J. Phys. Ther. Sci. 28: 1816–1818, 2016

The Journal of Physical Therapy Science

Original Article

The effects of eye movement training on gait function in patients with stroke

Kwon-Young Kang, PhD, PT[1)], Kyung-Hoon Yu, MSc, PT[2)*]

[1)] *Department of Physical Therapy, Wonkwang Health Science University, Republic of Korea*
[2)] *Department of Physical Therapy, Division of Health Science, Baekseok University: 330-704 Munam-ro, Dongnam-gu, Cheonan-si, Chungcheongnam-do, Republic of Korea*

Abstract. [Purpose] The present study examined the effects of eye movement training on gait function in patients with stroke. [Subjects and Methods] Fourteen patients with stroke were randomly assigned to either an experimental group or a control group. The experimental group underwent eye movement training while the control group underwent general gait training five times per week for six weeks. [Results] Patient walking speed, cadence, and step length were measured by ink-footprint. The experimental group exhibited significant changes in walking speed, cadence, and step length following training, while the control group exhibited no differences. [Conclusion] Findings indicate that eye movement training should be considered as part of a functional gait training program for patients with stroke.
Key words: Eye movement, Gait function, Stroke

(This article was submitted Jan. 19, 2016, and was accepted Mar. 12, 2016)

INTRODUCTION

Following a stroke, many patients have problems with asymmetric posture and abnormal balance, which can lead to difficulty with standing and gait[1)]. Diverse brain regions, such as the cerebral cortex, cerebellum, and brain stem are involved in gait. For nerve cells in individual brain regions to be rhythmically activated in order to achieve balance during normal gait, three functional factors are necessary: the supporting action of the musculoskeletal system, the coordination of functional eye movement, and the integration of sensory function with action[2)]. As such, eye movement training, in which movement patterns are adjusted through visual feedback, has been studied recently. Visual field and visual accuracy affect balance and movement ability, and in particular, patients with problems in the visual system often develop problems with balance ability[3)]. Eye movement training, intended to improve balance and visual ability, is based on neuroplasticity, which is the foundation of the rehabilitation of patients with central nervous system diseases. The neurologic basis for eye movement training can be found in the role of the vestibulo-ocular reflex (VOR). The VOR is one of the reflexes induced by the vestibular system. The VOR is involved in the maintenance of balance and plays an important role in sensing body position in space as well as equilibrium[4)]. In one study, when used as part of a fall prevention program, eye movement training improved agility and dynamic balance control in older people by impacting vision and proprioceptive sensory information that affects balance control[5)]. However, most eye movement studies have been focused on balance, and studies relating eye movement training to gait have been insufficient.

SUBJECTS AND METHODS

Fourteen stroke patients in OO Hospital, located in Yong-in City, were divided into an experimental group of seven patients and a control group of seven patients. These patients were selected from among those who understood the purpose

Corresponding author. Kyung-Hoon Yu (E-mail: yukh@bu.ac.kr)

of the present study and signed a written agreement to participate in the study in accordance with the ethical principles of the Declaration of Helsinki.

The selection criteria were as follows: patients who had a stroke at least six months prior, patients who had no visual field defects or vestibular system abnormality, patients who had no orthopedic problems, patients who could walk without caretaker assistance, and patients who had no problem with their state of consciousness. Both the experimental group and the control group consisted of three males and four females. The mean ages, heights, and weights of the experimental group and the control group were 63.37 ± 3.78 years and 62.25 ± 5.67 years, 163.87 ± 5.27 cm and 164.0 ± 7.23 cm, and 67.5 ± 2.92 kg and 66.75 ± 2.85 kg, respectively.

Ink foot prints were used to assess gait parameters. Patients were instructed to step on an inkpad and were asked to walk on the paper roll. A paper of 8 m length was divided into a 5 m walkway, with 1.5 m area left at each end to start and finish lines. The footprints from the sole of the feet were produced on the paper as the patients walked from one end of the walkway to the other.

The content of the eye movement program was as follows: First, a picture card was shown to the patient, and then mixed with 20 other cards and spread face up on the desk. The patient was instructed to find that one card. This task was repeated approximately 20 times. Second, the therapist moved a baton slowly while drawing curves and the patient was instructed to keep his or her gaze fixed on the tip of the baton. In this task, the distance between the baton and the patient was maintained at approximately 1 m and the task was performed for approximately five minutes. Third, the patient was instructed to shake his or her head laterally as quickly as possible and a letter card with letters written upside down was presented to the patient to read. This task was repeated approximately 10 times. Fourth, the therapist moved a baton slowly from a point approximately 5 cm away from the patient to a point approximately 50 cm away and the patient was instructed to keep his or her eyes on the baton. This task was performed for approximately five minutes. The experimental group underwent eye movement training while the control group underwent gait training for 20 minutes per session, five times per week for six months in total.

The data were statistically processed using SPSS software (Ver. 12.0) and t-tests were conducted to examine the degree of improvement in gait function for the experimental group and the control group.

RESULTS

After the intervention, the experimental group showed a statistically significant increase in Walking speed (m/s) from 0.39 ± 1.52 to 0.87 ± 1.08 ($p<0.05$), but the control group showed no significant difference, 0.47 ± 1.10 and 0.66 ± 2.01 ($p>0.05$). The experimental group showed a statistically significant improvement in the Cadence (steps/min) from 75.58 ± 0.90 to 81.65 ± 5.95 ($p<0.05$), but the control group showed no significant improvement, 78.36 ± 2.04 and 81.06 ± 2.10 ($p>0.05$). The experimental group showed a statistically significant increase in step length (m) from 0.53 ± 0.01 to 0.56 ± 0.11 ($p<0.05$), but the control group showed no significant improvement, 0.52 ± 0.04 and 0.53 ± 0.10 ($p>0.05$).

DISCUSSION

A prior study on weight distribution and gait in patients with stroke reported on the effects of visual feedback[6)]. Likewise, a study that added action observation training for patients with stroke using visual information reported that the training brought about improvements in weight bearing, stability, and gait function[7)]. In the present study, eye movement training brought about changes in walking speed over time, resulting in significant differences following training. Another study reported that after visual feedback training in patients with stroke, step length increased, along with walking speed and step length[8)]. In the present study as well, eye movement training brought about significant increases in walking speed, cadence, and step length. One study aimed at determining factors that affect gait in community-based patients with stroke investigated balance, deterioration of cardiopulmonary function, and walking speed, and reported that a diminished sense of balance led to deterioration of gait function[9)]. In addition, exercise programs using visual feedback in patients with stroke have reported improvements in walking speed, muscle strength, and balance ability, supporting the importance of visual training[10, 11)]. The application of eye movement training in patients with stroke who have difficulty with gait and balance is thought to induce positive changes in gait function because the direct stimulation of the visual and vestibular systems improves balance ability. The study subjects were greatly interested in the therapy program and participated at a high level, which seemed to improve their balance ability[12)]. Eye movement training is considered to be easy to complete for most patients, even at home. If further studies on eye movement focused on increasing the length of the intervention period, various spatiotemporal variables (stride, step, stride length and step width), kinetic parameters(joint moment and power) and the larger numbers of subjects, eye movement training could be generalized into a new exercise program for patients with stroke and additional effects could be examined.

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