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The Effects of Therapeutic Horseback Riding on Equilibrium for Children with Disabilities

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ABSTRACT

This study was performed on 26 disabled adolescent participants (16 male, 10 female) with the objective of testing changes in equilibrium after engagement in horseback riding. Participants of total 26 persons were divided into three groups as follows: 6 children with Cerebral Palsy (CP), 14 children with Intellectual Disability (ID) and 6 children with Autism (AT). Participants engaged in therapeutic horseback riding (TR) two times per week for 30 minutes per session. The 26 participants demonstrated a considerable increase in equilibrium ability, with an average increase in equilibrium time of 44.22 ± 50.70 sec after TR. Equilibrium also increased according to disability group: CP ($P < 0.05$), ID ($P < 0.001$), and AT ($P < 0.05$). TR should be considered as a possible method for improving functionality in the physically disabled. This data may also be usefully applied to the development of a horseback riding program for the improvement of equilibrium in the disabled.
(**Key words :** Cerebral palsy, Mental retardation, Intellectual disability, Therapeutic riding)

INTRODUCTION

Equilibrium is the ability to prevent rocking or other such instable movement in both stationary and moving positions (Nichols et al. 1996), and is a basic and necessary component to achieving proper bodily movement (Cratty, 1974; Burton and Davis, 1992; Casselbrant et al. 2000). The body achieves equilibrium by combining information from the somatosensory, optical, and vestibular systems (Whitney et al. 2006), and if any one of these systems is impaired in any way, the body loses its ability to maintain equilibrium (Nashner, 1989), and problems may arise with locomotion and other activities of daily living. Disabled children or adults' locomotive abilities are particularly impaired by such problems, thus making an exercise program to improve equilibrium especially vital in such cases. Various forms of physical therapy have been developed to help improve disabled persons' functionality and independence in their everyday living, including occupational therapy, exercise therapy, and language therapy.

Hippotherapy and TR are two such forms of physical therapy which are currently undergoing thorough investigation (Heiperz, 1981 Freeman, 1984; Sterba, 2002; Winchester et al, 2002; Cherng et al., 2004; Silkwood-Sherer, 2007; Davis et al, 2009).

The horse's gait is similar to that of humans, thus, a person who is riding a horse achieves a similar movement in their hips as if he or she were really walking (Fleck, 1992). As the neural mechanics of the horse's movement are similar to that of a human, normal neural locomotive reactions can be induced in a rider who is unable to walk, simply through the act of riding. The horse's rhythmic movements cause movement in the rider's center of gravity, creating a mutual state of physical stability between the rider and the horse (Freeman, 1984; Heiperz, 1981). Thus, horseback riding provides therapeutic results for mentally and physically disabled persons.

Sterba et al. (2002) reported an improvement in gross motor function in 17 children with cerebral palsy after 18 weeks of horseback riding, and Chereng et al. (2004) also reported improved gross motor function after 16 weeks of horseback riding. Until now, most research has used the Gross Motor Function Measure (GMFM) to evaluate the effects of horseback riding in disabled children (Winchester et al, 2002; Sterba, 2002; Cherng et al., 2004; Davis et al, 2009; Kwon et al., 2012). Silkwood-Sherer (2007) reported

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an improvement in equilibrium in multiple sclerosis patients after 14 weeks of hippotherapy using the Berg Equilibrium Scale, and Han et al. (2004) also reported improvements in equilibrium in children with cerebral palsy after 3 months of horseback riding. Kang et al. (2012) also reported improvement in equilibrium in mentally handicapped children after 8 weeks of horseback riding.

Physical equilibrium is vital to a disabled child's ability to live a normal, independent life and continuous therapy is required to improve equilibrium. Horseback riding is a complete-body exercise and thus can provide relief for chronic exercise deficiency and improve equilibrium in the disabled through nerve stimulation (Bertoti, 1988). However, the majority of prior research on the disabled has relied on the GMFM for its measurements, and research focused on the measurement of equilibrium remains lacking. Thus, the goal of the present study is to measure changes in equilibrium in disabled children after 5 months of horseback riding and provide data for the development of a therapeutic horseback riding program for the disabled.

MATERIALS AND METHODS

1. Participants

The participants consisted of 26 children (16 males and 10 females; age 9.8 ± 2.2 yr, height 113.1 ± 10.7, weight 23.8 ± 5.7) with disabilities. The participants were divided into three groups as follows: 6 children (2 males and 4 females) with CP (age 9.0 ± 1.5 yr, height 108.1 ± 3.7 cm, weight 19.7 ± 2.7 kg), 14 children (11 males and 3 females) with ID (age 10.0 ± 2.2 yr, height 115.7 ± 11.8 cm, weight 24.4 ± 5.0 kg) and 6 children (3 males and 3 females) with AT (age 10.2 ± 2.1 yr, height 112.0 ± 12.0 cm, weight 26.7 ± 7.9 kg).

