Effects of horseback riding exercise therapy on background electroencephalograms of elderly people

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Abstract. [Purpose] This study investigated the effect of horseback riding exercise on the background electroencephalograms of elderly people who performed horseback riding for 8 weeks. [Subjects] Twenty elderly people were divided into the horseback riding exercise and control group (n = 10 each). [Methods] The exercise was performed for 15 minutes, 3 times per week for 8 weeks. Electroencephalograms were analyzed. Post-exercise evaluation was performed after 8 weeks. [Results] After the horseback riding exercise, the relative slower alpha power index was active in the T3 and P4 domains but suppressed in the Fp1, Fp2, F3, F4, T4, and P3 domains. Moreover, the relative faster alpha power index was active in all domains of the horseback riding exercise group but was suppressed in all domains of the control group. There was a significant difference between groups in the F3 domain. [Conclusion] The alpha power index increased significantly after horseback riding exercise, suggesting the exercise improved background electroencephalogram.

Key words: Exercise therapy, Electroencephalogram, Horseback riding

INTRODUCTION

Regular exercise is an important factor for overall health promotion. Physical activities can preserve brain function and improve blood flow and oxygen transfer as well as slow the loss of hippocampal formation tissue in the aging brain.

Because of its unique three-dimensional movement, horseback riding has been applied as a physical therapy to stimulate movement to maintain balance. One of its effects is to transfer movement to the pelvis, producing an effect very similar to pelvic tiling. In addition, horseback riding exercises parts of the body that are not used by other frequently performed exercises, including agonistic muscles, which are deep muscles that contract and relax to maintain balance.

Psychological research on horseback riding exercise indicates it decreases depression in teenagers with emotional disorders as well as improves teenagers' self-esteem and self-control.

However, there is little information about horseback riding exercise as a physical therapy and even less information about whether such exercise is effective for elderly people or indeed how it may affect them. Therefore, this study investigated the effects of horseback riding exercise on the background electroencephalogram (EEG) of elderly people who performed horseback riding for 8 weeks.

SUBJECTS AND METHODS

This study involved 20 elderly people in U city. Elderly people are aged 65 or over 65. All participants or their guardians provided informed consent prior to participation. Before the start of the study, the purpose and methods were explained in detail to the participants. The participants were divided into 2 groups: a horseback riding exercise group and a control group (n = 10 each). The horseback riding training was performed before the main horseback riding interven-
Riding was performed for 15 minutes, 3 times per week for 8 weeks. The post-exercise tests were performed over a period of 8 weeks in the same manner as pre-study tests. The control group didn’t do any exercise.

We investigated the background EEGs, specifically the relative alpha power index, in both groups. For the exercise, we used Jeju horses from the Ireland rehabilitation center-affiliated horse riding course; these horses are normally used to provide riding experiences to visitors and are therefore healthy, accustomed to their surrounding environment, well trained, tame, and have stable strides. All participants wore protective gear including safety helmets, vests, and boots. At the beginning of the tests, the participants were led to perform warm-up exercises. The warm-up exercises were performed at a walking speed, which was the slowest speed (110 m/min). For this study, the slowest walking speed was maintained for the participants’ safety and comfort. In the exercise, an instructor led a horse by the bridle while another assistant supported a participant by holding him or her by the leg prevent them from falling from the horse and provide assistance as needed. Quantitative electroencephalography can be used to diagnose neurological changes in the brain; it constitutes an electric signal due to an active change in the brain that can capture the electrical flow between neurons through electrodes attached to the surface of the head. We collected the EEG data using a computerized polygraph (PolyG-I, Laxtha Inc., Korea) and TeleScan, which is a real-time analysis program. The EEG electrodes were attached to the surface of the head as they were seated in a comfortable reclining chair. To reliably capture data, the same researcher attached the electrodes and operated the testing instruments. Body and head movements were controlled as much as possible, and the participant kept their eyes closed for 3 minutes while resting in order to minimize the interruption of waves caused by eye movement. The participant was required to stop chewing and talking during EEG measurements. The EEG signals were analyzed for 60–120 seconds, excluding the first and last 60 seconds when the test might have been influenced by external environments.

