The effects of horseback riding simulator exercises on the muscle activity of the lower extremities according to changes in arm posture

Jungseo Park, PhD, PT1), Sangyong Lee, PhD, PT2), Daehee Lee, PhD, PT2)*

1) Department of Physical Therapy, Daejeon Institute of Science and Technology, Republic of Korea
2) Department of Physical Therapy, Youngdong University: 310 Youngdong-eup, Youngdong-gun, Chungbuk 29131, Republic of Korea

Abstract. [Purpose] This study aimed to determine the effects of horseback riding simulator exercise on the muscle activities of the lower extremities according to changes in arm posture. [Subjects] The subjects of this study were 30 normal adult males and females. [Methods] The horseback riding simulator exercise used a horseback riding simulator device; two arm postures were used, posture 1 (holding the handle of the device) and posture 2 (crossing both arms, with both hands on the shoulders). Electromyography was used to compare the muscle activities of the rectus femoris, biceps femoris, and hip adductors in the lower extremities. [Results] Posture 2 had significantly higher muscle activity than posture 1. [Conclusion] Posture 2, which entailed crossing both arms with both hands on the shoulders, was an effective intervention for improved muscle activity in the hip adductors.

Key words: Horseback riding simulator exercise, Muscle activity, Arm posture

INTRODUCTION

Because horseback riding has long been known to be an excellent full-body exercise around the world, it has been widely used not only for body exercise and mind training but also for rehabilitation exercise and therapy for various disabilities1).

Despite the many advantages of horseback riding as a recreational and sporting activity, it has not been very popular in South Korea due to the high cost and space limitations. Much attention thus has been paid to horseback riding simulators that can be used in indoor spaces at any time as a new type of exercise tool that allows the general public to enjoy the physical and mental benefits of horseback riding2). A previous also found that both real and simulated horseback riding showed significant effects on trunk and leg muscles3), and muscle activity during horseback riding simulator exercises significantly activated muscles for full-body muscle development and postural control5). Janura et al.4) reported that horseback riding simulator exercises were closely correlated with endurance, agility, coordination, flexibility, balance, and aerobic and anaerobic capacity and that horseback riding training devices or horseback riding simulator training (which utilizes similar motions as real horseback riding) can affect balance and postural control in individuals with disabilities.

SUBJECTS AND METHODS

This study selected 30 healthy subjects (fifteen males and fifteen females) who were 19 years old and attending Y University in Chungbuk, South Korea. The selection criteria were no abnormal health problems and no lesions in the lower extremities in the last six months. Subjects were given information about the purpose and methods of the study prior to the experiment; they gave voluntary consent to participate in the experiment and signed a consent form, in accordance with the ethical standards of the Declaration of Helsinki. Mean age, mean height, and mean weight of the subjects were 19.8±0.6 years, 169.4±9.0 cm, and 61.4±8.7 kg, respectively.

Subjects performed a full-body exercise program to gain the full-body effects of the horseback riding simulator exercise device (FRTIS, Seoul, South Korea). There were two positions for the arms: a posture in which the handle of the exercise device was held (P1) and a posture in which the arms were crossed and both hands were put on the shoulders (P2). To prevent subjects from falling while riding, two assistants who were trained to stop the device automatically kept an eye on the subjects. To prevent subjects from becoming physically fatigued, the P1 exercise was performed in the morning, while the P2 exercise was done in the afternoon.
The horseback riding simulator device was similar to actual horse size, and exercise intensity could be adjusted by controlling saddle movement, speed, and range. Actual equine motions were reproduced mechanically with a 3,350 RPM motor that reciprocated 190 times per min, generating short and fast three-dimensional figure-8 movements.

In order to measure changes in muscle activity, electromyography (MP150, BIOPAC Systems Inc., Santa Barbara, CA, USA) was used, while the surface electrodes were attached to the transverse rectus femoris (RF), the biceps femoris (BF), and the hip adductors (HAs). Data were collected for five min; data obtained during the first one min and last one min were excluded, so only data from the middle three min were used. The average value of the EMG signal of the subject was presented as a percentage of the maximum voluntary isometric contraction (% MVC).

A nonparametric paired sample test was used in this study to determine differences in muscle activities in the lower extremities with respect to the two different arm postures. The significance level α was set to 0.05 to test the significance level statistically, and SPSS Version 12.0 for Windows was used to process the data statistically.

RESULTS

The study results showed that P2 had higher muscle activity in the HAs than P1 (p<0.05) (Table 1).

DISCUSSION

Horseback riding is an exercise that improves muscle control through improvements in muscle strength achieved by coordinating one’s body movements with those of the horse to maintain posture. Westerling5) reported that static muscle contraction increases when riding on a horse that is running slowly.

Kim et al.6) reported that balance, gait, and daily living activities were improved significantly after training with horseback riding exercises for six weeks in patients who had suffered stroke. Back and Kim7) conducted a study on horseback riding simulation training for eight weeks with stroke patients and reported improvements in balance capabilities as well as the thickness of abdominal muscles. Lee et al.8) reported that indoor horseback riding exercise significantly improved muscle activities in the rectus femoris and adductor longus in normal adults. Back et al.9) reported that indoor horseback riding simulation exercise significantly improved muscle activity in the rectus femoris and adductor longus in normal adults. In the study, performance by 40 normal adults using a horseback riding simulator increased muscle activity in the biceps brachii, transverse abdominis, abdominal oblique, and adductor longus muscles compared with jogging.