Three of the children with CP have hemiplegia (1 male and 2 female) and three have paraplegia (1 male and 2 female). Participants were recruited through the local community center and participants with epilepsy or convulsions were excluded from the study.

2. Therapeutic riding

This study protocol was approved by the Ethics Committee for Human Research (Approval NO. 2012-14) and animal care and use committee (Approval No. 2012-0007) of Jeju National University, South Korea. Permission was granted from all participants' parents and horseback riding was performed twice per week, 30 minutes per session, for 5 months.

After mounting the horse, the participants performed 5 min of warm-up exercises to stretch (arm circles-forward, backward, left and right, raise body hands above head, two points up etc.) on the horse. Then, the participants were instructed to perform for 20 min the following horse riding skills: starting and stopping, control rein, use of proper riding aids (hand, legs, seat etc.), walk and trot. Finally, they conducted warm-down for 5 min.

The horses used for this study were clinically healthy Jeju crossbred riding horses and Shetland pony (2 females, 11.5 ± 0.7 yr of age, weight 252.0 ± 5.7 kg, withers height 136.0 ± 2.8 cm).

3. Measurements

Equilibrium measurements are generally divided into two categories, those of static equilibrium and those of dynamic equilibrium. Static equilibrium is a measure of how long one can maintain equilibrium in anon-moving position, and can be assessed through the act of closing one's eyes and trying to maintain equilibrium while raising one's foot. Dynamic equilibrium is a measure of how well one maintains equilibrium in a condition of movement, and can be measured by closing one's eyes and walking in a straight line, or by walking on an equilibrium beam. The current study used the DynaDisc® Equilibrium Cushion to measure static equilibrium.

The DynaDisc® Balance Cushion provides many of the same core exercises on a ball, but reduces the risk of falling. Add an Exertools DynaBoard Balance Board to create a full range of rocker and wobble exercises. Therefore, DynaDisc® Balance Cushion (14 inches in diameter) was used as a tool for measurements on the participants.

Participants were asked to stand on the circular footstool of the DynaDisc® Equilibrium Cushion and time until the subject's foot left the surface was recorded. Three data was used for the analysis. Initial measurements were taken before the start of the horseback riding program, and follow-up measurements were taken 5 months later, after participation in the program.

4. Statistical analysis

Table 1. Characteristics of CP, AT and ID

Diagnosis	Participants	Age	Weight (kg)	Height (cm)
CP	N = 6 (M=2, F=4)	9.0 ± 1.5	19.7 ± 2.7	108.1 ± 3.7
AT	N = 14 (M=11, F=3)	10.0 ± 2.2	24.4 ± 5.0	115.7 ± 11.8
ID	N = 6 (M=3, F=3)	10.2 ± 2.1	26.7 ± 7.9	112.0 ± 12.0
Total	N = 26 (M=16, F=10)	9.8 ± 2.2	23.8 ± 5.7	113.1 ± 10.7

CP, Cerebral Palsy; AT, Intellectual Disability; C, Autism.

Data was analyzed using the SPSS version 12.0 statistical program and presented as mean ± standard error. The significant differences in therapeutic horseback riding before and after were separated by the Wilcoxon signed-rank test, and P < 0.05 was considered significant. The data between groups were compared using the Kruskal Wallis test.

RESULTS

The current study examined changes in equilibrium in 26 disabled children after taking part in a 5-month horseback riding program. The results are shown in Table 2. The 26 participants showed a marked increase in equilibrium after the 5-month program, with an average equilibrium time of 58.62 ± 53.80 sec, versus 14.40 ± 12.00 sec before the program: an increase of 44.22 ± 50.70 sec (P < 0.001). By group, the change in equilibrium time for CP participants was from 6.13 ± 3.73 sec initially to 61.94 ± 81.51 sec post, an increase of 55.80 ± 82.36 sec (P < 0.05).

The ID group showed a change from 13.56 ± 10.05 sec initial to 42.07 ± 31.15 sec post, an increase of 28.51 ± 31.14 sec (P < 0.001). The AT group showed a change from 24.62 ± 15.29 sec initial to 93.93 ± 55.07 sec post, for an average increase of 69.30 ± 44.08 sec (P < 0.05).