The background EEG data were analyzed on the basis of the International 10–20 Electrode System. The saved data were transformed into frequencies using a fast Fourier transform, which expresses the quantitative relationship between EEG frequencies and their intensity. Power spectrum analysis was subsequently applied, and the band-to-band power was calculated. The relative alpha power (8–13 Hz/4–50 Hz), which emerges in a state of relaxation and rest, was subdivided into the relative slow alpha power (8–11 Hz/4–50 Hz) and the relative fast alpha power (11–13 Hz/4–50 Hz) and analyzed.

There were no significant differences in the general characteristics of the control and horseback riding groups (p > 0.05) (Table 1).

| Category          | Horseback riding (n=10) | Control (n=10) |
|-------------------|-------------------------|----------------|
| Age (years)       | 69.5 ± 3.2              | 69.7 ± 3.5     |
| Height (cm)       | 157.6 ± 8.7             | 158.5 ± 6.8    |
| Weight (kg)       | 58.8 ± 7.9              | 59.2 ± 6.7     |
| BMI (kg/m²)       | 23.6 ± 2.3              | 23.6 ± 2.6     |

Data are mean ± SD. BMI: body mass index

After the horseback riding program, the relative slower alpha power was analyzed; it appeared to be active in the T3 and P4 domains but was suppressed in the Fp1, Fp2, F3, F4, T4, and P3 domains (Table 2). Moreover, after the horseback riding program, the relative faster alpha power appeared to be active in all domains of the horseback riding exercise group but suppressed in all domains of the control group (Table 3). There was a significant difference between the horseback riding exercise and control groups with respect to the F3 domain (p < 0.05) (Table 4).

### RESULTS

During acute graded maximal exercise, the alpha wave power is reportedly decreased in the frontal and temporal lobes. Alpha wave power is an index of stable emotional status or mental health; in this regard, alpha wave power appears to be more closely associated with mental stress than exercise intensity, which is physically recognized. The present study evaluated the changes in background EEG, specifically alpha wave power, which indicates stability and relaxation.

### DISCUSSION
The relative slow alpha power was analyzed before and after the horseback riding exercise program; the results show it increased equally in all brain wave domains in the control group. In the horseback riding exercise group, the relative slow alpha power was active in the T3 and P4 domains but suppressed in the Fp1, Fp2, F3, F4, T3, and P3 domains. After the horseback riding exercise program, the relative fast alpha power was increased in all domains of the horseback riding exercise group. However, it was suppressed in all domains of the control group. The F3 domain differed significantly between the horseback riding exercise and control groups. Horseback riding exercise is considered to enhance concentration and comfort by activating the brain waves in all domains. The relative alpha power by the motor learning process is reported to increase in the Fz, Cz, and T4 domains during learning through exercise imagination but is decreased in those observing and performing behaviors(12, 13). After the learning process, the exercise imagination but is decreased in those observing and performing behaviors(12, 13). After the learning process, the exercise imagination but is decreased in those observing and performing behaviors(12, 13).

In the present study, there were small differences in the attachment points of the 8 brain wave channels, background EEG, and evoked EEG. However, the results corroborate the notion that learning through exercises helps increase the relative alpha power. The main limitation of this study is its lack of generalizability owing to the relatively small sample as well as the fact that the daily life habits aside from the horseback riding exercise program were known only through personal interviews. Therefore, individual life habits may have affected the results. Accordingly, further studies with more subjects and better evaluation methods are required to confirm the results. Moreover, further studies should investigate the psychological, cognitive, and physical changes as a result of horseback riding. Finally, comparative studies involving different age groups and patients suffering from differing diseases and conditions should be performed.

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