Horseback riding is an exercise that improves muscle control through improvements in muscle strength achieved by coordinating one’s body movements with those of the horse to maintain posture. Westerling5) reported that static muscle contraction increases when riding on a horse that is running slowly.

Kim et al.6) reported that balance, gait, and daily living activities were improved significantly after training with horseback riding exercises for six weeks in patients who had suffered stroke. Back and Kim7) conducted a study on horseback riding simulation training for eight weeks with stroke patients and reported improvements in balance capabilities as well as the thickness of abdominal muscles. Lee et al.8) reported that indoor horseback riding exercise significantly improved muscle activities in the rectus femoris and adductor longus in normal adults. Back et al.9) reported that indoor horseback riding simulation exercise significantly improved muscle activity in the biceps brachii, transverse abdominis, abdominal oblique, and adductor longus muscles compared with jogging.

The current study showed that P2 resulted in higher muscle activity in the HAs than P1. The above result is consistent with a study by Winter et al.10) in which difficulty due to changes in posture could disturb or stimulate the vestibular system, disturbance due to changes in posture could affect postural agitation, and increased postural agitation contributed to postural control through neuromuscular control of the appropriate legs. Furthermore, Amiridis et al.11) measured changes in muscle action potential according to postural change in 20 subjects in a youth group and 19 subjects in an elderly group; both groups showed increased postural sway due to the effect of narrowing the base of support. Le Bozec et al.12) reported that the postural control mechanism in the trunk is activated prior to (or simultaneously with) movements of limbs and that this mechanism plays a role in stabilizing the trunk against an unstable force, thereby providing the stability needed for connections between postural body segments in the presents study, the posture in which the arms were crossed and both hands were placed and putting both hands on the shoulders activated the hip adductor muscles in the lower extremities to compensate for the unstable postural changes of the trunk when a continuous three-dimensional movement pattern was applied during horseback riding exercises.

The limitations of this study include the fact that the results cannot be generalized to all ages because the study utilized a small number of subjects who were all 19 years of age; furthermore, study results may vary depending on particular physical traits or personal daily habits and activities.

REFERENCES

1. Bertoti DB: Effect of therapeutic horseback riding on posture in children with cerebral palsy. Phys Ther, 1988, 68: 1505–1512. [Medline] [CrossRef]
2. Back JH, Sung BJ, Lee BW: The analysis of electromyogram in horse riding simulator. J Sport Leisure Studies, 2005, 23: 341–352.
3. Cho SH, Oh BH, Hwang BG: The effects of hippotherapy on the activities of trunk muscles in preterm born children with spastic cerebral palsy, institute of special education & rehabilitation Science. Daegu Univ, 2012, 51: 349–364.
4. Janura M, Peham C, Dvorakova T, et al.: An assessment of the pressure distribution exerted by a rider on the back of a horse during hippotherapy. Hum Mov Sci, 2009, 28: 387–393. [Medline] [CrossRef]
5. Westerling D: A study of physical demands in riding. Eur J Appl Physiol Occup Physiol, 1983, 50: 373–382. [Medline] [CrossRef]
6. Kim YN, Lee DK: Effects of horse-riding exercise on balance, gait, and activities of daily living in stroke patients. J Phys Ther Sci, 2015, 27: 607–609. [Medline] [CrossRef]
7. Baek IH, Kim BJ: The effects of horse riding simulation training on stroke patients’ balance ability and abdominal muscle thickness changes. J Phys Ther Sci, 2014, 26: 1293–1296. [Medline] [CrossRef]
8. Lee S, Lee DK: Park J: Effects of the indoor horseback riding exercise on electromyographic activity and balance in one-leg standing. J Phys Ther Sci, 2014, 26: 1445–1447. [Medline] [CrossRef]
9. Winter DA, Prince F, Frank JS, et al.: Unified theory regarding A/P and M/L balance in quiet stance. J Neurophysiol, 1996, 75: 2334–2343. [Medline] [CrossRef]
10. Amiridis IG, Hatzitaki V, Arabatzi F: Age-induced modifications of static postural control in humans. Neurosci Lett, 2003, 350: 137–140. [Medline] [CrossRef]
11. Le Bozec S, Lesne J, Bouisset S: A sequence of postural muscle excitations precedes and accompanies isometric ramp efforts performed while sitting in human subjects. Neurosci Lett, 2001, 303: 72–76. [Medline] [CrossRef]

Table 1. Comparison of muscle activities of the RF, BF, and HAs in the lower extremities according to changes in arm posture (unit: %)

| Muscle | P1   | P2   |
|--------|------|------|
| RF     | 13.0± 10.7 | 15.7± 10.7 **|
| BF     | 13.6± 17.5 | 14.6± 9.2   |
| HAs    | 30.0± 18.0 | 37.4± 19.2 **|

RF: rectus femoris; BF: biceps femoris; HA: hip adductors; P1: posture 1; P2: posture 2.
*p<0.05, **p<0.01
Statistical analysis was performed with a nonparametric paired samples test.