A comparison of the results for males and females by group is shown in Fig. 1. Over the 5-month period, males (n = 16) showed an average increase in equilibrium time of 56.29 ± 50.00 sec, and females (n = 10) showed an average increase in equilibrium time of 24.92 ± 15.10 sec. The male group thus displayed a significant increase in equilibrium time than females.

By group, males in the CP group showed an average increase in equilibrium time of 111.12 ± 151.49 sec while females of the CP group showed an average increase in equilibrium time of 28.15 ± 24.42 sec.

In the ID group, the equilibrium time showed an average

Table 2. Effects of therapeutic horseback riding on equilibrium of children with disabilities

Type	Before	After	Differ	P-Value
	M±SD	M±SD		
Cerebral Palsy (n=6)	6.13±3.73	61.94±81.51	55.80±82.36	0.028
Intellectual Disability (n=14)	13.56±10.05	42.07±31.15	28.51±31.14	0.001
Autism (n=6)	24.62±15.29	93.93±55.07	69.30±44.08	0.028
Total (n=26)	14.40±12.00	58.62±53.80	44.22±50.70	0.000

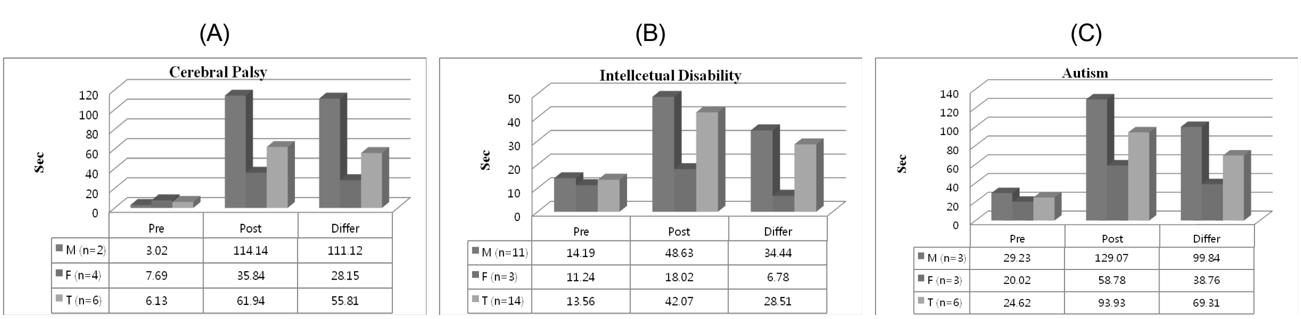

Fig. 1. Changes of equilibrium of children with disabilities after therapeutic horseback riding. A, Cerebral Palsy; B, Intellectual Disability; C, Autism.

increase in males group (34.44 ± 32.84 sec) and females group (6.78 ± 2.75 sec). Also, the variation of the equilibrium time measurements was observed in males (99.84 ± 37.44 sec) and females (38.76 ± 25.64 sec) in the AT groups. Males thus displayed a positive response to the therapy in all three groups.

DISCUSSION

Movement and locomotion are as vitally important in the disabled as they are in able-bodied persons, and as equilibrium is intrinsic to any movement, it can be considered the most important factor to physical movement. Horseback riding allows for physical simulation of normal locomotive hip movement in the rider, as well as stimulation of equilibrium and posture control (Fleck, 1992). Thus, this study aimed to measure changes in equilibrium ability in disabled children before and after engagement in a therapeutic horseback riding program. 26 disabled adolescent participants with cerebral palsy, intellectual disability, or autism were entered in a horseback riding program for 5 months, and their ability to equilibrium was measured before and after engagement in the program. The results of the study strongly suggest that horseback riding is an effective option for the treatment of equilibrium impairment in disabled children ($P < 0.001$). After 5 months of horseback riding training (twice per week; 30 minutes per session), the participants of each group, cerebral palsy (CP) ($P < 0.05$), intellectual disability (ID) ($P < 0.001$), and (AT) ($P < 0.05$), showed a notable increase in equilibrium ability. These results are attributed to the unique interaction between the rider and horse during exercise, including communication and signaling between the rider and horse, and the indirect gravitational effect and stimulus of the horse's movements (Fleck, 1992).

During horseback riding, the rider must continuously maintain equilibrium and control according to the horse's various movements. The horse's basic movements (static and dynamic movements, displacement of center of gravity, rotary motion) cause displacement of the rider's center of gravity and continuous coordination of muscle contraction, ultimately increasing posture stability and equilibrium ability (Freeman, 1984; Heperz, 1981).

