reported that the results of the 10MWT significantly increased after older adults used the horse-riding simulators. The elderly often show deceleration in walking; those who are at least 63 years old display deceleration by 16% every 10 years. The results of this study suggest that exercise using horse-riding simulators

Table 2. Comparison of measurement values at pre-test and post-test in HRS, KS exercise group

Group	HRS		KS	
Variables	pre	post	pre	post
10MWT (m/s)	10.1 ± 4.1	16.2 ± 5.6**	11.4 ± 1.4	13.0 ± 1.8**
Extension (lbs)	8.9 ± 2.9	9.7 ± 3.0*	6.8 ± 2.0	9.5 ± 3.4*
Flexion (lbs)	8.3 ± 3.3	10.1 ± 3.7*	7.0 ± 1.5	8.9 ± 2.3*
RF (%RVC)	113.3 ± 59.5	197.1 ± 99.4*	154.4 ± 79.7	180.7 ± 77.5*
VL (%RVC)	133.4 ± 62.1	177.9 ± 75.0*	139.7 ± 45.4	159.0 ± 49.2*
VM (%RVC)	110.0 ± 110.4	185.8 ± 129.4*	155.0 ± 81.9	204.0 ± 115.3*
HMS (%RVC)	111.1 ± 62.8	198.6 ± 79.2*	162.3 ± 102.5	187.8 ± 106.9**

Mean ± SD: mean ± standard deviation; 10MWT: 10-meter walk test; RF: rectus femoris muscle; VL: vastus lateralis muscle; VM: vastus medialis muscle; HMS: hamstring muscle
*p<0.05, **p<0.01

positively affects walking ability[19].

Both groups showed significant increase in muscular activity, a result that was consistent with that of Byun[20], who reported that exercise using horse-riding simulators significantly improved activities of the rectus femoris and the biceps femoris muscles. The elderly consistently suffer sarcopenia with aging, a muscular reduction that leads to muscular weakness, decreased activity level, and increased deterioration. The results of this study indicate that exercise using horse-riding simulators significantly improves muscular activity of older participants. Such increased muscular activity might improve stability of the knee joints and induce efficient delivery of power while moving the lower limbs, resulting in improvement in walking and balancing and prevention of falling in both groups.

The results of the muscular strength test in the knee joints in both groups to assess the strength pre- and post-intervention showed that the two groups significantly increased in muscular strength. Similarly, Araújo et al.[9] and Alfredson et al.[21] reported that the muscular strength of the lower limbs significantly increased after eight weeks of horseback riding. The muscle strength was increased by maintaining balance in the correct posture during horse riding simulator exercise[10]. Increased lower limb strength, pelvic movements by horse riding simulator improved gait ability[9, 22]. The muscular strength of the limbs is reduced by 8% every 10 years after the age of 30, and the reduction is accelerated in such a way that 20% to 40% of the mean muscular strength of healthy males and females is reduced between the age of 70 and 80[18]. The results of this study may be significant in that the muscular strength of the older people significantly increased.

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