The CP group in this study showed marked increase in equilibrium ability after engaging in horseback riding ($P < 0.05$). These results are attributed to the pelvic stimulation provided by the horse's movements and the effect of equilibrium maintenance which is continuously demanded of the rider during exercise. During riding, the rider's hip bone (ischium) becomes the axis for the rider's center of gravity, providing virtual alignment for the ears, shoulders, and heels (Belton, 2000). Maintaining equilibrium while riding requires careful control of muscles in the shoulders and lower back, requiring muscular and neural stimulation which is otherwise difficult to achieve in children with cerebral palsy. It is this unique process of stimulation that is seen as the cause of improved equilibrium in adolescent CP participants.

The AT group showed the greatest improvement in equilibrium ability, with an average increase in equilibrium time of 69.30 ± 44.08 sec after engaging in the horseback riding program. Such results again suggest that the physical process of learning horseback riding, and the reciprocal interaction between the horse's movements and rider, is a highly unique and stimulative activity. People with autism have particular difficulties with communication, sensory integration, and concentration, and the proprioceptive and vestibular disabilities which underlie such problems are also at the root of equilibrium impairments. Thus, the benefits which autistic participants may receive from TR participation include improvement in sensory ability, motor skills, and detection of external stimuli.

In a study of 34 children with autism, Bass et al. (2009) reported a significant increase in sensory integration and concentration after 12 weeks of therapeutic horseback riding. Bass and colleagues also emphasized the critical role of the cerebellum in motor and social domains, and suggested a connection between cerebellum functionality and TR engagement. In the present study, the role of the cerebellum was not examined; however, as in the study by Bass and colleagues, improvement in sensory function was observed.

In the case of ID patients, who also suffer from impaired sensory integration, this impairment can be improved through rehabilitative exercises which stimulate neural sensory processes. Persons with intellectual disability are said to have a lower propulsive force in the ankle plantar flexion muscles, which are necessary for accelerative movement (Ciono et al. 2001; Samela et al. 2001). The musculoskeletal system of the ankle is vital to maintenance of equilibrium of the center of gravity during bodily movements (Perry, 1992; Craik and Oatis, 1995).

In a study by Kwon et al. (2009), 5 adolescent ID participants, after 12 weeks of horseback riding, showed improvement in ankle musculoskeletal system functionality during locomotion, as well as improvement in stability and equilibrium. Similar results were also shown in the present study, supporting the hypothesis that TR contributes significantly to improved equilibrium in children with ID.

The participants in this study displayed focus and attention to the instructions of the TR instructor during training. TR programs in this study were conducted on all three groups simultaneously and at no time were participants grouped in their training program by their group designation (for example, 1 CP rider with 2 AT riders together); participants were grouped at random during exercise. This system was implemented for 5 months in order to provide a pleasant and enjoyable exercise environment.

In the present study, equilibrium in male participants improved compared to females. Though these results are based on a small pool of participants, they cannot be excluded. No previous studies have yet compared the relative effects on males versus females and further research is needed for the development of physical rehabilitation treatments for the disabled.

The chief limitations in this study were small sample size and lack of consideration of individual symptoms. This study did not customize the program according to disability type. Also, little information was gathered on individual exercise or training habits. Thus, there is some difficulty in concluding that the results were due entirely to TR. Despite such limitations, the study did demonstrate that TR is an effective method for the rehabilitation of functional impairments in the disabled.

The physical stimulation created through TR is unique compared to other methods of physical stimulation. The horse's unique movements and gait induces the rider not only with varying stimulation, but also requires the rider to continuously and unconsciously utilize sensory and muscular processes to maintain communication with the horse and stability of the center of gravity. Thus, TR can be considered as an effective treatment for sensory integration dysfunction. For improvement of equilibrium, various sports and exercises have been reported as effective treatments, including equilibrium board training (Oliver and Di Brezzo, 2009), tennis (Zappini et al., 2007), and skiing (Kim et al., 2010). However, such activities are designed for able bodied individuals and present many difficulties for the physically disabled. Horseback riding is unique among physical activities in requiring precise communication and exchange of feeling between the participant and another living creature. Such a requirement could be difficult for able bodied individuals, and all the more so for the disabled. Despite this, TR can be considered a highly useful method for improving functionality in the disabled. Future research is necessary to thoroughly investigate sensory function and environmental and genetic characteristics in the disabled, and their relationship to TR-related improvements in functionality. Furthermore, we suggest that the data from this study be used for the development of a TR program for the improvement of equilibrium in the disabled.

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